



The role of water pricing and water allocation in agriculture in delivering sustainable water use in Europe – FINAL REPORT - ANNEXES

European Commission

Project number 11589 | February 2012



Client	European Commission DG ENV – D1 Protection of Water DG ENV.SRD.2 (BU-5 00/122) B-1049 Brussels +32 2 296 91 05
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The role of water pricing and water allocation in agriculture in delivering sustainable water use in Europe

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Revision		
Version	Date	Remarks
1	20 December 2011	Final report
2	February 2012	Final report adapted for comments
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Annex 1: (Non-exhaustive) overview of Water Allocation Policies in the EU

Member State	Source of water	Are water use rights (in agriculture) defined through a public allocation system of licenses, permits or authorisations?	Information or details on the allocation process (rationale and implementation: considering e.g. environmental impacts of water abstractions, economic efficiency, value of water, ...)	Additional information (definition of water rights, threshold values for licenses, ...)	Water use right: duration, (max) quantity, definition of hands-off flows, ...	Ranking / priority of water rights and/or motivation for ranking (in case of water shortages, ...)	Permits issued at LOCAL level	Permits issued at REGIONAL level	Permits issued at RB DISTRICT level	Permits issued at NATIONAL level	Additional information regarding the competent public authority
Austria	Surface water	Yes							X		
	Groundwater	Yes		Water rights usually exclusively with landholders					X		
Belgium - Flanders	Surface water	<ul style="list-style-type: none"> Navigable rivers: Yes Un-navigable rivers: usually not 		<ul style="list-style-type: none"> Navigable rivers: for abstracted volumes > 500m³, else notification. Un-navigable: (equal) use right for riparian owners, non-riparian owners sometimes need permit, 	<p>Navigable rivers: yearly renewal of notifications (licenses are annually renewed by payment of surface water abstraction tax)</p> <p>Water use rights of riparian owners are not allowed to restrict or damage water use of downstream riparian owners.</p>			X			<ul style="list-style-type: none"> Navigable rivers: Licenses issued by the specific river or water authority. Un-navigable rivers: Court decisions ("Vrederechter") can limit water use rights of riparian owners in case of water shortages
	Groundwater	Yes	Environment Agency is consulted on the permit request.	licenses for abstracted volumes > 500m ³ , else notification.			X	X			province and local councils
Belgium – Walloon region	Surface water	No									
	Groundwater	Yes		Additional environmental permit is needed for abstracted volumes > 3000m ³ ,				x			Walloon Ministry of Environment

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Belgium – Brussels region	Surface water	No									
	Groundwater	Yes		licenses for abstracted volumes ≤ 96 m³/day, else notification				x			Brussels Ministry of Environment
Bulgaria	Surface water	Yes	<p>Upon the issuance of a permit, authorities take into consideration:</p> <ul style="list-style-type: none">the available water resources;the needs of the applicant for water use permit or water body use permit, as the case may be;the status of the water body;the acquired rights. <p>Upon authorisation of water use, applications shall be granted in the following order of precedence:</p> <ol style="list-style-type: none">domestic water use;therapy and preventive care - applicable solely to mineral waters;agricultural water use;other uses, including industrial water use, recreation activities, and hydraulic power engineering.	Water use permit required in all cases except for water abstraction below 10m³ per day.	Permit issued for maximum period of 35 years (irrigation). Other uses have shorter license periods (10 to 25 years). Water abstraction rights may be restricted (~ scarcity, status of the water body)				X	X	Basin Directorate Director, and in some cases Ministry of Environment
	Groundwater	Yes	See surface water	Water use permit required in all cases except for water	Permit issued for maximum period of 35 years (irrigation).	Water abstraction rights may be restricted					

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				abstraction below 10m ³ per day and pump capacity below 0.2 l/s.	Other uses have shorter license periods (10 to 25 years).	(~ scarcity, status of the water body)					
Cyprus	Surface water	Yes	<p>Government Water Works or Projects (GWP): annual water demand and allocation scenario prepared by Water Development Department. The rationing scenario is prepared with participation of different stakeholders. With the approval and put into force of the water allocation scenario, each farmer is issued a license/permit for the quantities of water from the GWP he/she is allowed to use, specified for each field under a certain crop in the coming irrigation period.</p> <p>Non-government schemes (Water users Associations / WUA): Formal water use rights on own sources of water. These encompass licenses to operate wells, or abstraction permits for surface waters (mostly streams, negligible due to declining rainfall / run-off and downstream impacts of large GWP).</p> <p>User based / traditional or customary (re-)allocation: small</p>		Annual quota in GWP under the rationing procedure. Supply can be disconnected in case of overconsumption. Some irrigation divisions have systems based on irrigation times.	Preference to domestic supply (including livestock).				X	National: Water Development Department

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			irrigation schemes (WUA), managed by committees chaired by the District Officer based on water availability.								
	Groundwater	Yes	Drilling and abstraction licenses; process under review at the moment. New wells (limited to existing permanent plantations if the aquifer is at risk or over-pumped – “poor status”) and reviews of applications for a change to an existing abstraction license							X	National: Water Development Department
Czech Republic	Surface water	Yes		Surface and groundwater rights are owned by the State			X	X			Regional and local government
	Groundwater	Yes		Surface and groundwater rights are owned by the State			X	X			Regional and local government
Denmark	Surface water	Yes	The administration of water abstraction permits is regulated by Water Resource Plan drawn up by regional state environmental centers.				X				Municipalities.
	Groundwater	Yes	The administration of water abstraction permits is regulated by Water Resource Plan drawn up by regional state environmental centers.	Abstraction of groundwater needs a permit, to be renewed at specific times. Irrigation permits are only for up to 15 years.	Groundwater permit needs to be renewed at specific times. Irrigation permits are for a period of 15 years		X				Municipalities
Estonia	Surface water	Yes		Abstractions > 30 m ³ per day.							
	Groundwater	Yes		Abstractions > 5 m ³ per day.							

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Finland	Surface water	Yes		Water is a common property (Water Act). Landowners have primary entitlement Territorial waters are generally jointly owned by landowners.				X			Regional authorities
	Groundwater	Yes		Water is a common property (Water Act). Landowners have primary entitlement Territorial waters are generally jointly owned by landowners.				X			Regional authorities
France	Surface water	Yes	The "Préfet de département" (representative of the French State in the "département" level) can take into account territorial specificities (e.g. areas subjected to a quantitative deficit or in polluted areas, etc.). When an authorisation is demanded, the decision to grant it or not is made after an investigation for assessing the potential impacts of the project and consulting the population concerned. Review of licensed volumes based on actual need and environmental capacity. Abstraction rules are more stringent in some areas qualified nationally as suffering of chronic water	The right to use water, in particular for irrigation, is established by the <i>Code Civil</i> (Code Napoléon) and is linked to the ownership of the land. But the <i>Code de l'Environnement</i> includes the principle that water belongs to the common heritage of the Nation (art L.210-1) and includes provisions from water laws of 1992 & 2006, attributing to the State the mission to manage abstraction activities with a river basin approach. Authorisations for activities abstracting more than certain	Annual authorisations, tendency to authorisations for more than 1 year Water abstraction authorisations include maximum volumes. Drought Flow standards below which water abstraction restrictions are triggered. Water abstraction authorisations / water right can be limited or revoked in situations of water shortage.	Authorisations can be temporarily or permanently revoked or reduced by the Prefects in case of water scarcity, as required to ensure adequate environmental protection and/or domestic water consumption.		X			Department level

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			<p>shortage (ZRE, Zones de Répartition des Eaux).</p> <p>According to the Water Law of 2006, starting in 2012 and if agreed at local level, an "<i>organisme unique pour la gestion des prélèvements d'irrigation</i>" can be set up: a multi-annual authorisation with a maximum amount of water is given by the Préfet de département to the <i>Organisme</i>, which shares the water between the irrigators. The authorisation should require that the objective for low flow is respected 8 years on 10.</p>	<p>thresholds. Most usual threshold for surface water is 5% of the low flow. The "<i>Préfet coordonnateur de Bassin</i>" (WFD authority at River Basin level, beyond the "département" level) can classify an area in "<i>Zone de Répartition des Eaux</i>" if considered in water stress. The threshold for abstraction is then lower.</p>							
	Groundwater	Yes		Most usual threshold for groundwater is 200,000 m ³ / year				X			Department level
Germany	Surface water	Yes		Water is a public good (public right).	Time limited						
	Groundwater	Yes	Beyond a legally fixed threshold, authorisation procedure includes an environmental impact assessment.	Water is a public good (public right).	Time limited						
Greece	Surface water	Yes		Anyone can extract water (with a license) but land owner has primary entitlement					X		
	Groundwater	Yes		Anyone can extract water (with a license) but land					X		

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				owner has primary entitlement							
Hungary	Surface water	Yes	License depending on available water resources, the importance of the water use and time of recharge (hydrologic and hydro-geologic assessments)	Licenses for all water abstractions, to build, modify or to abandon water infrastructure or to all type of water uses (capacity >500 m3/year).		Priority of uses defined in the Water Management Act (1195.LVII): public supply priority over all uses, animal farms and fish ponds third place and irrigation and (other) agricultural use fifth place.		X			Regional Inspectorate for environmental protection
	Groundwater	Yes	License depending on available water resources, the importance of the water use and time of recharge (hydrologic and hydro-geologic assessments).	Licenses for all water abstractions, to build, modify or to abandon water infrastructure or to all type of water uses (capacity >500 m3/year).				X			Regional Inspectorate for environmental protection
Ireland	Surface water	Yes		Public owned rights							
	Groundwater	Yes		Public owned rights							
Italy	Surface water	Yes	Collective irrigation E.g. Sardinia: at the beginning of each year, the regional government assigns water volumes for agricultural uses on the basis of the requirements of the Reclamation and Irrigation boards (<i>Consorti di bonifica e irrigazione</i> - RIB) and the availability in the reservoirs. RIBs	Water is a public good	Collective irrigation: annual water volumes Individual farmers: duration depends on the capacity.	Priorities in water use: (1) human consumption, (2) agricultural uses, (3) other uses.		X			Water rights are the competence of Regioni and the Provinces. Collective irrigation: Regional government Individual farmers: provinces for lower capacities and

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			may be given quota on water to be abstracted from natural sources (e.g. Sardinia: Within each RIB (allocation at lower spatial scale), individual farmers may be submitted to quota or abstraction turns. Individual farmers: capacity determines the issuing authority and time								regional government for higher capacities
	Groundwater	Yes		Water is a public good. Maximum quantities are 10 l/s	Individual farmers: maximum 40 years						Water rights are the competence of Regioni and the Provinces.
Latvia	Surface water	Yes		Certain threshold up to which the use is not a taxable activity (and thus does not require a permit). License market mechanism for natural resource extraction considered. This system is not introduced for practical reasons.	Permit authorises water users to utilise water, and lays down terms (body of provisions that regulates activity, rights, duties and liabilities of a water user), conditions, regulations and restrictions for water use.						
	Groundwater	Yes		Certain threshold up to which the use is not a taxable activity (and thus does not require a permit). License market mechanism for natural resource extraction considered. This	Permit authorises water users to utilise water, and lays down terms (body of provisions that regulates activity, rights, duties and liabilities of a water user), conditions, regulations and						

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				system is not introduced for practical reasons.	restrictions for water use.						
Lithuania	Surface water	Yes		Permit is necessary for abstractions above 100 m ³ per day							
	Groundwater	Yes		Permit is necessary for abstractions above 100 m ³ per day							
Luxembourg	Surface water	Yes		Water permit	The permit will lay down, in particular, the conditions according to which water extraction may be carried out and the control procedures with respect to the extraction.					X	National Ministry of Interior
	Groundwater	Yes		The extraction of ground water using a drilling/extraction well also requires a classified establishment operating permit, which no longer requires to apply for a separate water permit application.	The permit will lay down, in particular, the conditions according to which water extraction may be carried out and the control procedures with respect to the extraction.					X	National Ministry of Interior
Malta	Surface water				Civil code regulates collection of natural water resources flowing naturally on land					X	Malta Environment and Planning Authority
	Groundwater	Yes	Registration / notification of groundwater abstraction sources established through regulations. Regulations on borehole drilling	Registration / notification of groundwater source and/or the installation of meters to groundwater sources do not	Powers of the Malta Resources Authority are established through regulations and can:					X	Malta Resources Authority

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			<p>within saturated zones establish:</p> <ul style="list-style-type: none"> • Moratorium on drilling of new boreholes for groundwater abstractions • Permitting of boreholes for other purposes than abstraction (e.g. engineering works) • Permitting of drilling of sea-wells and abstraction under specific conditions 	automatically result in any vested rights to abstract groundwater.	<ul style="list-style-type: none"> • Close, seal and decommission any groundwater source • Limit the abstraction of groundwater from any source if needed (including e.g. periods of water shortages) 						
The Netherlands	Surface water	Yes		Individual farmers have historical rights to abstract water. When surface water is sufficiently available, smaller abstractions (< 10 m ³ per hour) are possible without notification for e.g. irrigation purposes. Abstractions between 10 and 50 m ³ per hour (middle range) need notification. Large capacity abstractions (over 50 m ³ per hour) always need a permit.	Authority can restrict water withdrawals in times of shortage	Provincial ranking of water supply for several land uses in times of shortage		X		X	State and the Water Boards
	Groundwater	Yes	Smaller groundwater abstractions (e.g. for agriculture) are regulated by the Water Boards (ordinance or <i>keur</i>). This regulation can imply a permit obligation or general rules for smaller abstractions of groundwater.	Individual farmers have historical rights to abstract water. For the Scheldt Basin, groundwater abstractions above 240 m ³ per day need a permit. It is of note that regional differences occur.	Authority can restrict water withdrawals in times of shortage	Provincial ranking of water supply for several land uses in times of shortage		X			Provinces in the past. Today, abstractions for agriculture managed by Water boards

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Poland	Surface water	Yes		Extraction of more than 5 m ³ /day determines the “special use of waters” and requires a water-law permit				X			sub-basin voivodships
	Groundwater	Yes		Extraction of more than 5 m ³ /day determines the “special use of waters” and requires a water-law permit				X			sub-basin voivodships
Portugal	Surface water	Yes		Portuguese Water Law combines public and private ownership of water resources. Extraction equipment power > 3.7 kW (5 hp): authorisation; < 3.7 kW (5 hp) notification	Defined time period Defined quantity	The priority of uses is defined in the law, being that the water abstraction for public supply has priority over all other uses.			X		River Basin districts (ARH)
	Groundwater	Yes		Portuguese Water Law combines public and private ownership of water resources. Extraction equipment power > 3.7 kW (5 hp): authorisation; < 3.7 kW (5 hp) notification	Defined time period Defined quantity	The priority of uses is defined in the law, being that the water abstraction for public supply has priority over all other uses.			X		River Basin districts (ARH)
Romania	Surface water	Yes	Based on a water balance, which takes into account total water supply in reservoirs with water permit requests from all water using sectors.	Water is a state public property. All abstractions require a permit. Permits may not be sold.	In an approval letter from the <i>Apele Romane</i> (i.e. <i>National Administration</i>) farmers are informed of potential restrictions on water	The domestic sector is the priority user.			x		National Administration (<i>Apele Romane</i>) and regional branches

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					abstraction in times of drought. Permits set the quantity allowed for the year.						
	Groundwater	Yes	Groundwater is only used for livestock farming and aquaculture within the agriculture sector.	Water is a state public property. Groundwater sources can't be used for irrigation purposes.	In an approval letter from the <i>Apele Romane</i> (i.e. <i>National Administration</i>) farmers are informed of potential restrictions on water abstraction in times of drought. Permits set the quantity allowed for the year.				x		National Administration (<i>Apele Romane</i>) and regional branches
Slovak Republic	Surface water										
	Groundwater										
Slovenia	Surface water										
	Groundwater										
Spain	Surface water	Yes	Surface water in Spain is predominantly public. Individual water users, municipalities or irrigator associations are granted water permits by the RBA (either regional or national governments). The requests are dealt with under application of the allocation priorities for water users.	Usually, water rights in agriculture are allocated to irrigation communities or farmers directly, and associated to land ownership. Minor water trading experiences exist under the umbrella of the Water Law, and controlled by RBA.. Licenses for all abstractions > 7000 m3/yr	Right to use a certain volume of water for a specific purpose, in a specific location, for a maximum renewable period of 75 years, and with possible restrictions e.g. during droughts.	The water legislation defines first urban water supply, second environment, and third agriculture			X		RBA, either based at the National or Regional governments.. The National government also intervenes in case of inter-basin transfers.
	Groundwater	Yes	Groundwater in Spain is mainly public, though private rights (from	Usually, groundwater usage permits in agriculture are	Right to use a certain volume of water for a specific	The water legislation defines first urban			X		RBA, either based at the National or

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			abstractions previous to 1985) still exist. Individual water users, municipalities or irrigator associations are granted water permits by the RBA (either regional or national governments). The requests are dealt with under application of the allocation priorities for water users.	allocated to farmers, and associated to land ownership, usually above the groundwater body. Minor water trading experiences exist under the umbrella of the Water Law, and controlled by RBA. Licenses for all abstractions > 7000 m3/yr	purpose, in a specific location, for a maximum renewable period of 75 years, and with possible restrictions e.g. during droughts.	water supply, second environment, and third agriculture, and with minor exceptions this scheme is applied in all basins.					Regional governments.
Sweden	Surface water	Yes	For any abstraction that is likely to cause environmental effect, obligatory permit.					(X)			5 Environmental courts are responsible for providing water use permits across river basins
	Groundwater	Yes	For any abstraction that is likely to cause environmental effect, obligatory permit.					(X)			5 Environmental courts are responsible for providing water use permits across river basins
United Kingdom	Surface water	Yes	To date, licenses have been granted on a first come-first serve basis. New CAMS (Catchment Abstraction Management Strategies – availability of water resources) licensing strategy: granting of a license depends on the amount of water available after the needs of	Water abstraction license needed for quantities above 20m³ per day. Water rights trading (right to abstract water / license trading) are encouraged (no additional abstractions)	License usually issued for 12 year period (aim is to move towards common-end dates). Conditions on licenses that require abstractions to stop or be reduced when a river flow or level falls below specified point (Hands of					X	Environment Agency (England and Wales)

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			the environment and existing abstractors are met and whether the justification for the abstraction is reasonable. Environment Agency protects rights of existing license holders and lawful water users in granting new licenses		Flows, HoF). This management regime decreases the reliability of abstraction licenses, as In drier years, license holder will be prevented from abstractions for longer periods.						
	Groundwater	Yes	To date, licenses have been granted on a first come-first serve basis. New CAMS (Catchment Abstraction Management Strategies – availability of water resources) licensing strategy: granting of a license depends on the amount of water available after the needs of the environment and existing abstractors are met and whether the justification for the abstraction is reasonable. Environment Agency protects rights of existing license holders and lawful water users in granting new licenses	Water abstraction license needed for quantities above 20m³ per day. Water rights trading (right to abstract water / license trading) are encouraged (no additional abstractions)	License usually issued for 12 year period (aim is to move towards common-end dates). Conditions on licenses that require abstractions to stop or be reduced when a river flow or level falls below specified point (Hands of Flows, HoF). This management regime decreases the reliability of abstraction licenses, as In drier years, license holder will be prevented from abstractions for longer periods.					X	Environment Agency (England and Wales)

Annex 2 : (Non-exhaustive) overview of Water Pricing Policies in the EU

EU Member State	Design of tariffs - for water provided	Design of tariffs - for self-supply		Importance of self-supply (including information on irrigation infrastructure or collective facilities / services)	Cost recovery (financial costs + Environmental and Resource costs - ERC)	Metering
		Surface water	Groundwater			
Austria	<ul style="list-style-type: none"> Mixed tariff system exists: fixed charge and volumetric charge Tariff systems vary however between regions. 				For water delivered: 100 % of operational and maintenance (O&M) costs and 100% of capital costs	
Belgium	<p>Flanders:</p> <p>Mixed tariff system: fixed charge (diameter of pipe) and (usually) volumetric (decreasing) block tariffs: Water suppliers use similar price structures but apply highly different levels and definition of the blocks.</p> <ul style="list-style-type: none"> Share of fixed charge is small (0.05% to 6% of total charge) and is lower for larger volumes Decreasing block tariffs for large volumes usually above 3000m³ Illustration of prices, varying with annual volume (prices 2008): from 0.87 – 2.62 € per m³ (1000 m³); from 0.87 – 1.61 €/m³ (10,000 m³); from 1.05 – 1.58 €/m³ (25,000 m³) <p>Brussels Region:</p> <p>Fixed administrative charge (varying per municipality) and flat volumetric tariff of 1.539 €/m³ (between 0-5000 m³) (2008)</p> <p>Walloon Region:</p> <p>Combined tariff for « Coût-Vérité Distribution » (CVD – for water provided) and « Coût-Vérité Assainissement » (CVA – for water sanitation) (2008):</p> <ul style="list-style-type: none"> Fixed charge for renting of water meter: (20 x CVD) + (30 x CVA) Degressive volumetric tariff (2008): <ul style="list-style-type: none"> – 30-5000 m³: CVD + CVA > 5000 m³: (0,9 x CVD) + CVA <p>CVD (2008): 1.43 – 1.94 €/m³ depending on water supply company</p>	<p>Flanders:</p> <p>Volumetric decreasing block tariffs: Surface water abstraction tax above 500 m³/year from navigable rivers (volumetric). In region "Kempen", farmers pay a fixed charge per year. Abstractions are free of charge if below 500 m³ or from un-navigable rivers</p> <ul style="list-style-type: none"> 0.063149 €/m³ for quantities below 1 Mm³ (lower unit rates for higher blocks). Kempen: minimum fee of 181.96 € <p>Brussels Region:</p> <p>no charges</p> <p>Walloon Region:</p> <p>No charges</p>	<p>Flanders:</p> <p>Volumetric charge: groundwater abstraction tax (payable to Environment Agency): volumetric charge above a threshold of 500 m³/year. Total price thus depends on the volume, but is also differentiated by the aquifer and a regional factor (the latter factor will annually rise from 2010 to 2017 to take into account the pressure on groundwater in the region):</p> <ul style="list-style-type: none"> 0.05 €/m³ (indexed annually) from 500 to 30,000m³ from phreatic groundwater sources Above 30,000m³ or from closed aquifers (0.062 €/m³ (increased with 0.75 x ratio abstracted volume/100,000) x regional factor <p>Brussels Region:</p> <p>no charges</p> <p>Walloon Region:</p> <p>groundwater abstraction tax > 3000 m³ (payable to Environment Agency) - increasing block tariff (2008):</p> <ul style="list-style-type: none"> 3,000-20,000 m³: 0.0248 €/m³ 20,000 – 100,000 m³: 0.0496 €/m³ > 100,000 m³: 0.0744€/m³ 	<p>Flanders:</p> <p>Most infrastructure is private.</p> <p>Recent developments of (sometimes government supported) projects to create surface water basins in view of the evolution to more restrictive groundwater permits.</p>	<p>Flanders:</p> <p>High level of (financial) supply cost recovery due to the predominating individual abstractions.</p> <p>Recovery of part of environmental and resource costs for groundwater: price is differentiated by the aquifer and a regional factor. Annual increase of this factor has been defined from 2010 to 2017 to take into account the pressure on groundwater in the region.</p> <p>Walloon Region:</p> <p>« Coût-Vérité Distribution » (CVD) integrates financial costs, costs for protection of resources (0.092 €/m³ in 2008) and costs for social fund (0.0125 €/m³ in 2008)</p>	<p>Flanders:</p> <p>Water metering obligation for licensed abstractions (>500m³) from navigable rivers. Every groundwater abstraction has metering obligation (also for irrigation purposes). Except below 500m³ for domestic use or hand pumps.</p> <p>Brussels Region:</p> <p>mandatory metering - the abstracted volumes of GW and SW need to be registered to ensure that the volume does not exceed the licensed volume.</p>
Bulgaria	<p>No uniform pricing system nationwide. The 1999 Water Act establishes fees for both the use of water and the use of public water facilities. The total price consists of an abstraction fee and a water supply charge. Each ISC (Irrigation System Companies, state-owned) and IWUA (Irrigation Water User Associations) uses a different method to calculate and set price (and structures):</p> <ul style="list-style-type: none"> Area based charge Volumetric charge <p>The water abstraction fee depends on the source of the water. Total irrigation water prices depend on the sourcing of irrigation (water) -</p>	<p>Water abstraction fee. The water abstraction fee depends on the source of the water.</p>		<p>Most irrigation water is supplied by the Irrigation System Companies (ISC - public) but the importance of collective irrigation (Irrigation Water User Associations, both using public or private infrastructure) on the rise after early 2000.</p> <p>Since 2001, use rights on irrigation assets have been freely transferred to water user associations (WAUs). The</p>	<p>Revenue from water charges (for water supplied) usually covers only part of the O&M costs and in some cases part of the capital costs. Subsidies to ISCs make up the difference between prices and costs. No information on calculation of recovery of environmental and resource costs identified.</p>	<p>Permit obliges users to measure water quantities</p>

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		Surface water	Groundwater			
	gravity or pump. Prices for pumping irrigation water (from Danube and reservoirs) are usually two to three times higher than for gravity-fed water. Illustration of old water prices (1996-1998): average price between 0.011-0.091 €/m³ 1996–98.			decline of agriculture production and irrigation activities is due to water price increases and change in the ownership structure.		
Cyprus	<ul style="list-style-type: none">Government / Public schemes for irrigation (55% of the area): Flat volumetric tariff with varying price levels (use). No differentiation between areas. Differentiated tariffs for bulk supply to irrigator's organisations and for individual farmers (latter: higher tariffs). Different (lower) tariff for water provided from treated sewage effluent. Overconsumption charged at a price multiple of the regular prices.<ul style="list-style-type: none">Irrigator's organisations: 0.15 €/m³ (0.05 €/m³ for treated effluent)Individual farmers: 0.17 €/m³ (0.07 €/m³ for treated effluent)Overconsumption charge: 0.56 €/m³Irrigation divisions and non-governmental suppliers: no charge by the government.<ul style="list-style-type: none">Usually volumetric charge, considering total financial costs of abstraction and relevant utilities.Area based charging or charge based on irrigation time exists in some small irrigation divisions abstracting water from the few natural surface water sources (small rivers).	Individual self-abstractions (groundwater, wells) are not charged (yet). The evaluation to establish abstraction charge is in progress since the beginning of 2011, but will most likely need considerable time to be successfully and fully implemented.	Cyprus invested severely in government controlled irrigation infrastructure (dams and conveyor systems). Grants for infrastructure to irrigation divisions. +/- 55% of irrigation (area) supplied from (Government Water Projects) GWP. GWP provide around 50% of total annual irrigation water demand under "normal" hydrological conditions, but in recent years were only able to cover approximately 25% of irrigation water.	With regard to cost recovery levels, taking into account both the actual unit costs (financial + environmental +resource costs) of providing irrigational water and the current water prices, the average cost recovery level is calculated as 41% through GWP and 61% from other Use of irrigation water is metered inside and outside of the GWP sources. Financial cost recovery levels of irrigational water supply outside the GWP are assumed to reach 100%. Currently Cyprus government is promoting a new pricing system with inclusion of Environmental and Resource Costs (ERC).	Metering devices are installed and controlled throughout the GWP areas	
Czech republic	Water tariffs from public water supply systems are regulated by law: mixed tariff system, fixed charge and a volumetric charge above a threshold level.	Water from surface and groundwater resources under 500m³ per month or 6000m³ per year is free (excluding water from public water supply systems).				Metering for all abstractions above monthly and / or yearly threshold
Denmark		Tax on licensed water quantities and tax on abstracted water quantities. Irrigation is looked upon as a part of production facilities and is as such covered with no tax on the abstracted amount of groundwater.			For water delivered: 100 % of operation and maintenance (O&M) costs and 100% of capital costs	Annual abstraction must be measured and reported to the authorities once a year
Estonia		Water abstraction charge depending on the source of the water (groundwater, surface water, mineral water) and the region. This charge is not applied to all uses. Water used for irrigation, fishing ponds and energy generation activities based on water are for instance not charged. Volumetric: rate ranges from 0.0013 and 0.42 €/m³ (groundwater, lowest ground level) (year 2005)				Water permit holders need to meter volumes of abstracted water and report to Environmental Board once a quarter
Finland	Agricultural water (e.g. livestock and dairy farming) from public piped water supply system: Mixed system of fixed charge and volumetric charge	no pricing policy (irrigation system and abstraction by individual farmers)		Irrigation systems are farmer operated	Present pricing policy supplies in full supply cost recovery (capital, operational and maintenance).	

EU Member State	Design of tariffs - for water provided	Design of tariffs - for self-supply		Importance of self-supply (including information on irrigation infrastructure or collective facilities / services)	Cost recovery (financial costs + Environmental and Resource costs - ERC)	Metering
		Surface water	Groundwater			
France	<ul style="list-style-type: none"> Water abstraction tax payable to water agencies: <ul style="list-style-type: none"> Adour-Garonne: average abstraction tax levied by Water Agency was 0.7 c€/m³ in 2009. For non-gravity fed systems: mixed (binomial) tariff is most commonly used: fixed part based on area and volumetric part based on water use <ul style="list-style-type: none"> Area based: 158 € per hectare (ASA, Adour-Garonne) Mixed tariff: 157 € per subscribed ha and 0.082 € per m³ (ASA, Adour-Garonne) or 51 € per m³ per hour (capacity) and 0.0568 € per m³ Flat rate for gravity fed irrigation systems. <ul style="list-style-type: none"> 50€ per hectare (Adour-Garonne, CACG), 39 € per hectare (ASAs) <p>Adour-Garonne: average price of water between 0.09 and 0.12 €/m³ (2004-2005)</p>	<ul style="list-style-type: none"> Volumetric charge: Water abstraction tax payable to water agencies for abstracted volumes above a threshold: <ul style="list-style-type: none"> Adour-Garonne: average abstraction tax levied by Water Agency was 0.7 c€/m³ in 2009. Tax is payable for abstracted volumes above 7,000 m³ per year. The water abstraction charges are only a few percentages of the cost of irrigation. 		<p>In several basins, individual water abstraction systems dominate (e.g. Charente Basin >80%).</p>	<p>Reflection of supply costs and ERC in the tariffs as much as possible. France is recovering a share of environmental costs through water abstraction charges. For agriculture, cost recovery can vary from 40% for some collective systems to 100% for individual systems (of financial supply costs). (Financial) supply cost recovery for water provided in collective systems: 100% of operational and maintenance costs, between 15 and 95% of capital costs depending on the River Basin.</p> <p>Water Agency abstraction tax on water use by irrigators also aims to internalise resource costs, but the level of environmental cost recovery is quite low.</p>	<p>Monitoring measures are mandatory for any authorised abstraction. This includes mandatory metering and registration. Incitation to metering through tariffs.</p>
Germany	<p>Mixed system: fixed charge and volumetric charge for public water supply</p> <p>Abstraction charges over legally fixed minimum threshold. Different policies in regions or federal states (Länder)</p>	<p>Volumetric charge: Water abstraction taxes / fees for quantities over legally fixed minimum threshold in different federal states. Only 11 out of 16 Länder have established fees on water abstractions with considerable differences between Länder (e.g. not necessarily on both groundwater and surface water abstractions). Example for Brandenburg federal state:</p> <ul style="list-style-type: none"> Agriculture: 0.0014 €/m³ for SW and 0.007 €/m³ for GW. The level of the tax is only 7% of the statutory charge, 0.02 €/m³ and 0.10 € per m³ respectively. 		<p>Irrigation systems are privately owned and operated (by farmers)</p>	<p>Abstraction charges are an instrument for internalisation of ERC. Cost recovery calculations in RBMPs are omitting ERC. Shortcomings in cost recovery levels for agriculture (irrigation). Irrigation nor self-supply are included in the analysis of water services. No analysis available on subsidies for irrigation infrastructure and for costs of Water Boards associated with surface irrigation (GRÜNE LIGA).</p>	
Greece	<p>Co-operative irrigation projects, fees from farmers in public schemes collected by Local Land improvement General Boards (TOEV):</p> <ul style="list-style-type: none"> Flat rate (area-based) tariffs predominate: 73-190 €/ha or 90-210 €/ha according to the source. Less frequent volumetric charges: 0.02 – 0.7 €/m³ <p>Based on article5 reporting (2008), average water tariff for irrigation in Greece was estimated at 0.0243 €/m³ ranging from 0.011€/m³ to 0.1 €/m³ according to the region.</p>			<p>+/- 40% (of irrigated acreage) serviced by public co-operative schemes</p>	<p>Charges paid to TOEVs (public co-operative schemes) cover part of operational and maintenance costs and no capital costs (the latter are financed by GOEV, the National Land Improvement General Board): literature sources 2002-2003.</p> <p>The level of cost recovery for water service irrigation (including ERC) is calculated at 54% (art 5 reporting 2008).</p> <p>Individual irrigators pay both capital costs and operational and maintenance costs.</p>	
Hungary	<p>Price is set by the supplier and consists of three parts:</p> <ul style="list-style-type: none"> Resource fee (abstraction tax): on permitted quantity, installed in 1976 (depending on m³, base charge, metered or not and type of water use and source). Irrigation and fish ponds are exempted. Livestock farmers and other agricultural users still need to pay the tax. Calculation method by ministerial decree 43/1999 (XII.26.) and payable to the state. Delivery charge: usually region based and volume based minimum supply charge Costs of 'watering': maintenance costs, energy costs, wages 	<p>Individual self-abstraction (irrigation and fishponds) is not charged. Livestock farmers and other agricultural users still need to pay the resource fee to the state budget.</p>		<p>Surface water: regional water and environment directorates operate large scale water distribution systems (channels, reservoirs, weirs, rivers, etc.). Other state owned systems operated by water management associations exist. Equipment, facilities and local distribution within farms are private.</p> <p>For 'private / individual abstractions', surface water and groundwater take a similar share. In general, groundwater use is less important and usually self supply, infrastructure then private.</p>	<p>O&M costs appear to be fully recovered. No transparent information on irrigation costs versus costs for inland water management (multifunctional channels); New water pricing regulation and cost calculation system for agriculture under preparation.</p>	
Ireland	<p>Mixed tariff:</p> <ul style="list-style-type: none"> Volumetric charge: All non-domestic users are charged based on volumetric usage. Farmers using public water supplies pay a standing charge for the installation and operation of a water meter. 	<p>On the home farm, the first 227 m³ (50.000 gallons) per year are free, followed by a volumetric charge above this threshold.</p>		<p>In the eastern part of the country, water for agriculture is generally privately sourced and owned by the farmer involved. In the west, farmers are more dependent on public water supply.</p>	<p>Level of cost recovery for water provided: unspecified % of capital and O&M costs</p>	

EU Member State	Design of tariffs - for water provided	Design of tariffs - for self-supply		Importance of self-supply (including information on irrigation infrastructure or collective facilities / services)	Cost recovery (financial costs + Environmental and Resource costs - ERC)	Metering
		Surface water	Groundwater			
Italy	<p><i>Consorti di bonifica e irrigazione</i> (RIB or Irrigation Boards) own the license for water abstraction and pay an annual fee for the license. Agricultural users pay them a charge for the service provided / supply. Pricing systems are established independently in each RIB leading to a wide variety of different systems in place, even in closely located areas (depending on volume, type of cultivation or type of irrigation).</p> <ul style="list-style-type: none">Per hectare (flat rate) water charges are predominant. Area based payments can be based on land registry area, irrigated area (self-reported), differentiated contribution per crop area (self reported).<ul style="list-style-type: none">Huge differences in literature and between regions: 50-150 €/ha in the North, 30-100 €/ha in the South. Values up to 500 € per ha found in literature. 30€ per ha (Veneto, Toscana, Molise) to 700 € per ha (Piemonte, Lazio, Campania, Puglia) are reported.Volumetric charging is very rare and is usually included in a mixed system: an area rate (to cover fixed costs), plus a volumetric charge.<ul style="list-style-type: none">Volumetric rates between 0.04 and 0.07 €/m³. Other sources mention rates between 0,12 and 0,25€/m³ (South) (contact through EUWMA)Sardinia: water price depending on three variables: type of irrigation, type of cultivation, size of area (in absence of water meters already announced in Regional Law n. 6/2008). It is of note that Sardinia is not representative for all 21 Italian regions.	<p>Concessions are paid for licenses / permit for water withdrawals, usually on quantity permitted (e.g. € l/s, € per m³). No information identified on the amount of the concession. Different criteria apply in the calculation of the annual fees following regional legislation.</p> <p>Sardinia: Surface water users and groundwater users pay an annual fee of 40,11 € per 100 l/s of flow rate (volumetric). It is of note that Sardinia is not representative for all 21 Italian regions.</p>	<p>Consorti di bonifica e irrigazione (RIB) distribute +/- 50% of irrigation water (but there are claims of up to 90% in the literature) and 50% of the irrigated farms. From official data published from ANBI (Italian Association of Drainage and Irrigation Boards) in 2004, Consorti di bonifica e di irrigazione distribute 80% of irrigation water. Only 20% is directly abstracted by farmers. Usually, infrastructure for irrigation is managed by irrigation boards but are public.</p> <p>Regional differences exist. In the Po district for example practically all irrigation water supplied by collective systems (1,4 out of 1,6 million hectares).</p>	<p>RIB have a contribution system aimed at completely recovering their O&M cost, while investment or depreciation costs are borne by the state/regions. ERC are not paid for.</p> <p>For water provided cost recovery is estimated at 20 to 30% of O&M and capital costs in the South; 50 to 80% in the North.</p>	<p>Water metering is mostly limited to the areas in which water is distributed through pipes (minority). Water metering is going to be increasingly used in Southern area (Puglia, Sardegna, etc) where there is more scarcity of water.</p> <p>In Emilia-Romagna, since 2007, "Irrinet" expert system for irrigation was introduced (with the support of Region Emilia-Romagna and European Union). Irrinet improves irrigation by saving 15-25% waters. Irrinet is already at the attention of European Commission –DG Environment - Agriculture Unit as a possible case study.</p>	
Latvia		<p>Flat volumetric tariff: Water abstraction volumetric charge depending on the source of the water (groundwater, surface water, mineral water) (=natural resource tax). In case of use of natural resources over permitted (limited) amounts, the base rates and extra rates (three times higher than the respective base rates) are applied.</p> <p>Illustration base rates (year 2009) Surface water: +/- 0.003 €/m³ (0.002 Latvian Lat/m³) Groundwater: +/- 0.007 €/m³ (0.005 Latvian Lat/m³)</p>			<p>Daugava / Lielupe / Gauja / Venta: 100% cost recovery of financial costs in agriculture</p>	
Lithuania		<p>Flat volumetric tariff: Water abstraction volumetric charge depending on the source of the water (groundwater, surface water, mineral water). The tax rates are set on the Tax of State Natural Resources Law. Tariffs differentiate by type of resources and water use (including agriculture).</p> <p>Illustration (year 2002): Surface water: 0.0003€/m³ Groundwater: 0.014€/m³</p>				<p>Permit holders need to meter volumes of abstracted water and report to region Department of Environmental protection once a year.</p>
Luxembourg	<p>Flat volumetric charging: water tariffs proportional to consumption volumes</p> <p>Water tariffs differ by municipality but are calculated based on a harmonised methodology.</p>	<p>Flat volumetric tax for abstraction of surface water: 0.10 €/m³</p>	<p>Flat volumetric tax for abstraction of groundwater: 0.10 €/m³</p>		<p>100% financial cost recovery is aimed at through a harmonised methodology imposed on municipalities</p>	

EU Member State	Design of tariffs - for water provided	Design of tariffs - for self-supply		Importance of self-supply (including information on irrigation infrastructure or collective facilities / services)	Cost recovery (financial costs + Environmental and Resource costs - ERC)	Metering
		Surface water	Groundwater			
Malta	<p>Non-potable water supplied to agriculture is charged as follows:</p> <ul style="list-style-type: none"> Treated sewage effluent charged at flat rate of 83.86 €/ha per year Flat volumetric tariff for non-potable water supplied from public boreholes at the rate of 0,093 €/m³. <p>Tariffs for non-potable water supply vary according to the category of use. For non-residential use (not relevant for irrigation): Service charge of 130 € and volumetric charge: 2.10 €/m³ up to 168m³, then 2.50 €/m³ up to 40,000 m³ and 1.75 €/m³ above 40,000m³).</p>	<p>No abstraction charges are applied for private abstractions.</p> <p>The agricultural sector obtains water (self-supply) from 2 main sources where no tariffs are applied: private boreholes and rainwater harvesting schemes.</p>		Private groundwater abstractions are the main source of irrigation water.		<p>Groundwater abstraction metering mandatory (since April 2010, legal notice 241 of 2010)</p> <p>A programme of metering of groundwater sources is currently being implemented.</p>
The Netherlands		No specific levy for surface water abstraction. Area based fee to landowners (including farmers) charged by Water Boards for quantitative water management ("dry feet" – water system charge).	Provincial groundwater levy with different tariffs per province. Limited amounts of groundwater extraction are exempted (e.g. below 40.000 m³/year or low pumping capacity), which is an indirect exemption to agriculture and domestic abstractors. Irrigation is exempted from the <u>national</u> groundwater tax.		In general, water tariffs are based on full supply cost recovery	
Poland	<p>The issue of charges for water consumption, including agriculture, is regulated by the Act on Environmental Protection Law (Art. 275) in conjunction with the Act on Water Law. Different systems exist:</p> <ul style="list-style-type: none"> Mixed system: fixed charge and a volumetric charge Per hectare (flat rate) water charge 	<p>"Ordinary use of water" (not greater than 5m³/day) is not covered by fees.</p> <p>According to the Act on Environmental Protection Law some specific types of water abstractions are free of charge (fish rearing and fish farming, irrigation)</p>	<p>"Ordinary use of water" (not greater than 5m³/day) is not covered by fees.</p> <p>According to the Act on Environmental Protection Law some specific types of water abstractions are free of charge (for the operation of heat pumps and geothermal energy, if the water returned is of the same quantity and at least quality)</p>	Water delivery through water companies or by individual farmers.	Cost recovery level for water provided: unspecified % of O&M and capital costs. Dniester / Danube / Vistula: 4,1% cost recovery in agriculture. 5% in Odra and 5,6% in Elbe.	
Portugal	<p>Water Resources Levy (since 2008) constitutes of different components (A, E, I, O, U). The new Water Resources Levy is aimed at (major) users who cause greatest environmental concern and incur greater planning and monitoring costs (exemptions usually for installations below 3.7 kW (5 HP) but are detailed by component in Decree-Law n° 97/2008 of June 11). Component A, O and U are relevant for irrigation. The basic amount of the components are combined with the volume extracted or used (A and U) or area occupied (O):</p> <ul style="list-style-type: none"> Component A: individual use of water from the public domain (scarcity coefficient between 1 and 1.2 depending on the river basin), 0.003 €/m³ for agriculture. Component O: use of land in the public water domain of the State and to the use and creation of water plans. Basic amount of 0.05 € per m² of area occupied. Basic amount is reduced by half for areas greater than 1 ha and only apply to the excess part only. Component U: corresponds to the individual use of water, whatever its nature or legal status, subject to planning and public management, liable to cause significant impact. Agriculture pays 0.0006 € per m³ <p>Additionally, complex mechanism of charging by water users' associations (WUA) exist: mixed system of fixed charge and volumetric charge. Complexity of the mechanism arises from the fact that WUAs sometimes supply municipal water as well, property size</p>	<p>Water abstractions have traditionally been allowed free of charge provided that users do not generate significant levels of pollution.</p> <p>The new Water Resources Levy (2008) is aimed at (major) users who cause greatest environmental concern and incur greater planning and monitoring costs (exemptions usually for installations below 3.7 kW (5 HP) but are detailed by component in Decree-Law n° 97/2008 of June 11). Component A, O and U are relevant for irrigation. The basic amount of the components are combined with the volume extracted or used (A and U) or area occupied (O):</p> <ul style="list-style-type: none"> Component A: individual use of water from the public domain (scarcity coefficient between 1 and 1.2 depending on the river basin), 0.003 €/m³ for agriculture. Component O: use of land in the public water domain of the State and to the use and creation of water plans. Basic amount of 0.05 € per m² of area occupied. Basic amount is reduced by half for areas greater than 1 ha and only apply to the excess part only. Component U: corresponds to the individual use of water, whatever its nature or legal status, subject to planning and public management, liable to cause significant impact. Agriculture pays 0.0006 € per m³ 		Only +/-20% of irrigation (19-25% of area equipped for irrigation) by public schemes (mainly in southern areas).	<p>Individual irrigators pay 100% of operational and maintenance costs and capital costs (share of investments financed by EU and Portuguese government though). Farmers in collective schemes pay on average 90% of operational and maintenance costs and no capital costs (source of 2003 mentioned in OECD 2010). Overall financial supply cost recovery in collective schemes (agriculture) estimated at 23% in 2002. Environmental and resource costs not considered in the calculation besides a small part effectively paid and thus internalised.</p> <p>Changed situation with the introduction of the Water Resources Levy but no sources identified with calculations on cost recovery of the new tariff system.</p>	

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	<p>affecting the charge and potential inclusion of drainage fees. Yearly set charge called TEC (<i>Taxa de Exploração e Conservação</i>) including a selection of no more than 3 of following 5 components:</p> <ul style="list-style-type: none"> • (Fixed charge per hectare ameliorated or reclaimed land) • Fixed charge per irrigated hectare: 18 – 115 € per ha • Volumetric charge per m³ if metering is possible: 0.011 – 0.092 €/m³ • (Drainage fee, when drainage of excessive water needed) • Crop-based fee applicable for specific crops and projects (per ha): 13 – 210.9 € per ha <p>Average flat rate would be 120 € per ha. Average volumetric charge would be 0,02 € per m³.</p>					
Romania	<p>Water prices differ according to use, also within the agriculture sector itself. The price is a volumetric charge and reflects a contribution for using the water resource and the water management system.</p> <p>In addition to the water prices, irrigators are also charged for operation and maintenance costs of irrigation systems (pumping systems, canals). Irrigation systems and supply of irrigation water can be organised publicly (National Administration of Land Reclamation - NALR) or by Water User Organisations (WUOs):</p> <ul style="list-style-type: none"> • NALR: Farmers need to pay for the cost of pumping and transporting water from the reservoirs. Prices can vary significantly depending on height and distance. When these transport costs are included, total price can range from +/- 2 €/1000m³ to 247 €/1000m³. No further info on the design of the tariff for farmers. • WUOs: In those areas where irrigators' associations have developed, they have set their own charges to cover abstraction costs and their own financial costs (i.e. operational, maintenance). Total charge consists of on-farm irrigation water supply charges, annual membership fee on the basis of the size of land owned or used, and operation and maintenance charges. No further info on the design of the tariff for farmers. 	<p>The price is a volumetric charge and reflects a contribution for using the water resource and the water management system.</p> <ul style="list-style-type: none"> • Livestock from SW: 11.9 €/1000m³ • Irrigation from SW: 0.71 €/1000m³ • Aquaculture from SW: 0.12€/1000 m³ 	<p>The price is a volumetric charge and reflects a contribution for using the water resource and the water management system.</p> <ul style="list-style-type: none"> • Livestock from GW: 13.69 €/1000m³ • Irrigation not allowed from GW • Aquaculture from GW: 2.62€/1000 m³ 	<p>The main irrigation infrastructure belongs to the National Administration for Land Reclamation: Irrigation management works, drainage works facilities (by pumping and / or gravitational), facilities works for soil and erosion control.</p>	<p>Cost recovery for the water management system is at 100% as the “contributions for using the water resource” (paid by the water resource users) cover the operational and maintenance costs of the water management infrastructure system (Dykes, dams, water intakes, river regulations), which belong to National Administration “<i>Apele Romane</i>”. There is no mention of taking ERC into account in Romania.</p>	<p>Metering of all water abstractions</p>
Slovak Republic	<p>Negotiated prices for water supply on average 0,031 €/m³ and maximum 0,046 €/m³ regardless of the type of use. Water for irrigation is not paid for.</p>	<p>Water for irrigation is not paid for. Water abstraction is normally paid for based on real water withdrawals, not permitted quantities.</p>				
Slovenia		<p>Abstraction volumetric charge of 0,03 €/m³ for both GW and SW.</p>				
Spain	<p>Area based fee from the <u>River Basin Authority</u> for services provided:</p> <ul style="list-style-type: none"> • When the use is benefiting from publicly financed surface and groundwater regulation works (usually a dam) implemented and operated by the State: regulation levy CR (<i>Canon de Regulación</i>) • When the use is made possible by an infrastructure (canals, pumping stations, etc.) implemented and operated by the state: water use tariff TUA (<i>Tarifa de Utilización del Agua</i>). <p>Regulation levy and water use tariff are paid to the Irrigation District (ID) but destined to the River Basin Authority (excluding water use tariff if irrigation District abstracts own water). Additional tariff is imposed by ID to cover the costs of the District itself. Legislation allows payment by volume, surface or mixed. Several approaches prevail:</p> <ul style="list-style-type: none"> • Annual fee per hectare (flat rate) in many traditional Irrigation Communities - over 80%, usually if surface irrigation (the most common in the Guadalquivir basin) • Mixed system: fixed charge + variable charge (volumetric or depending on duration of irrigation) • Irrigation-event fee • Volumetric tariffs: still rarely applied across Spain (in the 	<p>Users pay their own supply costs directly. There is currently no regulation fee for self-supply irrigators.</p>		<p>About 70% of all Spanish irrigated acreage is serviced by irrigators' communities or districts</p>	<p>Cost recovery for water provided: 90% of O&M costs and an unspecified % of capital costs. Environmental and resource costs are not being internalised yet.</p> <p>For irrigation with surface waters, environmental cost is estimated at 0.12 €/m³ approximately, from data of on-going modernisation projects of the Irrigation Communities. As regards for the resource costs, the dRBMP assumes them to be merged with environmental costs, and estimated to be between 0.18 €/m³ (water rights market 2005-2008) and 0.50 €/m³ (industrial and horticultural uses), but not chargeable in any case to users.</p>	<p>Obligation to install water meters, by Ministerial Order ARM/1312/2009. Level of implementation unknown.</p>

EU Member State	Design of tariffs - for water provided	Design of tariffs - for self-supply		Importance of self-supply (including information on irrigation infrastructure or collective facilities / services)	Cost recovery (financial costs + Environmental and Resource costs - ERC)	Metering
		Surface water	Groundwater			
	<p>Guadalquivir basin +/- 10%), e.g. linked to improvements in irrigation technology (automated drip irrigation). Increasingly, irrigation associations are establishing charges by volume and penalisation for excessive use where water is scarce.</p> <p>Guadalquivir: 0.0262 €/m³ average price (excluding CR and TUA or charges destined for the RB Authority). Average per hectare charge in Guadalquivir is the highest in Spain with 262.9 € per ha), although the volumetric tariff is not one of the highest.</p>					
Sweden	not relevant (irrigation insignificant)	not relevant (irrigation insignificant)				
United Kingdom		<p>Mixed system, fixed + volumetric: License holders pay a fixed application and advertising administration charge in exchange for a license and an annual subsistence charge (standard charge and environmental improvement charge) based on volume. The annual charge takes into account licensed volume, source of the abstraction, seasonal factor and a loss factor (the latter is highest for spray and trickle irrigation due to high consumptive nature of the use).</p> <p>Annual charge for spray and trickle irrigation usually is subject to special scheme: Two-part tariff, half of abstraction charge based on licensed quantity and other half on actually metered quantities.</p> <ul style="list-style-type: none"> Fixed application charge: +/- 152.5 €¹ Fixed advertising administration charge: +/- 113 € Standard unit charge: ranging from +/- 13.1 and 31.1 € per 1000m³ Environmental improvement charge: ranging from 0 to 8.2 € per 1000m³ 		Most irrigation in the UK is carried out by individual farmers, abstracting from their own licensed sources, in some cases stored in privately owned farm reservoirs.	For water provided: 100% of O&M and capital costs, unspecified % of environmental costs	

¹ 1 GBP = 1.12955 € (end of August 2011)

Annex 3 : Fact sheets of long-list of potential case studies

Country: Italy		
<p><i>River basins or regions of particular interest:</i> Emilia-Romagna region (or Po-river basin) in Northern Italy. However, the role of irrigation is more important in the South. Sardinia could also be considered.</p>		
Characteristics of the country or regions		
Water exploitation Index	0,24	water stressed, high share of abstraction for irrigation. Water demand for agriculture has been decreasing since 1970, although future water demand for irrigation is forecasted to stabilize around the present level of consumption
Occurrence of scarcity and droughts	Evidence of an increase in drought events and their severity in some regions in Italy	
Characteristics of agriculture and (its) water use: key information and indicators		
Importance of agricultural water abstraction as opposed to other abstractors	45% for irrigation withdrawals, 61% of consumptive use of water	
Arable land to total (utilised) agricultural land	54% (eurostat land use farm structure)	
Irrigated land to agricultural land	21% to total, 38% to arable land (25% in another source)	
Agricultural water demand per irrigated area (level of abstraction)	7700 m³ per ha/year (period 2002-2004)	
Type of irrigation	- 37% of the irrigated area is sprinkler irrigated - 20% is drip irrigated - 38% is irrigated by flooding or watering techniques	Emilia Romagna: flood systems for rice and drip systems for fruit
Water provided or self-supply	Irrigation consortia distribute +/- 50% of irrigation water. Some are self-financed, some are partly financed by regional administrations. Other 50% directly supplied by farmers.	
Type of abstraction	groundwater +/- 30% of agricultural water demand.	Regional differences e.g. groundwater is the main source in some areas of Tuscany and Puglia. Surface water predominant in northern regions except Liguria
Level of illegal abstraction	Illegal abstraction volumes tend to range between 12% and 20% of total abstraction. The estimates are of about 1.5 million illegal wells (Contratto Mondiale dell'Acqua).	In eight regions (Abruzzo, Molise, Puglia, Campania, Basilicata, Calabria, Sicilia e Sardegna), about 830,000 ha are irrigated legally while the total of irrigated area reaches about 1.6 million ha. Alone in the Puglia region, 300,000 illegal wells are estimated which provide for one third of the total irrigated area in that region. Specific measures for increasing controls on unauthorized abstractions are provided in the management plan of the River Po District and also authorized abstractions to verify if they respect the established limitations.
Type of production	Mainly annual crops (maize and vegetables), fruit and fodder crops. Rice in the North	

Information on water allocation and pricing policies in agriculture		
Water allocation		
General information on allocation	System of licences for water withdrawals. Ownership of water allocation entitlements for both surface and groundwater in the agricultural sector are mixed between farmers and water suppliers. Different quantities allowed for summer and winter irrigation.	
Allocation of surface water	No specific info	
Allocation of groundwater	No specific info	
Water pricing		
General information on water pricing	Pricing policy does not provide adequate incentives for users to use water efficiently, with the exception of a tariff regulation for the civil sector.	
Main aim of the policy	The tariff system is usually based on the running costs of servicing an area	
Type of payment or tariff structure	<p>- Country: per hectare (flat rate) water charges are predominant. Volumetric charging is very rare. Agricultural users in most cases pay a small abstraction charge that is due in exchange for the license, and tariffs that cover only part of O&M costs and nothing of investment or depreciation costs. Only in a small part of the total irrigated area water is measured and volumetrically priced.</p> <p>- Regions: The Emilia-Romagna Region has developed and applied many metering programmes, technologies and systems in the agricultural sector. Romagna Occidentale Irrigation board: 87% served by open canals or non-metered pipe systems (per ha 42,6 € and 132,2 €), while metered systems (pressurized distribution) pay 20,66 € per ha and a volumetric component). According to WADI, volumetric charging for both rice and fruit. Surface based charging for cereals in Lombardy (Po Basin). Sardinia: water price depending on three variables: type of irrigation, type of cultivation, size of area</p>	
Specific details for surface water	No specific info	
Specific details for groundwater	No specific info	
Cost recovery	20 to 30% of O&M and capital costs in the South; 50 to 80% in the North. Italian farmers pay much less than other users.	<p>- 70-80% of supply costs, continental - North Italy (maize)</p> <p>- 50-60% of supply costs: Mediterranean – Central Italy (horticulture)</p> <p>- 50% of supply costs (operational costs only) Mediterranean – South Italy (fruit, vegetable, durum wheat)</p> <p>Storage facilities are shared with hydropower in the North and water supply companies in the South.</p>
Other items		
Access to data		
Language	Language skills (Italian) not present in the project team	
Motivation and potential for case studies		
<p>From the Member State responses (Follow-up reports Water scarcity and droughts, 2010), it appears that metering programmes are developing in the Emilia Romagna region. The region has also been studied in related WADI project listing 5 case studies relating to irrigation pricing for various agricultural products (e.g. Cereal in Lombardy; Fruit in Emilia-Romagna). It could be interesting to see whether a comparison between pricing systems is possible.</p> <p>Little specific information on the region has been found so access to data could be an important barrier. The same remark for Sardinia.</p>		
Information sources		
<p>- Dworak, T.; Berglund, M.; Thaler, T.; Fabik, E.; L.; Amand, B.; Grandmougin, B.; Ribeiro, M. M.; Laaser, C.; Matauschek, M. (2010): Assessment of agriculture measures included in the draft River Basin Management Plans - Summary Report.</p> <p>- Garrido, A. (2010), Agricultural water pricing: EU and Mexico. Background document to OECD (2010) Sustainable management of water resources in agriculture.</p> <p>- European Commission (EC), DG ENV data, 2010. MS responses to the DG ENV questionnaire on The Third Follow-up of the Communication on water scarcity and droughts</p> <p>- European Environment Agency, Eurostat and World Bank for figures</p> <p>- OECD member country questionnaire responses on agricultural water resource management</p> <p>- Vecino and Martin, 2004, Sustainability of European Irrigated Agriculture under Water Framework Directive and Agenda 2000</p> <p>- http://www.emwis.org/topics/waterpricing/water-pricing-some-eu-countries</p>		

Country: France			
<u>River basins or regions of particular interest:</u> Boutonne river basin (as part of the Charente river basin).			
Characteristics of the country or regions			
Water exploitation Index	0,17		
Occurrence of scarcity and droughts	In south-west France there is evidence of an increase in the maximum number of days over a growing season without rain, but no reduction in monthly rainfall	Adapting to droughts mainly involves changes in farming practices and systems (e.g. replace irrigated crops by dryland crops). Adaptation and mitigation policies	
Characteristics of agriculture and (its) water use: key information and indicators			
Importance of agricultural water abstraction as opposed to other abstractions	Between 9,8% and 12,4%, depending on the source Agricultural water use mainly for irrigation		
Arable land to total (utilised) agricultural land	67%		
Irrigated land to agricultural land	5,5% to total 8% to arable land		
Agricultural water demand per irrigated area (level of abstraction)	2804 m³/ha		
Type of irrigation	Relative modest share of surface irrigation (6%), sprinkler systems dominate (only 3% for drip systems)		
Water provided or self-supply	+/- 24% from water supply networks	Charente river basin scale: over 80% of individual abstractions and assumed to be even higher in Boutonne River Basin	
Type of abstraction	around 32% of the irrigated area relies on groundwater and 16% on surface water. +/- 24% from water supply networks. Remainder is supplied from a mix of different sources.		
Level of illegal abstraction			
Type of production			
Information on water allocation and pricing policies in agriculture			
Water allocation			
General information on allocation	Abstraction licenses can be granted to farmers and suppliers for both groundwater and surface water. Authorisation for abstraction based upon impact assessment (delivered by "Préfets" des "départements"). Can be limited or revoked in situations of water shortages. (OECD Q) The respect of the administrative obligations related to water abstraction is part of the GAEC (Good Agricultural and Environmental Conditions) and is therefore a precondition to benefit from CAP payments. (Follow-up reports WS&D 2010) All sectors are pushed to have tariffs based on metering in order to reflect water scarcity (incitation to metering of water for agriculture given throughout the tariffs) (WS&D second interim report 2007 - EMWIS 2008) The water Law of 2006 also determines the conditions under which users can abstract surface and groundwater resources, the procedure by which the State (Préfets départementaux, who are the local State representatives) grants the use rights (OECD country 2010) legally established authorisation procedure for water abstraction, in particular for agriculture. (follow-up reports 2010)		

Water pricing		
General information on water pricing	Water pricing at regional / RBD level. Water agencies or 6 water basin authorities. In general, water charges across all irrigation units in France have been increasing over time. The French Water Law of 2006 imposes the equipment of volumetric metering devices, defines the types of charges that can be levied for water consumption by the 6 water agencies.	
Main aim of the policy	Water basin authorities charge all users, independently of the type of supply, a water tax inspired in the polluter pays principle.	
Type of payment or tariff structure	Remarkable differences in tariff structures and levels even within one basin e.g. Charente river. Nearly 25% of farmers pays flat rate per ha, one third of the farmers pays a binomial tariff fixed per ha and a volumetric component.	
Specific details for surface water	- mixed tariff is most commonly used, fixed part based on area and volumetric part based on water use for non-gravity fed systems. Flat rate for gravity fed irrigation systems: In 2005, 71% of farms (=85% irrigated area) equipped with volumetric devices and can amount up to 90% of exploitations when considering different literature sources	
Specific details for groundwater	Volumetric charge with metering now mandatory	
Cost recovery	- For agriculture, cost recovery can vary from 40% for some collective systems (dams and channels) to 100% for individual systems. - Reflection of supply costs and environmental and resource costs in the tariffs as much as possible. 100% of O&M costs, 15 to 95% of capital costs depending on the water basin	Rhine-Meuse and Meuse Sambre 25%, 14% for Guadeloupe and 44% for Loire (% of financial supply costs)
Other items		
Access to data		
Language	Language skills (French) available in the project team	
Motivation and potential for case studies		
In the Boutonne river basin, as in several other basins, a volumetric based management of water resources has been implemented. Water pricing is used to establish ecological minimum flows. In the context of the study "Scenarios of water demand management – Impacts at regional level" a specific case study on water pricing and quotas has been performed in the region. Data is broadly available to the team. The whole Charente basin has an important share of individual pumping systems. Self supply-systems pay water abstraction taxes proportionally to the volume and cover a higher share of capital and O&M costs compared to farmers in collective systems. Water pricing has a history in France and metering is broadly applied. Documents in French can be screened by the team.		
Information sources		
- Owen Le Mat (Acteon), LOUBIER Sebastien Loubier (UMR G-EAU, Cemagref), STROSSER Pierre Strosser (ACTeon), Guy Gleyses (UMR G-EAU, Cemagref) (2009): Scenarios of water demand management – Impacts at regional level- ENV.D.2/ETU/2007/00097r - Case study report: The Boutonne River Basin (France), March 2009 -Dworak, T. (2009): Final Report for the Project "Scenarios of water demand management – Impacts at regional level -ENV.D.2/ETU/2007/00097r -Ecologic (2007). EU Water saving potential (Part 2 – Case Studies) - European Environment Agency, Eurostat and World Bank for figures - Garrido, A. (2010), Agricultural water pricing: EU and Mexico. Background document to OECD (2010) Sustainable management of water resources in agriculture - OECD member country questionnaire responses on agricultural water resource management - Office International de l'Eau (2009), Les modes de tarification et de distribution de l'eau pour l'agriculture dans le bassin Méditerranéen: Synthèse technique - http://www.emwis.org/topics/waterpricing/water-pricing-some-eu-countries		

Country: Spain		
<u>River basins or regions of particular interest:</u> Júcar river basin Guadalquivir river basin (Southern Spain) Duero river basin (Northern Spain)		
Characteristics of the country or regions		
Water exploitation Index	0,3	w ater stressed, high share of abstraction for irrigation Guadalquivir: WEI over 0,5 around 2000. The rising demand for irrigation w ater, coinciding w ith a series of dry years and reduced recharge, has undoubtedly increased this w ater deficit.
Occurrence of scarcity and droughts	Evidence of an increase in the number and severity of drought events. capacity.	Support payments fro upgrading irrigation infrastructure and increasing w ater storage capacity.
Characteristics of agriculture and (its) water use: key information and indicators		
Importance of agricultural water abstraction as opposed to other abstractors	Betw een 58% and 68% of total w ithdraw als, depending on the source. Consumptive use amounts up to 72% Agricultural w ater use mainly for irrigation	Júcar Basin:77% Guadalquivir Basin:85% Duero Basin:93%
Arable land to total (utilised) agricultural land	48%	
Irrigated land to agricultural land	13% to total 27,5% to arable (18% in another source)	Guadalquivir: 25,5% of cropped area (only 12% for Spain in total). Significant pressure on local w ater resources.
Agricultural water demand per irrigated area (level of abstraction)	5841 m³/ha	Júcar basin: 4047 m³/ha/year Duero: 6300 m³/ha/ year Quadalquivir: An in-depth analysis of a representative sample of 22 irrigation districts in Guadalquivir (30% of irrigated area) indicates that w ater consumption per unit of irrigated surface has decreased from an average of 7000 m³/ha to 5000 m³/ha in 2004. Moved to trickle irrigation and pressurized distribution, but farmers have moved to more w ater intensive crops not leading to w ater savings
Type of irrigation	+/- 38% of irrigated area surface irrigation. Sprinkler and drip both around 30% (2003 farm survey). Figures not consistent in different sources.	Similar figures on irrigation systems for Júcar. Irrigation efficiency in Duero (60-70%) low er w ith predominating surface irrigation.
Water provided or self-supply	About 70% of all Spanish irrigated acreage is serviced by irrigators' communities or districts	
Type of abstraction	around 48% of the area from w ater supply netw orks. Ow n installations abstract from groundw ater (32% of the area) and surface w ater (14%). Figures not consistent in different sources.	Júcar: 38% surface w ater, 27% groundw ater and high share of recycled w ater Guadalquivir and Duero: over 85 to 95 % from surface w ater
Level of illegal abstraction	Estimated 510,000 illegal w ells (> 7,000 m³). Illegal w ater extraction reaches 3,600 millions of m³/year, representing the 45% of the total amount of w ater pumped from aquifers per year. This w ater is used for the irrigation of about one sixth of the total irrigated land in Spain. Betw een 2002 and 2005 the Spanish Nature Protection Service (SEPRONA) annually initiated 1,545 proceedings (on average) for offences connected w ith w ater use in Spain. In many cases, unauthorized w ater extraction is linked to other illegal practices, such as unauthorized transformation of protected areas or common lands into irrigated arable land or for urban development. Continuous increase in illegal w ater use: In aquifers 23 and 24 of La Mancha, officially declared overexploited for the last 20 years, it is estimated that 10 new w ells are drilled every day. 22.000 illegal boreholes in the Upper Guadiana area. In the Doñana area similar problem w ith an estimation of 700 illegal boreholes (70% of total).	
Type of production		Crops cultivated in Duero area mainly low -value-added like maize (30%), w inter cereals (25%), sugar beet (15%), alfala and sunflow er. Wide range of crops in Guadalquivir, both low and high-value-added crops (vegetables and olive groves).

Information on water allocation and pricing policies in agriculture		
Water allocation		
General information on allocation	The competent authority (Regional government or national government if river basin runs through several regions) issues entitlement and use rights for both surface water and groundwater. Usually, water ownership in agriculture is with farmers rather than with water supply companies. Only on the Canary Islands and in the case of non-conventional resources (desalinated seawater and recycled waste water) can ownership be with water supply companies. Existing water rights are attached to land ownership. Water rights can't be traded, but can be transferred under certain conditions, with the approval of the competent authority. In the case of transfers between irrigation water users, identification of the fields that the transferor waives or agrees to irrigate with less water allocation during the contract term and the land in which the water will be used. Allowed maximum water volume extracted per year: 7.000 m³	
Allocation of surface water		
Allocation of groundwater		
Water pricing		
General information on water pricing	River Basin authorities (RBAs) charge intermediate actors (municipalities, industrial users, irrigation associations) for transportation and regulating services (only regulation levy if irrigation districts abstracts own water (OECD country 2010)). These actors in turn charge final users for these costs and own distribution and treatment services. The Water Law allows RBA's to modulate charges to provide incentives for water savings. (WS&D second interim report 2007 - EMWIS 2008)	
Main aim of the policy		
Type of payment or tariff structure	Increasingly, irrigation associations are establishing charges by volume and penalisation for excessive use where water is scarce. Depending on Basin and Irrigation district. The most commonly used tariff structures are: - Fixed per ha (usually for surface water irrigation – 82%) - Volumetric (usually from groundwater – 13% irrigated area): per m³, per irrigation turn or per hour - Binomial (remaining 5%, predominant in private and modern publicly developed districts)	
Specific details for surface water	Both mixed system of fixed charge and a volumetric charge and per hectare (flat rate) water charge exist For principal (inter-regional) basins: On average 106 € per ha (distribution + Irrigation district costs) or 0,021 €	
Specific details for groundwater	Fixed fee and volumetric charge For principal (inter-regional) basins: On average 500 € per ha or 0,09 € per m³	
Cost recovery	90% of O&M costs, an unspecified % of capital costs for surface water from service providers. +/- 87% of financial (full supply) costs in another source. Very few available studies permit a detailed application of the criteria for cost evaluations and the cost recovery rates though Average tariffs are well below public costs to supply water. Groundwater users pay their supply costs directly.	
Other items		
Access to data	Good local networks	
Language	Language skills (Spanish) available in the project team	
Motivation and potential for case studies		
In Júcar basin, there are several approaches and tariff structures. Surface irrigation is still important (+/- 40%) but less than in the other considered basins. Guadalquivir and Duero have mainly surface based (per ha) tariffs. In all three basins, agriculture is responsible for around or more than 80% of all water abstractions. Guadalquivir experiences in allocation policies (reductions of allocations to irrigation over time e.g. concession of 6000 m³ per ha per year) and pricing (some experiences with volumetric billing). High share of drip irrigation systems in Guadalquivir. The basin was also part of the case studies conducted within the DG ENV study "Scenarios of water demand management – Impacts at regional level" Fuentes (2011) states that water scarcity rank of Duero is much lower than for Júcar and Guadalquivir. The team has good knowledge of local conditions and has a network of experts that good facilitate access to reliable information for these basins.		

Country: Greece		
<u>River basins or regions of particular interest:</u> Central Greece, the south-western part of the department of Thessaly. Two major reservoirs Plastiras and Smokovo. The Thessaly district has a largest water demand in Greece.		
Characteristics of the country or regions		
Water exploitation Index	0,13	
Occurrence of scarcity and droughts	The decrease in rainfall is leading to growing incidence and severity of droughts	Central planning infrastructure works for water storage and artificial recharge for agriculture and other sectors impacted by drought
Characteristics of agriculture and (its) water use: key information and indicators		
Importance of agricultural water abstraction as opposed to other abstractions	Between 81% and 89% depending on the source. Highest figure for EU. Practically all for irrigation purposes.	
Arable land to total (utilised) agricultural land	52%	
Irrigated land to agricultural land	31-32%. irrigated to arable land roughly 60% (only 35% in another source)	Plastiras and Smokovo: Roughly 80% of cultivated land is irrigated (2001)
Agricultural water demand per irrigated area (level of abstraction)	6443 m³/ha	Irrigation water demand has been slowly increasing past decades and tendency is to stabilize (irrigated acreage has increased 65% over past 20 years)
Type of irrigation	- Private initiatives (+/-60%): mainly sprinkler or drip technologies - Co-operative projects TOEVs and GOEVs (40%): 41% of the irrigated area (public projects) still uses gravity fed systems Figures not consistent in different sources.	
Water provided or self-supply	Co-operative projects TOEVs and GOEVs take around 40% of the irrigated area. 60% for private initiatives.	Plastiras and Smokovo: 7 000 private and 150 communal boreholes operate in the Plastiras and Smokovo area.
Type of abstraction	Over 40% of the agricultural water demand is supplied by groundwater resources. Zones in the North use surface water. Water for 34% of area sourcing from water supply networks. Nearly 30% of private abstractions exclusively groundwater and 10% exclusively surface water. Remaining area is irrigated using different sources.	Plastiras and Smokovo: Groundwater is overexploited in the area (basically for irrigation) with adverse effects to its levels and quality (especially in the region of Sofades). Irrigatory needs are covered by the two reservoirs and private boreholes.
Level of illegal abstraction	Excessive pumping of groundwater has caused water levels to fall dramatically in some rural areas, as well as salt water intrusion in some coastal aquifers. Illegal abstractions and discharges pose a hurdle to improving water management. Enforcement of regulations and water permit conditions has not sufficiently improved. Agricultural water prices neither cover the cost of supply nor provide sufficient conservation incentives. Little attention has been paid so far to ecological aspects of water quality.	
Type of production		Agricultural systems: fruit trees and other crops, arable crops with cotton as basic crop and arable crops with tobacco as basic crop (irrigated regions of Central and Northern Greece)

Information on water allocation and pricing policies in agriculture		
Water allocation		
General information on allocation	use rights and licenses. Use right to individual farmers. Anyone can extract water (license) but land owner has primary entitlement	
Allocation of surface water		
Allocation of groundwater		
Water pricing		
General information on water pricing	new legislative and institutional framework in December 2003: regional water directors and councils for all water regions or river basin districts, i.e. 14 in total	
Main aim of the policy	cost recovery and polluter pays new legislative and institutional framework (December 2003)	
Type of payment or tariff structure		
Specific details for surface water	per hectare (flat rate) water charge for water delivered from water suppliers (tariffs differ amongst local authorities, from 150 to 280 € per ha for rice and between 70 and 175 € per ha for other crops)	
Specific details for groundwater	volumetric charge for water delivered from water suppliers	
Cost recovery	Average level of full cost recovery (O&M, capital and environmental and resource costs) was 22% for agriculture and 57% for all water users (water from service providers). Other sources state 54% of full costs for irrigation and nearly 64% for all uses (the percentage for irrigation could include private and individual initiatives) Studies underway to examine implementing water supply cost recovery. Revenues include charges to polluters as well. CAP subsidies are included as a cost in the calculation. Before 2003: Charges of TOEVs cover part of O&M and no capital costs, while individual irrigators pay both.	
Other items		
Access to data		
Language	Language skills (Greek) available in the project team	
Motivation and potential for case studies		
The proposed region shows an important role of irrigated agriculture. Plastiras and Smokovo is basically a rural area with a strong agricultural heritage and orientation. Private abstractions are important in the area. From the consulted documents and sources, it does however not appear that pricing and allocation policies are well-developed. The new legislative and institutional framework was launched in December 2003 but implementation in practice is most likely far from realised. This case study could bring interesting insights on the reasons why implementation is so difficult, even if legal action has been taken.		
Information sources		
<ul style="list-style-type: none">- Background paper to the conference "Application of EU water-related policies at farm-level". Louvain-la-Neuve (Belgium), September 2010.- Ecologic (2007). EU Water saving potential (Part 2 – Case Studies)- European Environment Agency, Eurostat and World Bank for figures- Fuentes, A. (2011), "Policies towards a sustainable use of water in Spain", OECD Economics Department Working Papers No. 840, OECD Publishing- Garrido, A. (2010), Agricultural water pricing: EU and Mexico. Background document to OECD (2010) Sustainable management of water resources in agriculture- OECD member country questionnaire responses on agricultural water resource management- WADI project (2004). Sustainability of European agriculture under Water Framework Directive and Agenda 2000.- Office International de l'Eau (2009), Les modes de tarification et de distribution de l'eau pour l'agriculture dans le bassin Méditerranéen: Synthèse technique		

Country: Cyprus		
<u>River basins or regions of particular interest:</u> The whole of Cyprus as one river basin		
Characteristics of the country or regions		
Water exploitation Index	0,64	water stressed, high share of abstraction for irrigation
Occurrence of scarcity and droughts	In 2008, Cyprus faced one of the most acute and prolonged droughts since the beginning of the twentieth century. water restrictions are applied to the irrigation water sector every year, according to water availability. It is expected that the water scarcity situation will continue, but at a less dramatic level (2010-2011)	
Characteristics of agriculture and (its) water use: key information and indicators		
Importance of agricultural water abstraction as opposed to other abstractions	Between 69% and 80% depending on the source. Nearly all abstractions for irrigation purposes.	
Arable land to total (utilised) agricultural land	74%	
Irrigated land to agricultural land	21% to total, 29% to arable land	
Agricultural water demand per irrigated area (level of abstraction)	4971 m³/ha	
Type of irrigation	Around 15% of the area surface irrigation, sprinkler and drip irrigation both roughly 40%	High irrigation efficiency (80 to 90%). Public schemes have higher efficiencies than private.
Water provided or self-supply	Public schemes supply +/- 55% of the area.	
Type of abstraction	Public schemes for irrigation use both surface water and groundwater. Private schemes usually private groundwater abstractions (office international de l'eau, 2009)	
Level of illegal abstraction	50,000 illegal bore-holes. Illegal abstraction in periods of scarcity as the government then gives priority to drinking water	40% of aquifers are overexploited Pilot Study in the Western Mesaoria Area has been launched for the identification of illegal wells
Type of production		

Information on water allocation and pricing policies in agriculture	
Water allocation	
General information on allocation	
Allocation of surface water	Recently voted law 79(I) / 2010: for abstractions from surface waters, permits for abstraction works and permits for water abstraction are now legally required
Allocation of groundwater	Licences for sinking of new wells are limited to existing plantations if the aquifer is at risk or is overpumped. Each application for a change to an existing abstraction licence is reviewed regarding its maximum abstraction quantity taking into account the extent of the irrigated plantation and the status of the aquifer, with the objective to reduce the allowed maximum abstraction quantity.
Water pricing	
General information on water pricing	Water charges on a volumetric basis both for domestic and irrigation purposes, have been a tradition of the water authorities in Cyprus.
Main aim of the policy	Assessment of the incentive properties of current pricing policies in progress: expected to be completed end of 2008
Type of payment or tariff structure	- Government / Public schemes for irrigation (55% of the area): volumetric charge (water metering), (relatively low - subsidised when compared to e.g. drinking water) - Non-government / Private: tariffs based on volume or hour schedule
Specific details for surface water	No specific info
Specific details for groundwater	No specific info
Cost recovery	between 34 and 77% of supply costs. Confirmed that irrigation water is heavily subsidised, by as much as 77%. Another source states however that charges in government schemes are covering a high proportion of the total financial cost
Other items	
Access to data	Possibility to contact local experts
Language	Language skills (Greek) available in the project team
Motivation and potential for case studies	
<p>Due to specific geographic and climatic circumstances, Cyprus has a strongly regulated water market. Long experience with volumetric water pricing though the water sector is characterised by dependence on significant government funding, through price subsidies to customers or grants for the development of infrastructure. Low priority for seasonal crops during droughts. The level of abstraction largely surpasses recommended levels of abstraction. Interesting to assess situation where government works control most of the irrigation water supply (monopolist situation). Desalination and wastewater reuse are also sources of water and priced</p> <p>Cyprus was also a case study in the project "Scenarios of water demand management – Impacts at regional level". Data and information on historic development is available to the team.</p> <p>It is expected that the necessary information could be collected and screened even if not all sources are in English.</p>	
Information sources	
<ul style="list-style-type: none"> - Background paper to the conference "Application of EU water-related policies at farm-level". Louvain-la-Neuve (Belgium), September 2010. - Dworak, T. (2009): Final Report for the Project "Scenarios of water demand management – Impacts at regional level - ENV.D.2/ETU/2007/00097r - Ecologic (2007). EU Water saving potential (Part 2 – Case Studies) - European Environment Agency, Eurostat and World Bank for figures - European Commission (EC), DG ENV data, 2010. MS responses to the DG ENV questionnaire on The Third Follow-up of the Communication on water scarcity and droughts - European Environment Agency, Eurostat and World Bank for figures - http://www.emwis.org/topics/waterpricing/water-pricing-some-eu-countries 	

Country: UK			
<u>River basins or regions of particular interest:</u> Scottish River Basin District			
Characteristics of the country or regions			
Water exploitation Index	0,13, for England and Wales		
Occurrence of scarcity and droughts	Increasing frequency of drought events (records over 200 years)		
Characteristics of agriculture and (its) water use: key information and indicators			
Importance of agricultural water abstraction as opposed to other abstractors	3% to 13%, according to the source. Only 5 to 7% of agricultural water use (primary sector) for irrigation purposes in England and Wales	Scotland: Most agricultural water needs are met by precipitation, however, where irrigation is necessary, the benefits are substantial.	
Arable land to total (utilised) agricultural land	37%		
Irrigated land to agricultural land	1% to total 2% to arable		
Agricultural water demand per irrigated area (level of abstraction)	485 m³/ha		
Type of irrigation			
Water provided or self-supply		Scotland: nearly 30% of water use in agriculture was identified as irrigation water from private supplies (2001)	
Type of abstraction			
Level of illegal abstraction			
Type of production			
Information on water allocation and pricing policies in agriculture			
Water allocation			
General information on allocation	<p>Many abstraction licences contain conditions that prohibit abstraction if flows drop beneath the specified threshold. Failure to comply is a criminal offence. Abstraction regimes can be altered e.g. by the Environment Agency through drought permits, and restricting abstractions for spray irrigation, and by Government using droughts orders.</p> <p>The ownership of land is not a precondition to obtain an abstraction licence, but right to access to the point of abstraction is required.</p> <p>In Scotland, authorisation above threshold of 10m³/day and registration if below 50m³, simple licence if >50m³ and complex licence if >2000m³. In Northern Ireland, an environmental statement shall be submitted for abstraction and/or diversion.</p>		
Allocation of surface water	Water abstraction license for quantities above 20m³ per day, including (environmental) conditions (IA other users and environment by environment agency) and 12 year time period.		
Allocation of groundwater	Water abstraction license for quantities above 20m³ per day, including (environmental) conditions (IA other users and environment by environment agency) and 12 year time period. - Consent by EA before pumping license is granted.		

Water pricing		
General information on water pricing	Water charging is already in place in England, Wales and Scotland. Charges for all non-domestic customers was phased in from April 2008. In January 2010, the NI Executive announced that there will be no additional charges in 2010/11.	
Main aim of the policy		
Type of payment or tariff structure	Two-part tariff, half of abstraction charge based on licensed quantity and half is a volumetric charge Water abstraction charges for farmers are increased in the dry (summer) months.	
Specific details for surface water		
Specific details for groundwater		
Cost recovery	100% of O&M and capital costs, unspecified % of environmental costs	
Other items		
Access to data		
Language	Language skills (English) available in the project team	
Motivation and potential for case studies		
<p>Pressure from agricultural water use is significantly lower than for Southern European countries. Scotland (mainly the Scottish River Basin District) is not a water scarce region. However, the WFD instigated the application of the Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR) which for the first time makes the country regulate agricultural water abstraction. Consequently, for the first time farmers have realised that water is not free of charge. Particular attention in the case study could be attached to the evaluation of the level of charge, environmental outcomes and acceptability. Authorisation and licencing procedure depending on quantities in Scotland. From one of the sources it appears that, in the UK, water abstraction charges for farmers are increased in the dry (summer) months. The level of cost recovery in the UK, also in agriculture, is rather high compared to other countries.</p> <p>Access and screening of documents is expected to be feasible.</p>		
Information sources		
<ul style="list-style-type: none">- European Commission (EC), DG ENV data, 2010. MS responses to the DG ENV questionnaire on The Third Follow-up of the Communication on water scarcity and droughts-Dworak, T. (2009): Final Report for the Project "Scenarios of water demand management – Impacts at regional level -ENV.D.2/ETU/2007/00097r- European Environment Agency, Eurostat and World Bank for figures- OECD member country questionnaire responses on agricultural water resource management- Presentation by Angileri (2009),- SEPA (2004), An economic analysis of water use in the Scotland river basin district. Summary report.- http://www.emwis.org/topics/waterpricing/water-pricing-some-eu-countries- http://www.sepa.org.uk/water/water_regulation/regimes/abstraction.aspx		

Country: The Netherlands		
<i>River basins or regions of particular interest:</i>		
Characteristics of the country or regions		
<i>Water exploitation Index</i>	0,11	
<i>Occurrence of scarcity and droughts</i>	no evidence, climate change projections indicate a considerable increase in drought damage for agriculture	
Characteristics of agriculture and (its) water use: key information and indicators		
<i>Importance of agricultural water abstraction as opposed to other abstractors</i>	0,7%	
<i>Arable land to total (utilised) agricultural land</i>	55%	
<i>Irrigated land to agricultural land</i>	11% to total, 19% to arable land (Figures not consistent in different sources, higher figures in other sources)	
<i>Agricultural water demand per irrigated area (level of abstraction)</i>	684 m ³ /ha	
<i>Type of irrigation</i>	No surface irrigated area. Practically all area equipped for sprinkler systems (+/- 3% drip)	
<i>Water provided or self-supply</i>	Practically no deliveries from water supply networks for irrigation.	
<i>Type of abstraction</i>	Nearly 60% of irrigated area sources from groundwater abstractions.	
<i>Level of illegal abstraction</i>		
<i>Type of production</i>		

Information on water allocation and pricing policies in agriculture		
<u>Water allocation</u>		
General information on allocation	Provincial ranking of water supply for several land uses in times of shortage, and authority to restrict water withdrawals in times of shortage	
Allocation of surface water	water withdrawals require a license, individual farmers have historical rights to extract water	
Allocation of groundwater	water withdrawals require a license, individual farmers have historical rights to extract water (up to a certain threshold) Some provinces allow groundwater withdrawals only on condition that farm has a water plan Groundwater abstraction for agriculture needs a permit given by the provinces of the Netherlands	
<u>Water pricing</u>		
General information on water pricing	Dutch provinces charge for groundwater abstractions, in order to cover costs for groundwater management. On a national level, environmental levy for groundwater abstractions	
Main aim of the policy	Water tariffs based on full cost recovery (in general).	
Type of payment or tariff structure		
Specific details for surface water	per hectare (flat rate) water charge	
Specific details for groundwater	volumetric charge Environmental levy for groundwater abstractions, so also for private abstractions	
Cost recovery	unspecified % of both O&M and capital costs. Unlike in most other countries, the Dutch agriculture sector contributes more revenue to water management costs than it is actually spent in its benefit (+/-5%)	
Other items		
Access to data		
Language	Language skills (Dutch) available in the project team	
Motivation and potential for case studies		
No evidence for relevant case studies identified to date. Pressure from agriculture is modest compared to many other countries. Information collection is expected to be feasible and language skills are available in the team.		
Information sources		
<div>- Berbel et al. Water pricing and irrigation: a review of the European experience.</div> <div>- European Commission (EC), DG ENV data, 2010. MS responses to the DG ENV questionnaire on The Third Follow-up of the Communication on water scarcity and droughts</div> <div>- European Environment Agency, Eurostat and World Bank for figures</div> <div>- OECD member country questionnaire responses on agricultural water resource management</div> <div>- http://www.emw.is.org/topics/waterpricing/water-pricing-some-eu-countries</div>		

Country: Latvia		
<i>River basins or regions of particular interest:</i>		
Characteristics of the country or regions		
Water exploitation Index	0,006	
Occurrence of scarcity and droughts		
Characteristics of agriculture and (its) water use: key information and indicators		
Importance of agricultural water abstraction as opposed to other abstractors	Betw een 13% and 24%, depending on the source	
Arable land to total (utilised) agricultural land	63%	
Irrigated land to agricultural land	No reliable figure found	
Agricultural water demand per irrigated area (level of abstraction)	no info	
Type of irrigation		
Water provided or self-supply		
Type of abstraction		
Level of illegal abstraction		
Type of production		
Information on water allocation and pricing policies in agriculture		
<u>Water allocation</u>		
General information on allocation	No specific info	
Allocation of surface water	No specific info	
Allocation of groundwater	No specific info	
<u>Water pricing</u>		
General information on water pricing	Water pricing at national level. Natural resource tax in order to restrict ineffective use of natural resources and subsequent pollution	
Main aim of the policy		
Type of payment or tariff structure		
Specific details for surface water	Water abstraction charge per m³	
Specific details for groundwater	Water abstraction charge per m³ (higher than for surface w ater), tariff depending on the use .	
Cost recovery	Daugava / Lielupe / Gauja / Venta: 100% cost recovery of financial costs in agriculture	
Other items		
Access to data	No easy contacts	
Language	Language barrier expected	
Motivation and potential for case studies		
No evidence for relevant case studies identified to date. Pressure from agriculture is modest compared to may other countries. Information collection is expected to be difficult, both because of the language barrier and the limited availability of documents.		
Information sources		
- Dw orak, T.; Berglund, M.; Thaler, T.; Fabik, E.; L.; Amand, B.; Grandmougin, B.; Ribeiro, M. M.; Laaser, C.; Matauschek, M. (2010): Assessment of agriculture measures included in the draft River Basin Management Plans - Summary Report. - The Regional Environment Center for central and Eastern Europe (2001). Environmental taxes in an enlarged Europe		

Country: Hungary		
<u>River basins or regions of particular interest:</u> Tisza River Basin or Tisza-Danube interstice		
Characteristics of the country or regions		
Water exploitation Index		
Occurrence of scarcity and droughts	Distinct rise (recent years) in the incidence and severity of droughts, with a steady overall rise in the national drought index	
Characteristics of agriculture and (its) water use: key information and indicators		
Importance of agricultural water abstraction as opposed to other abstractors	6 to 12%, depending on the source. 13% of agricultural water use for irrigation purposes. 10% (Berbel)	Tisza Basin: more than 42% of consumptive use for agriculture and 35% for irrigation (to total). Irrigation consumption is expected to increase significantly by 2015 (68% of total)
Arable land to total (utilised) agricultural land	84%	
Irrigated land to agricultural land	2% to total, 2,5% to arable land	
Agricultural water demand per irrigated area (level of abstraction)	527 m³/ha (water use 2007 - area 2005) 2240 m³/ha (water use 2004 - area 2005)	
Type of irrigation	+/- 14% of the area through surface irrigation, 6% for drip systems and sprinkler systems dominating (80%)	
Water provided or self-supply	Around half of the irrigation water from water supply networks.	
Type of abstraction	For 'private / individual abstractions', surface water and groundwater take a similar share.	
Level of illegal abstraction		
Type of production		
Information on water allocation and pricing policies in agriculture		
Water allocation		
General information on allocation	Independently of the ownership entitlement, all users have equal rights to use water. Both surface and groundwater use require licences. Deeper groundwaters, and karstic waters cannot be used. Water Management Acts govern water rights and regulations. (All) water users / using activities require a license from the Regional Inspectorate for Environmental Protection. Approval is also required for building irrigation infrastructure. Both the landowner and other users have equal rights to use water.	
Allocation of surface water	No specific info	
Allocation of groundwater	No specific info	

<u>Water pricing</u>		
<i>General information on water pricing</i>	The water tariff (Water-resources tax) depends on the quantity of water-using. Recent amendment of the Water Management Act suppressed the tariff system for agriculture uses.	
<i>Main aim of the policy</i>		
<i>Type of payment or tariff structure</i>	Tisza River Basin: Water Resource contribution fee (volumetric in general, lower for surface than for groundwater) has been set to 0 for agriculture since 2006; low volumetric irrigation water charge and a flat fee per ha as water board contribution fee to finance maintenance of infrastructure. Self abstraction (of usually groundwater) is not charged, farmer pays only pumping and distribution costs (+/- 80% of total irrigation costs)	
<i>Specific details for surface water</i>	- Mixed system of fixed charge and a volumetric charge - per hectare (flat rate) water charge both exist	
<i>Specific details for groundwater</i>	Fixed fee and volumetric charge	
<i>Cost recovery</i>	Unspecified % of capital and O&M costs; recovery of other (environmental and opportunity costs) under evaluation Danube: 65-80% cost recovery in agriculture	
Other items		
<i>Access to data</i>	No easy contacts, some studies available	
<i>Language</i>	Language barrier expected	
Motivation and potential for case studies		
Hungary has the highest share of cultivated land among all of the EU member states; of the total land area of 9,3 million ha, the Utilised Agricultural Area (UAA) covers 5,8 million ha or 62,9% of the total. Importance of agriculture and irrigation in the Basin. It is expected that irrigation activity will continue to rise in the future and it will be responsible for two thirds of water abstractions in the area. Some studies on the basin are available and members of the team have knowledge of the area. The Danube Tisza interstice was a case Study in the project "Scenarios of water demand management – Impacts at regional level" This particular area is characterised by semi-substance farming and small farms. It is facing strong impacts from climate change resulting in lowering groundwater tables. Surface water irrigation infrastructure does not extend into the region, because of elevation rise, and is one of the few regions in Hungary that depends on groundwater for irrigation water demand. More stress has been placed on local groundwater resources, as periods of scarce precipitation have forced farmers to irrigate for longer intervals. Furthermore, the inefficient farming structure that has developed following privatisation in the early 1990s, has led to more individual farmers drilling boreholes without authorisation. In 1993, the water management directorate imposed restrictions on agricultural water abstraction, but the amount of abstraction probably has not decreased significantly due to weak regulatory enforcement on the landowners having unauthorised boreholes. In the year 2000, there were approximately 29.000 ha in the interfluvial area equipped for irrigation, and only a small fraction of arable land is irrigated (about 7.000 out of 414.207 ha). Irrigation demand is varying widely in the interfluvial area. In the summer of 2000 when there was a severe drought, shallow groundwater abstraction was 24 Mm ³ while in 2005 a year with above-average rainfall the irrigation demand was a total of 6 Mm ³ . This case study could be interesting to investigate the issue of water pricing in a small scale farm structure and how to deal with illegal abstraction. Data and information is partly available to the team. Language skills can be organised.		
Information sources		
<ul style="list-style-type: none"> - Background paper to the conference "Application of EU water-related policies at farm-level". Louvain-la-Neuve (Belgium), September 2010. - Dworak, T.; Berglund, M.; Thaler, T.; Fabik, E.; L.; Amand, B.; Grandmougin, B.; Ribeiro, M. M.; Laaser, C.; Matauschek, M. (2010): Assessment of agriculture measures included in the draft River Basin Management Plans - Summary Report. -Dworak, T. (2009): Final Report for the Project "Scenarios of water demand management – Impacts at regional level -ENV.D.2/ETU/2007/00097r H��lene Bouscasse (ACTeon), Julia Br��ndle (Ecologic), Thomas Dworak, (Ecologic Institute), James Lenoci (Lenoci LTD), Emese Kozma (Lenoci LTD), Pierre Strosser (ACTeon) (2009): Scenarios of water demand management – Impacts at regional level -ENV.D.2/ETU/2007/00097r- Case study report: Danube-Tisza Interstice (Hungary) - Ecologic (2007). EU Water saving potential (Part 2 – Case Studies) - European Commission (EC), DG ENV data, 2010. MS responses to the DG ENV questionnaire on The Third Follow-up of the Communication on water scarcity and droughts - European Environment Agency, Eurostat and World Bank for figures - OECD member country questionnaire responses on agricultural water resource management - Workshop background paper. Water pricing policies in agriculture to limit demand. Hungary, April 2010. Prepared by Thomas Thaler. - http://www.emwis.org/topics/waterpricing/water-pricing-some-eu-countries 		

Country: Australia			
<u>River basins or regions of particular interest:</u> Queensland: Sun Water Schemes Victoria: Murray-Darling Basin			
Characteristics of the country or regions			
Water exploitation Index			
Occurrence of scarcity and droughts	Severe droughts have occurred several times over the past 10 years. Projections in 2008 indicate that increase incidence and frequency of droughts will be widespread, and will disrupt the performance of agriculture		
Characteristics of agriculture and (its) water use: key information and indicators			
Importance of agricultural water abstraction as opposed to other abstractors	55 to 75%, depending on the source	States Queensland, Victoria and New South Wales account for around 85% of irrigated agriculture by volume of water supplied	
Arable land to total (utilised) agricultural land			
Irrigated land to agricultural land			
Agricultural water demand per irrigated area (level of abstraction)			
Type of irrigation			
Water provided or self-supply	Both water supply schemes and private infrastructure. As part of the reforms in Australia, water businesses have been institutionally separated from the regulatory bodies. The irrigation assets (dams, pipes, channels) have been moved from government departments to stand alone businesses with a commercial focus.	In Queensland, for example, around 50% of agricultural water use is supplied from farmer-built and owned infrastructure	
Type of abstraction			
Level of illegal abstraction			
Type of production			
Information on water allocation and pricing policies in agriculture			
Water allocation			
General information on allocation	<p>water trading via entitlements or property rights, rights to water is unbundled into a three part structure:</p> <ul style="list-style-type: none"> - entitlement = permanent trades - volumetric allocations (made to an entitlement) = throughout a water year (allocation trades or temporary trades, debiting and crediting) - use approvals = rules for applying water to a nominated area of land <p>Both supply schemes and private abstractions usually require some form of authorisation. Historically, entitlements were granted to farmers for free, more recently sold, e.g. by auction. Usually department of environment or sustainability of a State is responsible to grant bulk water entitlements to rural and urban water businesses (further distribution of water access entitlements e.g. for irrigators)</p>		
Allocation of surface water	general right to access a certain maximum volume of water (annually), issued in perpetuity and can be traded within or between irrigation areas / States		
Allocation of groundwater	water rights regimes less developed. Some states have more advanced regimes involving water entitlement licensees (e.g. for 5 or 10 years), annual allocations and trading		

Water pricing		
General information on water pricing	Water access entitlements have been unbundled from delivery rights, which is also applied in the pricing regime (to protect water supply schemes against trading outside the scheme, +/- like exit fees in other states). As part of the reforms in Australia, water businesses have been institutionally separated from the regulatory bodies. The irrigation assets (dams, pipes, channels) have been moved from government departments to stand alone businesses with a commercial focus. Agriculture water prices should cover the costs of those businesses – in Australia these prices are referred to as water storage and delivery charges	
Main aim of the policy	cost reflective pricing of water supply (reform 1994) (OECD country 2010) User pays + cost recovery (also externalities). Key definitions for lower bound and upper bound pricing, Water Act 2007 (OECD country 2010)	
Type of payment or tariff structure		
Specific details for surface water	Both flat rate per hectare and mixed system of fixed charge and a variable volumetric charge Queensland, Sunwater: Fixed charge + variable charge (reference tariffs set to cover 70% of lower bound costs with fixed charge + remaining 30% with variable charge). Tariffs differ per supply scheme. Subsidies in form of CSO / community service obligation (i.e. difference between revenues and lowerbound costs)	
Specific details for groundwater	% of planning and management costs	
Cost recovery	nearly all water basins cover O&M costs, some share of renewal and new capital costs and environmental externality costs. By 2010 some States expect to reach full cost recovery e.g. New South Wales Lower bound pricing has been achieved in the vast majority of government-owned water supply schemes (i.e. water business should recover at least operational, maintenance and administrative costs, externalities, taxes and interests): Queensland and New South Wales, lower bound pricing achieved in +/- 95% of public supply. For Victoria, nearly 100%.	Privatisation of major irrigation areas. Tariffs and figures not readily available for public. These districts are however financially independent and are thus required to have cost reflective pricing
Other items		
Access to data	Quite recent and up to date information.	
Language	Language skills (English) available in the project team	
Motivation and potential for case studies		
The process of determining of the irrigation prices for SunWater Schemes in Queensland appears to be very inclusive and considers various stakeholder groups. Price setting principles defined by the Queensland Competition authority (QCA) but prices are set by Sunwater, a state owned corporation operating 27 supply schemes. In the Murray-Darling Basin (Victoria), farmers incorporate water trading as a standard business strategy and brokers play an interesting role in facilitating trade. Unbundling of the water access entitlements and delivery rights allows for greater freedom for irrigators to sell their water outside of the scheme's delivery system. In general, it is expected that information availability will be good for both cases and experiences from the reform will be interesting.		
Information sources		
<ul style="list-style-type: none">- Bjornlund, H., 2002. Water exchanges: Australian experiences- Department of natural resources and environment (2001). The value of water - A guide to water trading in Victoria- OECD member country questionnaire responses on agricultural water resource management- Parker, S., Speed, R. (2010), Agricultural water pricing: Australia. Background document to OECD (2010) Sustainable management of water resources in agriculture- http://www.qca.org.au/water/Sun-Irrig-Price/index.php- http://www.nwc.gov.au/html/20-other-water-initiatives.asp		

Country: Southwestern United States			
<u>River basins or regions of particular interest:</u> California --> Central Valley Project and the California Aqueduct Northern Colorado Water Conservancy District (NCWCD) --> Colorado Big Thompson Project (C-BTP)			
Characteristics of the country or regions			
Water exploitation Index			
Occurrence of scarcity and droughts			
Characteristics of agriculture and (its) water use: key information and indicators			
Importance of agricultural water abstraction as opposed to other abstractors	- 80% in states Pacific (5) and Mountain (8) - 49% of withdrawals in Plains states (6) "Western states" count 19 states in total	Western states take +/-85% of agricultural water withdrawals in the US. Nearly all of the agricultural withdrawals are used for irrigation, with only a small amount used for livestock and aquaculture.	
Arable land to total (utilised) agricultural land			
Irrigated land to agricultural land			
Agricultural water demand per irrigated area (level of abstraction)	+/- 9100 m³ per ha in 19 western states (1998). Application was about 6100 m³ per ha and roughly 3000 m³ per ha was thus lost in conveyance		
Type of irrigation	All types do exist.	In Texas, farm-level choices have changed over time with changing irrigated area over time: gravity flow surface irrigation largely replaced by low-pressure sprinkler systems and subsurface drip irrigation	
Water provided or self-supply	Largest public purveyor of irrigation water in the American West is the U.S. Bureau of Reclamation (USBR): provides irrigation water for about 25% of irrigated area in the American west.		
Type of abstraction	Surface water is the major source of agricultural water in the Pacific and Mountain regions, while groundwater is the major source in the Plains region. Groundwater accounts for 35 to 39% of irrigation withdrawals in California (38%), Idaho and Arizona. In California, the remaining surface water abstractions show a ratio of 20% from the US Bureau of reclamation and 42% private abstractions (figures from 1990)		
Level of illegal abstraction			
Type of production			
Information on water allocation and pricing policies in agriculture			
<u>Water allocation</u>			
General information on allocation	Water rights are determined, issued and managed by state governments rather than the federal government. In most Western states, water rights are defined in conjunction with land ownership (impact on value and rights follows the owner). States also develop rules regarding the sale or lease of water rights (large differences between states, definitely for groundwater). Many farmers in Western states have purchased irrigation water in market transaction, due to reductions in their annual water allocations from state and federal purveyors (Emergency drought bank, facilitate transfer from willing sellers to buyers)		
Allocation of surface water	Historical appropriative rights (and seniority) - <i>first in time, first in right</i> (in the Western States, appropriative water rights currently account for substantially more water diversions than riparian rights). The appropriation doctrine of water rights arose to accommodate the diversion and transport of surface water for use on non-adjacent lands. Riparian rights are less useful in the West where substantial water demands occur on lands located far from surface water sources (but work well in the East).		
Allocation of groundwater	Some states regulate the volume of groundwater abstracted, while other states do not regulate groundwater withdrawals. Systems of groundwater rights are more complex than for surface water.		

Water pricing		
General information on water pricing	Institutional arrangements greatly influence prices for farmers (senior or riparian rights versus necessity to purchase water from a public or private purveyor)	
Main aim of the policy	Differences in policy components (financial cost recovery and/or polluter pays and/or incentive pricing) according to the state. Cost recovery and polluter pays according to the new legislative and institutional framework of December 2003	
Type of payment or tariff structure	Westland water district (Central Valley project): per ha rate (rate depending on area e.g. higher elevation) + volumetric charge (higher rate if irrigated area exceeds 390ha)	
Specific details for surface water	<div>- Mixed system of fixed charge and a volumetric charge</div> <div>- per hectare (flat rate) water charge (OECD Q)</div> <div>Many farmers, particularly in the Western United States, pay volumetric water charges (example for Westlands water district in the report, mixed tariff)</div>	
Specific details for groundwater	fixed permit fee (OECD Q)	
Cost recovery	<div>Subsidies in the form of repayment schedules based on farmers' ability to pay (substantial over time). Reclamation Law : higher prices with contract renewals</div> <div>In general, many privately formed canal companies and water districts deliver surface water, being "obliged to charge prices that enable them to recover their costs of securing water, operating, maintaining, and repairing their systems, and also generate capital replacement and reserve accounts. In this sense, farmers receiving water from privately formed canal companies and water districts pay the full supply-cost of water service, although the cost is not always imposed as a volumetric charge.</div>	<div>- California Central Valley project: renewal of contracts between reclamation bureau and districts reflects recovery of financial supply costs (also historical ones). Block pricing (80% cost of service, next 10% more towards full cost rate and last 10% at full cost rate). The latter aimed to generate additional revenue for investments in fish and wildlife resources.</div> <div>- California State water project: full supply cost recovery, limited extent of participation from agriculture</div>
Other items		
Access to data	A lot of figures are based on very old data (early 90's)	
Language	Language skills (English) available in the project team	
Motivation and potential for case studies		
Colorado Big Thompson Project (C-BTP) in Northern Colorado could be an interesting case of water markets in an irrigation district with close proximity to urban areas. The Californian Central Valley project shows interesting cases for water markets (allocation and pricing procedure). Private abstractions are important in California. First screening shows large differences between states and the complexity of water delivery from different projects + changing over time. It appears that some publications rely on old data.		
Information sources		
<div>- Macaulay, S. (2009). Advancement of progressive management strategies to promote regional and statewide water supply reliability in California, United States of America</div> <div>- OECD member country questionnaire responses on agricultural water resource management</div> <div>- Wichelns, D. (2010), Agricultural water pricing: United States. Background document to OECD (2010) Sustainable management of water resources in agriculture</div> <div>- Zimelman, D.D. (2008). Water Management in the Northern Colorado Water Conservancy District; Homepage NCWCD.</div>		

Country: Chile		
<i>River basins or regions of particular interest:</i> Limari Valley		
Characteristics of the country or regions		
Water exploitation Index		
Occurrence of scarcity and droughts		
Characteristics of agriculture and (its) water use: key information and indicators		
Importance of agricultural water abstraction as opposed to other abstractors	63% (World Bank)	
Arable land to total (utilised) agricultural land	8%, one third of these being permanent crops	
Irrigated land to agricultural land	Irrigated area in Chile accounts for 82% of total cultivated area	Limari basin irrigates on average 32,000 hectares of farmland every year every year. "La Paloma System": This technical and social system of water allocation is in operation since 1972. It is physically composed by three reservoirs.
Agricultural water demand per irrigated area (level of abstraction)		
Type of irrigation		Drip irrigation for vines
Water provided or self-supply		Limari: Nine different private organizations as well as the State are participating in the management of the system
Type of abstraction		
Level of illegal abstraction		
Type of production	The primary crops grown in Chile are grapes, apples, peaches, wheat, corn, and oats.	Grapes
Information on water allocation and pricing policies in agriculture		
Water allocation		
General information on allocation	The Water Code of 1981 applied market mechanisms to the reassignment of water rights. Within its clauses, the Code stresses the establishment of well-defined property rights. Not only do these water rights contain the right to use the water, but also, the owner benefits from and disposes of it. Rights are assigned definitively and in perpetuity. Water is considered to be an asset in itself (as opposed to an asset tied to land ownership) which means that water rights are transferable independent of land ownership. In Northern Chile, water markets result in intersectoral water transfers between mining, agriculture and urban areas while in Southern Chile the market is predominantly intrasectoral, agricultural water transfers arising from water markets.	
Allocation of surface water	No specific info	
Allocation of groundwater	No specific info	

Water pricing		
General information on water pricing		
Main aim of the policy		
Type of payment or tariff structure		
Specific details for surface water	No specific info	
Specific details for groundwater	No specific info	
Cost recovery		
Other items		
Access to data	Existing case studies on the Limarí Valley	
Language	Language skills (Spanish) available in the project team	
Motivation and potential for case studies		
<p>Studies have shown active trading for water use rights in the Limarí Valley, where water is scarce with a high economic value, especially for the emerging agricultural sector. Increases in prices (which are sometimes high) and a high percentage of reassigned rights indicate that the market does reflect the relative scarcity of water resources – and thereby, water is being used in higher-valued activities. The system needs more empirical studies on how better to define water rights and create a market can optimize the use and conservation of water resources. Many studies have been carried out focusing mainly on the efficiency impact of the reform but not on its distributive effects. It is expected that more information could be found on this case and language skills are present in the team. Network of local contacts is not available though.</p>		
Information sources		
<ul style="list-style-type: none">- Domper, Maria Da Luz, (2009). Chile: A Dynamic Water Market- Donoso Haris (2003) Mercados de agua - estudio de caso del código de aguas de Chile de 1981- FAO (2000). Country Profile:Chile. AQUASTAT- Global water intelligence, 2010 and global water markets 2011- Hadjigeorgalis and Lillywhite (2004). The impact of institutional constraints on the Limarí River Valley water market- Peña, H.T. (2002). Los mercados del agua: la experiencia Chilena;- Romano and Leporati (2002). The Distributive Impact of the Water Market in Chile- A Case Study in Limarí Province, 1981 - 1997- http://www.tradingeconomics.com/chile/agricultural-irrigated-land-percent-of-total-agricultural-land-wb-data.html- http://www.iwra.org/congress/2008/resource/authors/abs564_article.pdf		

Country: Israel			
<u>River basins or regions of particular interest:</u>			
National level			
Characteristics of the country or regions			
Water exploitation Index			
Occurrence of scarcity and droughts			
Characteristics of agriculture and (its) water use: key information and indicators			
Importance of agricultural water abstraction as opposed to other abstractors	53%		
Arable land to total (utilised) agricultural land			
Irrigated land to agricultural land			
Agricultural water demand per irrigated area (level of abstraction)		Large consumers are affected by pricing system. Over last 50 years, irrigation needs have decreased from 8000 m³ per ha to around 5000.	
Type of irrigation			
Water provided or self-supply	private and public agriculture (kibbutz and moshav)		
Type of abstraction			
Level of illegal abstraction			
Type of production			
Information on water allocation and pricing policies in agriculture			
<u>Water allocation</u>			
General information on allocation	Ministry of infrastructure - Water Commission responsible for quota and prices. Quota based upon consumption and metered volumes. Water users receive an annual allocation from the Water Commission, for which farmers pay incrementally. Ministry of agriculture does water management for agriculture. Reduction of quotas for agriculture (1998 as a base year): average reduction of 40% by 2000, renewed to around 50% since +/- 2002. For water allocation, distinction is made between private and public agriculture (<i>kibbutz</i> and <i>moshav</i>): - private, user rights defined in function of quantities used for cultivation and exploitation quota - for other exploitation, quotas are based on soil type, type of abstraction and the number and size		
Allocation of surface water			
Allocation of groundwater			
<u>Water pricing</u>			
General information on water pricing	Ministry of infrastructure - Water Commission responsible for quota and prices (Office international de l'eau, 2009). Water pricing is an integral part of Israeli water management, with total water supply measured and payments calculated according to consumption and water quality.		
Main aim of the policy			
Type of payment or tariff structure	volumetric charge (and progressive blocs: first 60% at +/- 0,1420 €/m³, volume to 80% of the quota at +/- 0.1725 €/m³ and over 80% at +/- 0,21 €/m³) Tariffs are still subsidised and lower than for industry and households, though aid is declining over time.		
Specific details for surface water			
Specific details for groundwater			
Cost recovery			
Other items			
Access to data	Little good contacts		
Language	Language barrier expected		
Motivation and potential for case studies			
From the decreased application rates per ha, it can be expected that the water pricing system has an effect, though the effect of e.g. modernisation of irrigation systems could not be considered. From the first screening process, it is expected that information will not be easy to collect.			
Information sources			
- FAO Aquastat (2009) Israel Country Factsheet on http://www.fao.org/nr/water/aquastat/countries/israel/index.stm			
- Office International de l'Eau (2009), Les modes de tarification et de distribution de l'eau pour l'agriculture dans le bassin Méditerranéen: Synthèse technique			
- http://www.emwis.net/topics/water-data			

Country: Poland			
River basins or regions of particular interest:			
Characteristics of the country or regions			
Water exploitation Index	0,18		
Occurrence of scarcity and droughts	data since 1951 reveals frequency and severity of droughts has increased, while the area of the country affected also rose		
Characteristics of agriculture and (its) water use: key information and indicators			
Importance of agricultural water abstraction as opposed to other abstractors	10%, around 9% for irrigation purposes		
Arable land to total (utilised) agricultural land	76%		
Irrigated land to agricultural land	less than 1%		
Agricultural water demand per irrigated area (level of abstraction)	1361 m³/ha (3700 m³/ha in early '90's and dropped to around 1000 m³/ha in 2004)		
Type of irrigation			
Water provided or self-supply	Water delivery through water companies or by individual farmers. Support provided for construction of small-scale irrigation, upgrading existing irrigation facilities and installations for rainwater storage.		
Type of abstraction			
Level of illegal abstraction			
Type of production			
Information on water allocation and pricing policies in agriculture			
Water allocation			
General information on allocation	17 sub-basin 'Voivodship' offices have management responsibility for water resources. Surface water and groundwater ownership can be either public or private; despite water is in any case a public good. Rights of abstraction and supply of water for irrigation are granted to both individual farmers and water supply companies. Separation of water from land entitlements though, only the right to 'normal' use combines with land use rights. Extractions of more than 5 m³/day require permission. Legal-water permission is issued for a specified period.		
Allocation of surface water	Permits required from sub-basin voivodships for withdrawals		
Allocation of groundwater	Groundwater also public ownership, but land owner is entitled to 'normal use' within their property		
Water pricing			
General information on water pricing	Water pricing at national level		
Main aim of the policy			
Type of payment or tariff structure			
Specific details for surface water	Both mixed system of fixed charge and a volumetric charge and per hectare (flat rate) water charge exist		
Specific details for groundwater	Volumetric charge		
Cost recovery	Dniester / Danube / vistula: 4,1% cost recovery in agriculture. 5% in Odra and 5,6% in Elbe.		
Other items			
Access to data	Little good contacts		
Language	Language barrier expected		
Motivation and potential for case studies			
Water use for irrigation purposes is very limited in Poland (>1%). Pressure from agriculture is therefore low and no major changes are expected in the future. Irrigation water application rates have dropped over time to meteorological conditions have not been considered. It is expected that relevant information will be difficult to identify and language problems will exist.			
Information sources			
<div>- Background paper to the conference "Application of EU water-related policies at farm-level". Louvain-la-Neuve (Belgium), September 2010.</div> <div>- Dworak, T.; Berglund, M.; Thaler, T.; Fabik, E.; L.; Amand, B.; Grandmougin, B.; Ribeiro, M. M.; Laaser, C.; Matauschek, M. (2010): Assessment of agriculture measures included in the draft River Basin Management Plans - Summary Report.</div> <div>- European Commission (EC), DG ENV data, 2010. MS responses to the DG ENV questionnaire on The Third Follow-up of the Communication on water scarcity and droughts</div> <div>- European Environment Agency, Eurostat and World Bank for figures</div> <div>- Fuentes, A. (2011), "Policies towards a sustainable use of water in Spain", OECD Economics Department Working Papers No. 840, OECD Publishing</div> <div>- OECD member country questionnaire responses on agricultural water resource management</div>			

Country: Bulgaria		
<i>River basins or regions of particular interest:</i>		
Characteristics of the country or regions		
<i>Water exploitation Index</i>	0,06	
<i>Occurrence of scarcity and droughts</i>	Mediterranean climate prevails in the south and summer droughts are considered normal. Every 2-3 years a drought may last for 40-50 days	
Characteristics of agriculture and (its) water use: key information and indicators		
<i>Importance of agricultural water abstraction as opposed to other abstractors</i>	Between 13% and 19%, depending on the source. 70% of agricultural water demand for irrigation purposes	
<i>Arable land to total (utilised) agricultural land</i>	87%; According to GTZ, 2006, arable land accounted for 79.4% of total agricultural land	
<i>Irrigated land to agricultural land</i>	2,5% to total, 3% to arable land; less than 1% (out of 4,805,00 total)	
<i>Agricultural water demand per irrigated area (level of abstraction)</i>	4125 m ³ /ha	
<i>Type of irrigation</i>	nearly 90% surface irrigation. Remainder of the area mainly sprinkler systems. Water use for irrigation in 2004 is 154,099 thousand m ³ , of which 143,671 m ³ is gravitational and 10,428 m ³ pumped (2006 GTZ Report).	
<i>Water provided or self-supply</i>	Most irrigation water is supplied by the Irrigation System Companies (ISC - public) but the importance of collective irrigation (Irrigation Water User Associations, both using public or private infrastructure) on the rise after early 2000.	
<i>Type of abstraction</i>	For 'private / individual abstractions', surface water and groundwater take a similar share.	
<i>Level of illegal abstraction</i>		
<i>Type of production</i>		

Information on water allocation and pricing policies in agriculture		
<u>Water allocation</u>		
General information on allocation	Permits and legal procedures for water abstractions (chapter 4 and art 50 and 58 of Water Act). Permit would include conditions for water use and oblige users to measure water quantities + rights might be restricted (scarcity, status of the water body). Extractions of more than 10m³/day require permission	
Allocation of surface water	No specific info	
Allocation of groundwater	No specific info	
<u>Water pricing</u>		
General information on water pricing	Irrigation water pricing depends on the source of the water. Water abstraction fee and a water use charge (fixed per hectare or volumetric)	
Main aim of the policy		
Type of payment or tariff structure		
Specific details for surface water	No specific info	
Specific details for groundwater	No specific info	
Cost recovery	Water tariffs cover part of O&M and in some cases part of capital costs around year 2000	
Other items		
Access to data	Little good contacts	
Language	Language barrier expected	
Motivation and potential for case studies		
Small share of irrigated land compared to total agricultural land. Application rates appear to be high, but it is difficult to find reliable data. No relevant case studies identified to date and little useful information has been found. It is expected that information in English will not be present.		
Information sources		
<ul style="list-style-type: none">- Background paper to the conference "Application of EU water-related policies at farm-level". Louvain-la-Neuve (Belgium), September 2010.- Berbel et al. Water pricing and irrigation: a review of the European experience.- European Environment Agency, Eurostat and World Bank for figures- European Commission (EC), DG ENV data, 2010. MS responses to the DG ENV questionnaire on The Third Follow-up of the Communication on water scarcity and droughts		

Country: Romania		
<i>River basins or regions of particular interest:</i>		
Characteristics of the country or regions		
Water exploitation Index	0,03	
Occurrence of scarcity and droughts		
Characteristics of agriculture and (its) water use: key information and indicators		
Importance of agricultural water abstraction as opposed to other abstractions	Between 10 and 17%, depending on the source. 22% of the agricultural water use then for irrigation.	
Arable land to total (utilised) agricultural land	63%	
Irrigated land to agricultural land	1% to total, 2% to arable land	
Agricultural water demand per irrigated area (level of abstraction)	1800 to 2000 m³/ha	
Type of irrigation	10 to 15% surface irrigation, remainder of the area sprinkler systems	
Water provided or self-supply	water for 55% of irrigated area by water supply networks	
Type of abstraction	Surface water dominates for 'private / individual abstractions' with over 30% of the water not supplied by providers.	
Level of illegal abstraction		
Type of production		
Information on water allocation and pricing policies in agriculture		
<u>Water allocation</u>		
General information on allocation	In Romania all water abstractions are regulated. The water use right is established through the water management permit. Meeting of the water demand for population has priority against other water uses. The water authorities have the right to limit or temporary suspend of water use. Water is a public property. Each water use needs an authorization to use. The authorized user cannot sell the right to use the water.	
Allocation of surface water	No specific info	
Allocation of groundwater	No specific info	
<u>Water pricing</u>		
General information on water pricing		
Main aim of the policy	The system of contributions, payments, bonuses and penalties is based on beneficiary, respective polluter pays principles and on the principle of rational use of water resources. (general art 9)	
Type of payment or tariff structure	Water prices in Romania are set by the government for each type of water use, so that all farmers in the country pay 0,4 € per 1000 m³ of irrigation water used and government also covers electricity costs. In those areas where irrigators' associations have developed they have set their own charges to cover their own supply costs.	
Specific details for surface water	No specific info	
Specific details for groundwater	No specific info	
Cost recovery		
Other items		
Access to data	Little good contacts	
Language	Language barrier expected	
Motivation and potential for case studies		
Small share of irrigated land compared to total agricultural land. No relevant case studies identified to date and little useful information has been found. It is expected that information in English will not be present.		
Information sources		
<ul style="list-style-type: none"> - Berbel et al. Water pricing and irrigation: a review of the European experience. - European Environment Agency, Eurostat and World Bank for figures - European Commission (EC), DG ENV data, 2010. MS responses to the DG ENV questionnaire on The Third Follow-up of the Communication on water scarcity and droughts 		

Annex 4 : Detailed analysis of case studies

1 AUSTRALIA: Murray-Darling river basin

All the information comes from literature sources. Most of the literature focuses on the trading scheme as it is the core of the policy. We also included information about pricing and allocation, as these interact with each other. We have contacted several experts who pointed useful literature sources or whom we requested to comment on a number of positions we took. These experts were Dr. Karen Hussey from the Australian National University and, amongst other, Co-Chair of the ANU Water Initiative and Programme Director of the ANU-USSC 'AUSCEW' project on climate-energy-water links; Matthew Walker, Manager Water Markets and Efficiency Group at the National Water Commission; and Gert-Jan de Maagd from the Dutch Ministry of Infrastructure and Environment.

1.1 Characteristics of the case study area

1.1.1 Broad introduction on the area and characteristics of agriculture

1.1.1.1 Location of the area

The Murray-Darling Basin is located in the south-east of Australia and is the catchment for the Murray and Darling Rivers and their many tributaries. It comprises 23 river valleys and has three of Australia's longest rivers flowing through the area, the Darling (2,740 km), Murray (2,530 km) and Murrumbidgee (1,690 km). It encompasses 14% of the country with parts of the states of New South Wales, South Australia, Victoria, and Queensland, and the whole of the Australian Capital Territory. The area is comprised of agricultural land (67%) and native forest (32%).

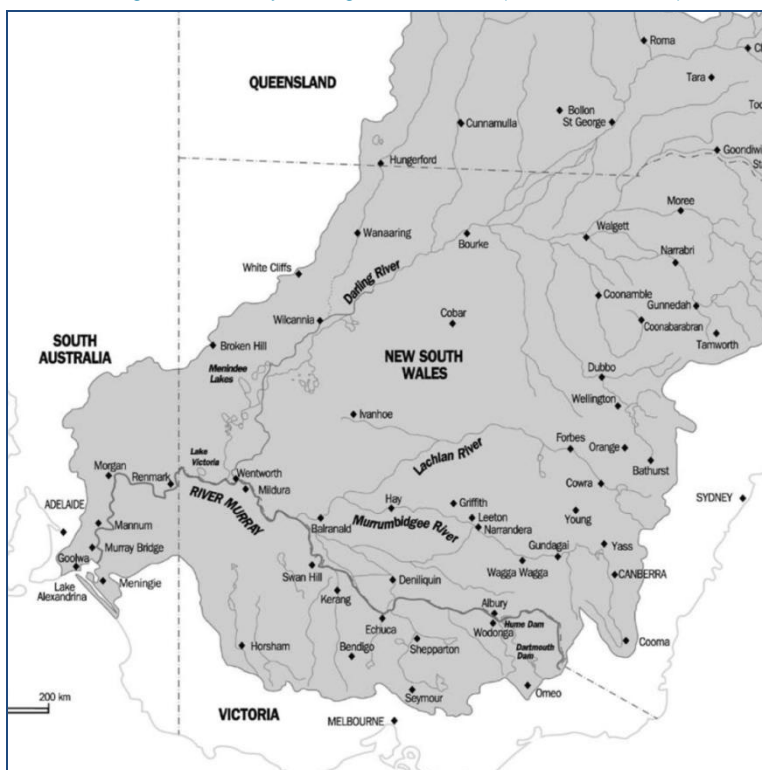
As a large, very shallow drainage basin covering more than 1 million square kilometres with only one exit flowing out of Lake Alexandrina in South Australia, the Murray-Darling Basin is an unusually complex biophysical system (website MDBA).

Diagram 1: Murray Darling Basin



Source: Wikimedia

Diagram 2 : Murray Darling Basin in detail (World Bank, 2006)



1.1.1.2 Main climate conditions

The climate of the Murray-Darling Basin is relatively dry compared to other regions of Australia but it is also very diverse. Climatic conditions range from rainforest regions, inland sub-tropical to arid and semiarid land of the far west. The north is characterised by semi-arid and ephemeral river systems, while the south is known for highly-regulated river systems fed from the Australian Alps (Commonwealth, 2011).

The Murray-Darling Basin appears to have returned to a drier period following an unusually wet period between 1950 and 1990. The last couple of years Australia had to deal with significant droughts and the early impact of changing climate conditions. There has been drought throughout most of the Basin since 2002. This has reduced inflows into river systems to record lows and, subsequently, the volume of water held in many major water storages has also fallen to record lows. The long term outlook for water in the Murray-Darling Basin is likely to be one of increasing water scarcity, with climate change as the major risk to water availability. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) estimates that by 2020, average annual flows could decline by about 15 per cent due to climate change, recovery from bushfire, farm dam and plantation expansion and increasing use of groundwater.

In 2009-2010, however, the average rainfall was, for two thirds of the basin, above average. The average temperatures were also slightly higher than usual (MDAB, 2011).

1.1.1.3 State of the Basin hydrology and ecosystem

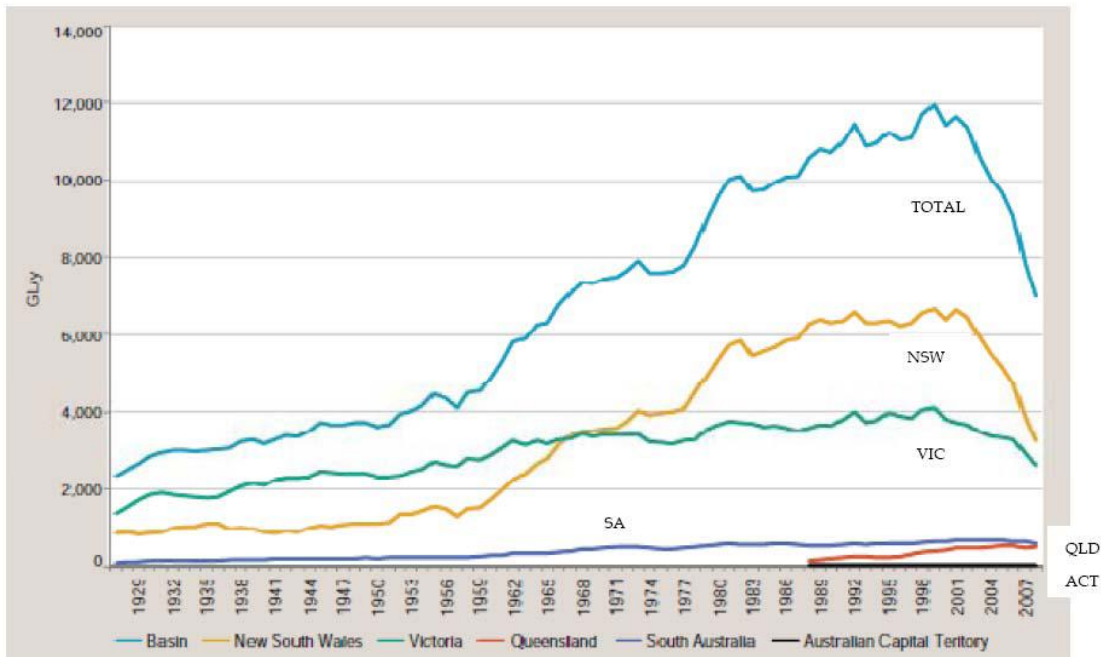
A century of intensive and largely unsuitable land clearing and cropping (arising from a tendency to copy European farming practices in a foreign climate) and high water diversions for irrigation have changed the hydrology of the basin. Water use in the Basin has increased five-fold in less than a century (

Diagram3). As a consequence, there is insufficient water to maintain the Basin's natural balance and ecosystems, resulting in a decline in its ecological health. Right now, there is severe land degradation and rising groundwater table (much of which is saline). Large amounts of salt have either reached the roots of the plants, crusted on the surface or drained back to the river systems, causing for a rise in salinity levels in the rivers.

The high nutrient levels that runoff the land cause algae problems, invasion of water plants and taste and odour problems in domestic water supplies. It also affects irrigators, as their trickle irrigation systems get blocked by these algae.

Next to land and water resources degradation there also has been a general decline in the basin's fauna and flora; with crop productivity declining as well in some areas (World Bank, 2006). At the time of European settlement, about 28 per cent of Australia's mammal species, about 48 per cent of its birds and some 19 per cent of its reptiles were found in the MDB. Many species that once were common are now rare and listed nationally for protection. At least 35 bird species and 16 mammals are endangered. Twenty mammal species have become extinct since 1900 and Murray Cod, Australia's largest freshwater fish which was once widespread, is in severe decline. The Basin contains also more than 30,000 wetlands, including 16 internationally significant wetlands that provide habitat for migratory birds but here as well there is degradation of the habitats (website SEWPAC).

Diagram3Growth in water use in the Murray-Darling Basin



Source: Commonwealth of Australia, 2011 from MDBA, Guide to proposed Basin Plan: Volume 1, 2010

1.1.1.4 Economic data of the region

The main economic activities in the Murray-Darling Basin are agricultural activities, including wheat, barley, oilseeds, rice, cotton, horticulture, dairying, sheep and cattle and pastures.

The Basin accounted in 2008 for about 40 per cent of Australia's total gross value of agricultural production, according to the Australian Bureau of Statistics. It produces 90 per cent of the nation's cotton, 56 per cent of its grapes, 42 per cent of its nuts and grapes and 32 per cent of the nation's dairy. The Gross Regional Product of the Basin is estimated at 9 billion AUD per annum for the agricultural industry alone².

The Basin is home to 2.1 million people and a further 1.3 million people are dependent on its water supply (Commonwealth, 2011). The agricultural sector employed about 11% part of this population in 2006 (Table 1). This percentage was actually much higher in previous years, as can be seen in Diagram4 This decline is also reflected in the incomes in the agricultural sector. First, we look at the evolution of the farmers' income in the MDB (Diagram4). Diagram5 illustrates that the decline in farmers' income is not only caused by the lower production value but also by the rising costs. We were unable to determine which costs were responsible for the rise.

The lower economic performance in the last decade is mainly caused by the drought but this is not the only reason. Many young people are leaving the basic communities and hence the farm life. Together with the ageing of the current farmers, this leads to a declining number of farm establishments and lower employment rates.

² Website Department of Sustainability, Environment, Water, Population and Communities of Australia (SEWPAC)

This socio-economic data reflect the entire agricultural sector in the Basin. We could not find separate data for the irrigated farms except for the broad acre farms in the Murray-Darling Basin for 2006-07. In these years the cash income for these farms averaged around 62,690 AUD or 46,034.52 EUR³. This means an average business loss of 36,390 AUD, or 26,721.90 EUR, compared to the year before. Overall, they recorded an average rate of return to capital of only 0.5 per cent.

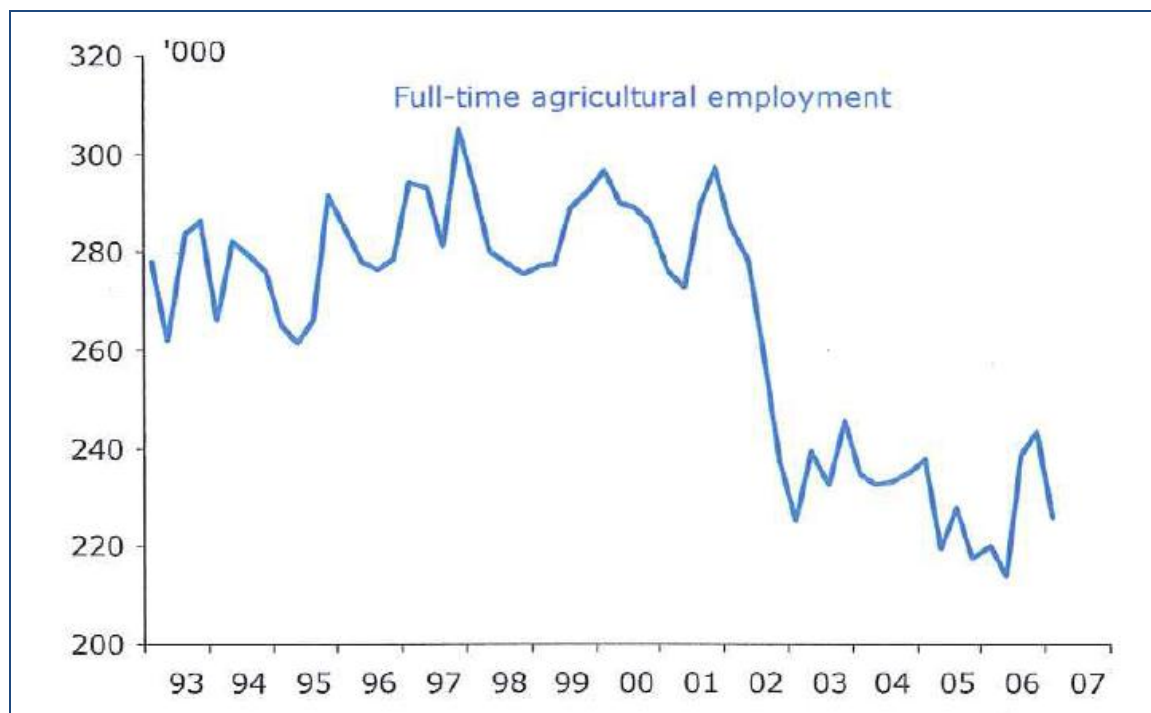
Table 1 : Key employment sectors in the Murray-Darling Basin, 2006

Sector	Percent % of employed persons
Wholesale and retail trade	14.3
Public administration (largely based in Canberra)	11.7
Agriculture	10.8
Education and training	10.6
Manufacturing	9.1
Healthcare and social assistance	8.1

Source: Commonwealth of Australia, 2011

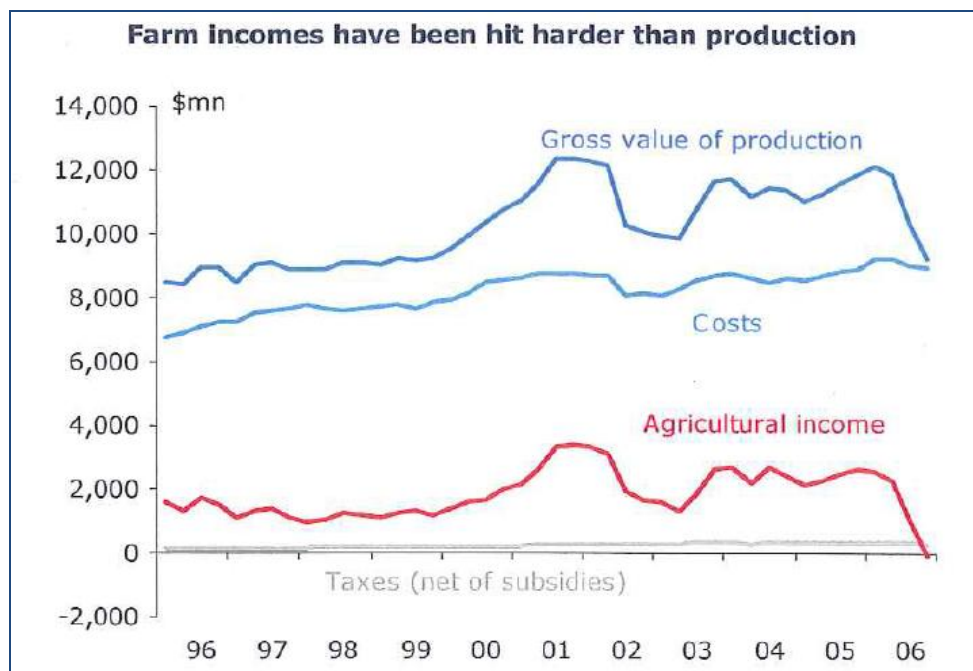
³ Conversion rate November 2011

Diagram4 : Full time agricultural employment in Murray-Darling Basin, 1993-2007



Source: Australian Bureau of Statistics

Diagram5 Farm incomes Murray-Darling Basin, 1996-2006



Source: Australian Bureau of Statistics

1.1.2 Water resources and aquatic ecosystems

The River Murray system is mainly fed by rainfall over the inland slopes of the Great Dividing Range. Flow in the Murray has a strong seasonal pattern, with peaks in winter and spring and lows in late summer and autumn. There is evidence of a water scarcity gap in the periods with lesser rainfall. During periods of drought stored water is released which can provide half of the water needed.

Cullen (2007) says the long-term inflow to the Murray River is around 10,500 GL (10.5 billion m³), but the average over the period 2001-2007 was only at 4,300 GL (4.3 billion m³). According to a study prepared for the World Bank in 2006, the river basin had 24.3 billion m³ annual basin runoff and 12.2 billion m³ annual outflow in 2005.

In Table 2 the minimum inflows in the MDB in 2006-2007 are represented relative to the inflows in the years before. We see that in the year 2006-2007 nearly all monthly minimum inflows were lower than historical minimum inflows. This gives a good representation of the severity of the drought in the basin.

Table 2 : Recorded minimum inflows into the River Murray System before 2006/7 and in 2006/7

Month	Previous lowest monthly inflow before 2006		2006 inflow	% of previous minimum inflow
June	110	GL in 1967	110	100%
July	150	GL in 1967	130	87%
August	130	GL in 1902	100	77%
September	180	GL in 1902	120	67%
October	140	GL in 1914	80	57%
November	60	GL in 1914	70	117%
December	60	GL in 1982	60	100%
January	50	GL in 1983	50	100%
February	60	GL in 2003	50	83%
March	50	GL in 1915	50	100%
April	70	GL in 1923	40	57%
May	80	GL in 1902	110	138%
Total	1140		970	

Source: OECD, 2010 based on Murray-Darling Basin, Commission, pers. Com. 2008

CSIRO's work conducted during 2007 and 2008, revealed that water use by consumption in the Basin has reduced average annual stream flow at the Murray mouth by 61 per cent. The river now ceases to flow through the mouth 40 per cent of the time.

The last couple of years not only the drought causes water scarcity but also the water trading system. As discussed further in this document there is a problem of over-allocation of entitlements. As a consequence too little water is going back into the river system to sustain the ecosystem services of the rivers. It is expected that climate change will make things worse.

On the issue of groundwater aquifers there is a need for further investigation. It is already clear that surface water and groundwater are linked to each other and that groundwater is being overused but a limited number of quantitative data is available.

On the website of the former Murray-Darling Basin Commission we found the following text concerning the groundwater in the Basin:

The Murray Groundwater Basin, covering some 297,000 km² is located in the southern part of the MDB. It is a relatively thin saucer-shaped basin, between 200 and 600 m thick, consisting of Cainozoic age unconsolidated sediments and sedimentary rocks, primarily silts, clays and limestones. The only outlets are by way of the Murray and to the surface. The basin has limited storage capacity and the sediments are largely saturated. The thin and flat nature of the basin means that it can fill quite rapidly, and there is evidence that it has refilled six or seven times over the past 500,000 years. While previous fillings took 2,000 to 3,000 years, the current one is taking less than one hundred years, due essentially to the clearing of natural vegetation and its replacement by shallow-rooted plants, both in dryland and irrigated farming areas. Studies have indicated significant rises in groundwater levels over the last 25 years.

The declining ecological condition of the internationally significant wetlands depending on groundwater, is a symptom of the deterioration of the ground water aquifer.

The basin accounts for around half of Australia's water use in 2004–05. Of the total water resources diverted for consumptive uses in Australia, around two-thirds or 18,000GL are in the Murray-Darling Basin. According to the Murray-Darling Basin Authority the usage of groundwater in 2009-2010 was at 1,300 GL (1.3 billion m³) and the use of surface water at 5,518 GL (5.5 billion m³). However, the information for the groundwater use was not complete.

Agriculture accounts for the vast majority of surface water consumed in the Murray–Darling Basin (83% in 2004-05); households (2%) and other industries (2%) consumed minor amounts in comparison. The remaining 13% of total water consumed in the Murray-Darling Basin was taken up by the water supply industry, which includes losses in delivery systems. In the next chapter we will see how much of this water is being used more specifically for irrigation purposes.

1.1.3 Water use for agricultural demand/supply

1.1.3.1 Irrigated agriculture

The Murray-Darling Basin supported around 70 per cent of all irrigation in Australia in 2004–05. About 1 million ha are irrigated in the Basin. This is about 10% of the total surface of the Basin (Table 3).

Table 3 gives also an indication of how much irrigation water is being used on the farms in Murray-Darling Basin and indicates the origin of the water. Irrigators used on average 4 ML (mega litre or 10^6 L) water per Ha. Half of the water used by the farmers comes from irrigation schemes (government or private), followed by groundwater (27%) and water captured from dams, rivers and lakes (26%). A minimal amount of water is recycled water (1.6%).

In the second column of Table 3 the number of agricultural businesses for each parameter is specified. This learns us that only 28% of the agricultural businesses in the Basin are using irrigation water. This coincides with the economic data that irrigated production accounted for around 30% of the total agricultural value in the Murray-Darling Basin. Furthermore, although half of the water used comes from irrigation schemes, these irrigation schemes are only used for 20% by the farms. More than half of the farms use groundwater. Little information is available on groundwater. Noticing that so many farms are using it, makes it an important area of for future study work.

Table 3: Water use on farms in the Murray-Darling Basin, 2009-2010

	Estimate n°	Number of agricultural businesses
Area of holding		
Area of holding – total area of holding (ha)	95,194,851	53,681
Agriculture water use		
Agricultural water use – Irrigation water – Total area watered (ha)	975,660	15,120
Agricultural water use – Irrigation water – total volume applied (ML)	3,564,481	15,120
Agricultural water use – Irrigation water – Application rate (ML/ha)	4	1
Agricultural water use – Other water – Volume (ML)	272,417	42,410
Sources of agricultural water		
Sources of agricultural water – Water supplied by government or private irrigation schemes – Volume (ML)	1,829,532	11,013
Sources of agricultural water – Surface water taken from dams, rivers and lakes - Volume (ML)	927,588	27,554
Sources of agricultural water – Groundwater – Volume (ML)	989,197	20,986
Sources of agricultural water – Town or country reticulated mains supply – Volume ML	13,803	3,979

	Estimate n°	Number of agricultural businesses
Sources of agricultural water – Groundwater – Volume (ML)	989,197	20,986
Sources of agricultural water – Town or country reticulated mains supply – Volume (ML)	13,803	3,979
Sources of agricultural water – Recycled/re-used from off-farm sources – Volume (ML)	58,108	661
Sources of agricultural water – Other sources – Volume (ML)	18,671	660
Sources of agricultural water – Total water used for agricultural production – Volume (ML)		

Source: Australian Bureau of Statistics, Commonwealth of Australia, 2011

Table 4 illustrates which crops and pastures are being irrigated in the Basin and how much water is used for each type of crop per hectare. The biggest users of water per Ha are the fruit trees, nut trees and other berry fruits with 5.7 ML per hectare. They are followed closely by the cotton farms, who use 5.6 ML per hectare. The cotton farms also use the largest total volume of water. Other crops that need a lot of water per hectare of crop, are the vegetables for human consumption, the grapevines and the plants used for decoration

Table 4 Pastures and crops irrigated in the Murray-Darling Basin, 2009-2010

	Agricultural businesses (p.)	Agricultural businesses irrigating (No.)	Area under pasture or crop (ha)	Area irrigated (ha)	Volume applied (ML)	Application rate (ML/ha)
TOTAL 2009-10	53,681	15,120	95,194,851	975,660	3,564,481	3.7
Pasture and cereal crops used for grazing or fed off	34,998	5,973	25,057,180	288,573	722,288	2.5
Pasture and cereal crops cut for hay	13,993	2,273	652,029	77,875	221,301	2.8
Pasture and cereal crops cut for silage	2,964	570	127,296	26,506	54,423	2.1
Rice	300					
Other cereals for grain or seed	19,894	1,741	9,966,163	188,758	468,944	2.5
Cotton	412	412	137,555	137,555	763,924	5.6
Sugar cane	3		103			
Other broadacre crops	7,194	325	1,478,291	27,479	46,795	1.7
Fruit trees, nut trees, plantation or berry fruits	3,132	2,416	149,513	48,646	449,862	5.7
Vegetables for human consumption	1,041	734	32,394	25,339	129,403	5.1
Nurseries, cut flowers and cultivated turf	332	267	3,128	1,856	8,242	4.4
Grapevines	3,965	3,759	101,865	96,050	427,580	4.5

Source: Australian Bureau of Statistics, Commonwealth of Australia, 2011

There is a also lot of difference across the Murray-Darling Basin between irrigation farms in terms of area operated, the degree to which farms rely on irrigation, and the extent of on-farm irrigation infrastructure. Horticulture producers operate on average the smallest irrigation farms in terms of total area operated, while the largest irrigation farms are operated by broad acre producers (following Table) (Ashton & Oliver, 2008).

Table 5 : On-farm irrigation infrastructure, by industry, 2006-07 average per farm

		dairy	broadacre	horticulture
Area operated	ha	273	1147	127
Area set up for irrigation	ha	160	417	55
Area irrigated in 2006-07	ha	115	131	38
Percentage of farms with				
River pumps	%	22	34	37
Groundwater pumps	%	36	28	18
On-farm irrigation storage	%	55	34	15
Tile drains	%	0	1	16
Other drainage reuse system	%	48	38	6

Source: Ashton & Oliver, 2008

Looking at the amount of land that is effectively irrigated compared to the land that was set up for irrigation, we see that dairy farmers effectively irrigated the largest part of their land (72 %). Horticulture producers irrigated around 70 per cent of the area set up for irrigation in 2006-07, while broadacre producers irrigated only 31 per cent of this area.

1.1.3.2 Economic value of irrigated agriculture

Irrigated production in the MDB accounted for 30% of the total value of all agricultural commodities produced in the Basin in 2008–09 (down from 33% in 2007–08). The value of this part of the production is represented by the Gross Value of Irrigated Agricultural Production (GVIAP). The GVIAP refers to the gross value of agricultural commodities that are produced with the assistance of irrigation. In 2008–09 the MDB had irrigated production to the value of \$4,349 million, or 36% of Australia's total value of irrigated production. This was a decline since 2000-01 when the value of irrigated production was \$5,085 million, or 53% of the total value of irrigated production for the nation (Commonwealth, 2011).

The commodities that contributed most to the value of irrigated production are illustrated in Table 6.

Table 6 : Murray-Darling Basin commodities that contributed most to GVIAP, 2008-2009

Commodity	Dollars \$ (million)	Percent %
Fruit and nuts	1033	24
Dairy production	791	10
Grapes	298	14

Source: Australian Bureau of Statistics, based on Census (2006)

1.1.3.3 Irrigation technologies

Irrigation reticulation systems in Australia consist of a variety of carriers including, constructed open channels (lined and unlined), natural streams and pipelines (gravity and pressurised). There is no specific information on the irrigation techniques used in the MDB. However there is information on the used techniques in each of the States of the MDB.

The majority of natural carriers are in Queensland. Queensland also has the most length of irrigation pipelines, i.e. 39% of the 2,740 km of pipeline in Australia. Victoria and New South Wales have the majority of Australian channel carriers, representing 45% and 43% respectively. In Victoria, to reduce losses due to evaporation and seepage some water is being delivered over the cooler winter months.

Surface drainage systems in Australia cover a total of 840,000 ha and are being serviced by 9,150 km of collector drains. 8,000 km of these drains are constructed open earthen or concrete drainage channels. In the Murray-Darling Basin 28% is serviced by surface drainage and 5% is serviced by sub-service drainage (ANCID, 1999/2000).

The average depths to water table reported for each of the irrigation systems in the ANCID Benchmarking Report 1999/2000 vary from 1.2 m to 35 m. Rising water table levels caused by irrigation is managed by the installation of sub-surface drainage and de-watering bores that serve to protect areas from water logging and salinisation. (Source: website Department SEWPAC).

1.1.3.4 On-farm irrigation

There is not a lot of information available on the type of irrigation systems that are used on the farms. The main irrigations methods in all four states in the MDB are flood, spray/sprinkle, trickle/drip and furrow (Australian Natural Sources Atlas, 2008).

Table 5 indicated that on average around 30 per cent of irrigation farms had some form of on-farm irrigation water storage, ranging from water held in channels to large farm dams. It is believed that increasingly more efficient water application methods are being implemented on the farms. The government also stimulates this. Currently, a new basin plan is being completed in which the taxation arrangements will differ for irrigators who take-up water efficiency investment grants.

The on-farm irrigation management techniques are described in Table 7. Although a range of soil moisture measuring tools are used by irrigation farms across the Murray-Darling Basin, more than three-quarters of farmers assessed soil moisture based on their own observations. Horticulture farms made wider use of tools such as probes and tensiometers and placed less reliance on personal observations.

Table 7 : Irrigation management practices, by industry, 2006-07 percentage of farms

Murray-Darling					
		dairy	broadacre	horticulture	Basin
Measuring soil moisture using					
Neutron probe	%	0	4	11	6
Capacitance probe	%	1	8	17	10
Tensiometers	%	2	3	21	11
Soil auger/probe	%	15	18	22	18
Heat probe	%	2	2	1	1
Own observations	%	94	87	71	80
Other	%	3	2	10	6
Timing irrigation on the basis of					
Soil moisture measuring tools	%	28	30	58	41
Calendar based	%	16	14	14	13
Weather forecast	%	37	35	38	36
Own observations/knowledge	%	96	90	87	90
Evaporation pan data	%	2	4	6	5
Consultant recommendations	%	5	12	8	9
Evapotranspiration estimate	%	2	6	6	5

Source: Ashton & Oliver, 2008

1.1.3.5 Pressure from irrigation

Historically, agriculture uses the biggest part of the Australian water. In the past whenever there was a conflict between rural and urban use, the urban users (households, industry and commercial use) were given the advantage. Since the NWI in 2004 the intention is to implement a new regime. If urban water uses increase they can only get the water from new sources (ex. recycling, new storms dams) or buy it from the rural sector⁴. So, the market mechanism is used to re-allocate the water amongst the different groups in the society (CSIRO, 2007).

⁴ Confirmed by Gert-Jan de Maagd, Ministry of Infrastructure and Environment, The Netherlands

1.2 Current water policies and practices influencing water use in Agriculture

1.2.1 Water allocation policy in the agricultural sector

1.2.1.1 Current framework

The National Water Initiative (2004) and the Water Act from 2007 are the fundamentals of the current water policy in Australia. This framework is the result of decades of reforms and lessons learned.

Agricultural water users in Australia can be split into two categories: those supplied from a water supply scheme (typically comprising large scale and common infrastructure such as channels) and those supplied from private infrastructure (for example, pumps to extract from rivers and on-farm diversions built and operated by farmers at their own expense) (OECD, 2010).

In both cases, water users usually require some form of authorisation to take water. In all States, rights to use water are defined in legislation and managed through a variety of licensing and planning arrangements. The legal aspects and the management systems differ between the States.

The water allocation policy consists of a system of water entitlements, water allocations, water licenses and water trading. Entitlements, allocations and licenses are unbundled to facilitate separate management of each of them. According to the National water Initiative, a water access entitlement is the exclusive access to a share of water from a specified consumptive pool as defined in the relevant water plan. The water plan is developed in interaction with the stakeholders. Entitlements can be given for a season or permanently⁵. The water allocation is the specific volume of water allocated to water access entitlements in a given season. Nearly all area-based licenses have converted into volumetric licenses.

Every season and depending upon availability, allocations are made in proportion to the number of entitlements held. These allocations can never be higher than the limit or “Cap” on the quantity of water that may be diverted by any State in any year. These decisions on allocating water are made in water sharing plans, developed in consultation with stakeholders, to determine when and how water is allocated to users and how much should be put aside for system maintenance and environmental needs. A typical water sharing plan, once approved by a State Minister, lasts for 10 to 15 years and is very difficult to change. This to provide all consumptive water users with the necessary investment security.

Water is allocated in many different ways across the Basin. The allocation types will be influenced by the trading scheme that is in place in each state. The different types of allocations are (MDB, 2010):

1. Volumetric Allocations

Water users are issued with volumetric entitlements. These entitlements specify a base volume of water that can be diverted each year and come in three main categories:

- 1.1. High security entitlements, which are available every year and get priority in the water allocations.

⁵ Source: Dr. Karen Hussey, Australian National University and, amongst other, Co-Chair of the ANU Water Initiative and Program Director of the ANU-USSC 'AUSCEW' project on climate-energy-water links

- 2.1. Normal security entitlements, which are subject to allocation announcements, made at intervals throughout the season. These give a right to water only after the allocated water is delivered to the high security entitlements holders.
 - 3.1. Volumetric entitlements on unregulated streams, which are available, provided there is flow in the stream
2. Continuous Accounting

Water users have individual accounts. The account increases when allocations are made and decreases as water is used. The usage in any season is limited to a specified percentage of the entitlement.
3. Allocation Transferred into Valley

A temporary inter-valley transfer will increase the allocation in the purchasing valley and reduce the allocation in the selling valley.
4. Carryover from the Previous Year

Carryover is available in a number of valleys in New South Wales, Victoria and South Australia. This enables unused allocation in one season to be carried over to the next, up to specified limits. Carryover differs from continuous accounting in that accounts are kept on an annual basis rather than a continuous one. In some valleys, carryover is cancelled as allocations approach 100% or can also be reduced to allow for increased evaporations.

The total volume of allocated water under annual accounting equals the sum of allocated water this year, carryover from previous year and water transferred into the valley.

Historically, farmers got their entitlements to water from water supply schemes for free. These days, entitlements to water from the schemes are traded, as will be discussed in the next paragraph. The entitlements are all registered in name and separated from land owning titles.

The groundwater allocation is also covered by the water plans.

1.2.1.2 Water allocation data

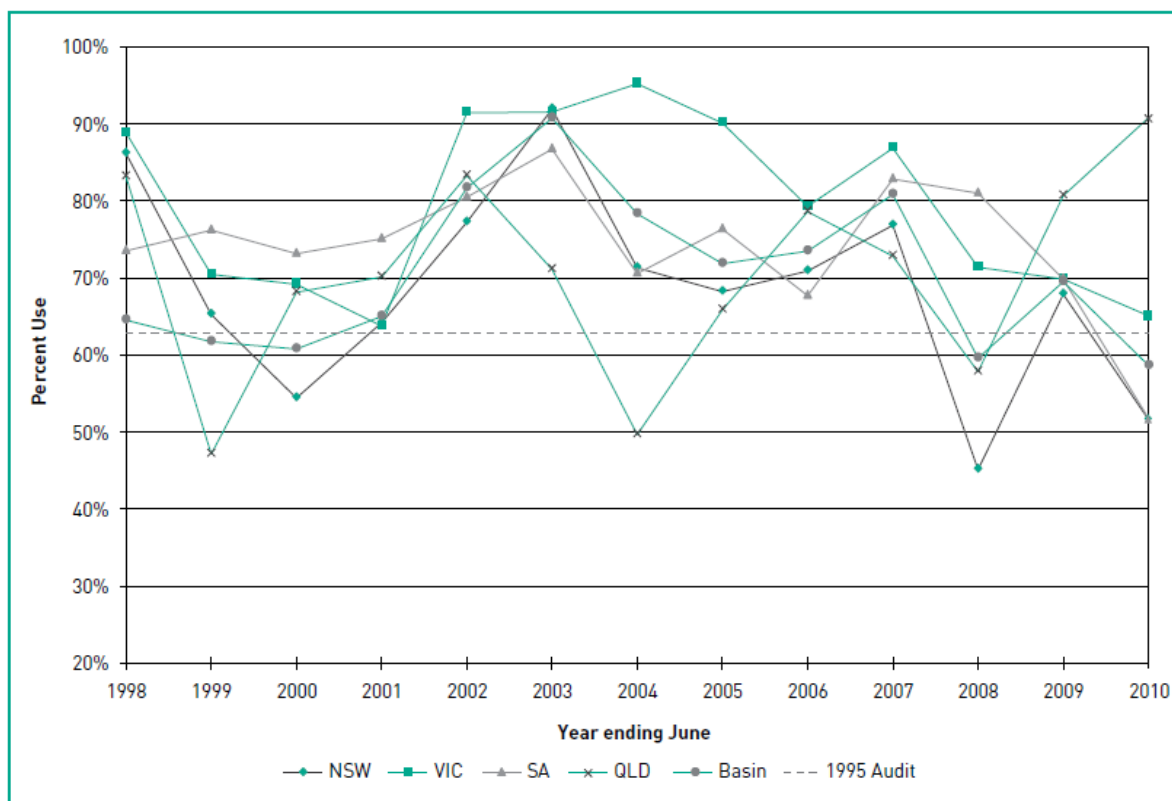
Diagram6 shows the water that is used since 1997–98 in the Murray-Darling Basin and the use in each of its valleys separately. It is compared to the quantity of water that has been allocated for use in that valley or in the Basin. The graph is a good measure of the degree of utilisation but covers only three quarters of the total diversions by the States.

We see that the water used hardly ever comes close to the limits of the allocations granted. In 2009–10 the lowest utilisation rate since Cap accounting started in 1997–98 is seen. Only 58% of the allocated water was used. Table 8 presents the actual numbers of that year.

This appears quite surprising given the dry conditions continued during 2009–10. It is partly the effect of the allocation management, which is inherently uncertain. Typically the utilisation of the allocations will be higher in the drier years and lower in the wetter years. However, if the amount of water resources improves during the year, improvements in allocations are progressively announced during the year. But planting decisions, which determine the water resources utilisation, have to be taken early in the irrigation season. Due to the

continuing dry conditions irrigators may become reluctant to take risks at the beginning of the season. The improvement in the water availability may have come too late to be utilised (MDAB, 2011).

Diagram6 : Utilisation of allocated water as percentage of the allocated volume since 1997–98.



Source: Murray-Darling Basin Authority, Water Audit Monitoring Report 2009-2010, April 2011

Table 8 : Use of Valley Allocations in 2009–10

	Total Allocated water in Valley (GL)	Use of Allocated water in Valley (GL)	Use as a % of Authorised Valley use
Total Basin	5,863	3,412	58

Source: Murray-Darling Basin Authority, Water audit Monitoring Report 2009-2010, April 2011

When water restriction measures are being taken, for example the water allocations to irrigators are limited.

1.2.2 Water pricing policy in the agricultural sector

1.2.2.1 Current framework

The ownership structure and corporate form of water businesses varies across jurisdictions. In Victoria the rural water businesses are state government owned. In New South Wales and South Australia a few are private co-operatives or companies owned by irrigators. These irrigators are then united in water users associations⁶. The major rural water business in Queensland, SunWater, is a government-owned corporation. In the Australian Capital Territory, the only water business is government-owned (NWI, 2007).

In the past, the operational costs of water supply schemes were heavily subsidised by the government. Now, farmers pay charges to the supply scheme operator that minimum cover the costs. In a number of States, ownership is passed to the irrigators within the scheme. This means that the investment and maintenance costs of the channels are paid by the farmers directly and no longer to an operator. Typically only the channel systems pass over, and not the bulk water supply assets, such as reservoirs.

The States committed to “lower bound pricing”. This means that the water price should minimum cover the operation, storage, maintenance and supply costs – but not include a commercial return on the assets. The eventual goal is to move towards upper bound pricing. This is the level at which, to avoid monopoly rents, a water business should not recover more than the operational, maintenance and administrative costs, externalities, taxes or tax equivalent regimes, provision for the cost of asset consumption and cost of capital (website NWC). Some rural water businesses are not yet at the lower bound of full cost recovery, and many are not yet on a path towards the upper bound (NWI, 2007).

The way water charges are set varies across the states. Differences in approaches to determining and passing on water storage and delivery charges include: ownership and corporate form; the legal and regulatory framework applied to setting water charges, i.e. the application of pricing principles; determining revenue requirements; setting a structure for water charges and socio-economic considerations. Also the mandate under which water charges are set and the decision makers involved can differ a lot. Decisions on water charges may be made by governments, ministers, economic regulators, local governments, water businesses, or a combination of the above (NWI, 2007).

1.2.2.1.1 Tariffs

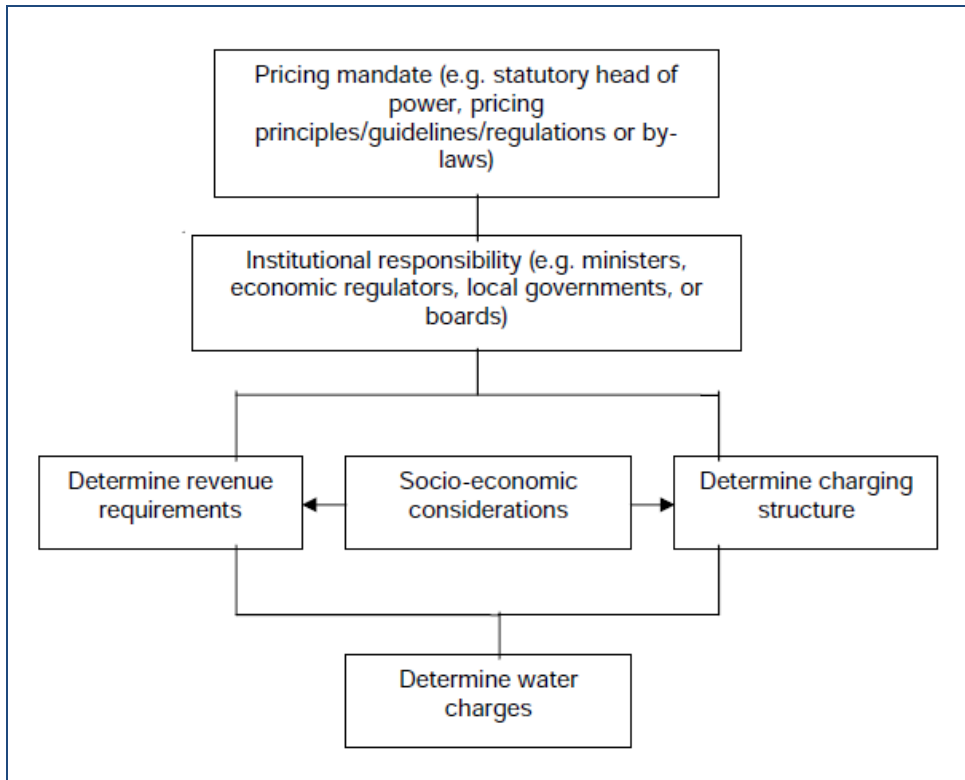
When water is traded as a commodity, the value (price) of water is set in the market, determined by the consumers’ willingness to pay. For a number of reasons, the operation of water markets is limited, and in some areas will always remain so due to physical limitations. When water cannot be traded, the water service and delivery, and water planning and management charges determine the cost of water to users (NWI, 2007).

When water businesses are state owned, often the prices are set by an independent regulator. The price setting of private businesses happens by the companies themselves and is not so transparent.

Diagram7 gives a view on the way prices are set.

⁶ Source: Gert-Jan de Maagd, Ministry of Infrastructure and Environment, The Netherlands

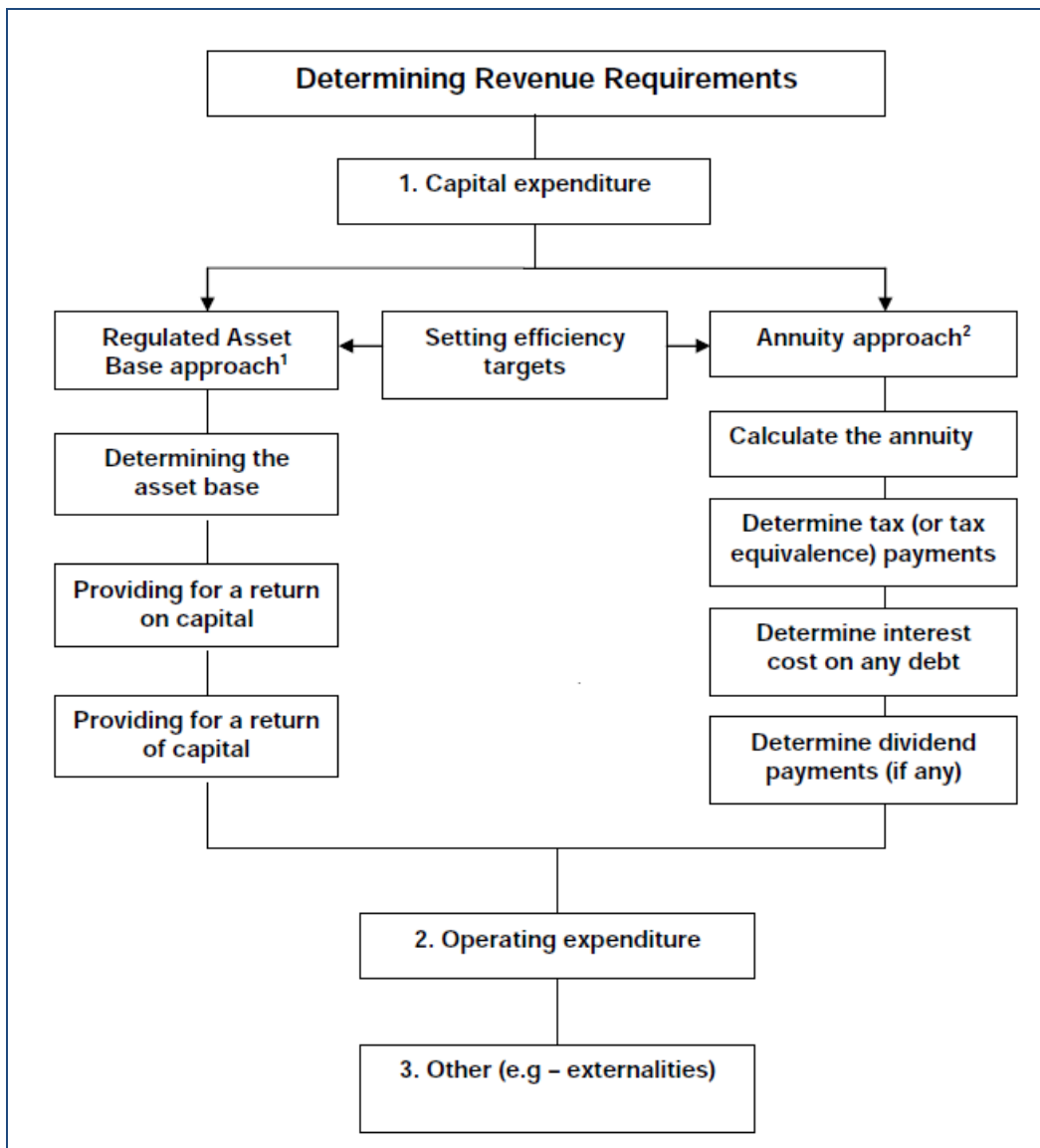
Diagram7 Institutional and regulatory framework



Source: NWI, 2007

The revenue requirement of a water business reflects operating costs (operating, maintenance, administration, bad debts and working capital) and capital costs (replacing assets, expansion, depreciation and [when at the upper bound] a return on assets) associated with providing water storage and delivery services. The key steps involved in determining revenue requirements are outlined in the following Diagram. There are differences between jurisdictions in the way they determine revenue requirements at all points in the process (NWI, 2007).

Diagram8 : Determining revenue requirements



Notes: 1. The RAB approach includes an allowance for a return of capital (depreciation) and a return on capital. Taxes (where a pre-tax WACC is used) and dividend payments are provided for under the RAB approach. 2. The annuity approach forecasts asset replacement and growth costs over a fixed period and converts these to a future annualised charge (assumptions regarding rates of return on, and of, capital are implied within this process).

Source: NMI, 2007

Charges generally comprise a wholesale water charge (where applicable), an infrastructure access fee, a usage charge and an account fee. The infrastructure access fee typically is a 'fixed charge' and the water usage charge a 'variable charge'. Often infrastructure access charges are applied based on the entitlement held. Some use a pre-determined split between fixed and variable charges (NWI, 2007).

For example, the biggest water supplier in Queensland uses a two part tariff system: one part is fixed and the other part is variable. Most of their water schemes work under a price cap (i.e. that the tariffs of the fixed and variable parts don't vary along with the costs). In this system the revenues of the water supplier will vary as costs can fluctuate with the amount of water being supplied. The other scheme works with a revenue cap,

where the irrigators pay a fixed revenue part to the supplier. This puts the risks with the users of the water (OECD, 2010).

In Victoria, water access entitlements (an irrigator's right to a share of the available water resource) and delivery rights (a right to a share of the capacity of a distribution system) have been unbundled. Consequently, irrigators in Victorian supply schemes hold both a water access entitlement and a delivery share, with different charges attached to each of these two elements.

This system gives more freedom to an irrigator so he can sell his water share outside of the scheme's delivery system. This while ensuring that the irrigator (who still owns the delivery share) remains liable for the fixed charges associated with the delivery share, thus contributing to operation and maintenance of the delivery assets. This approach protects a water supply scheme owner from the risk of lost revenue as a result of water access entitlements being traded out of the scheme and reducing the scheme's revenue. In other Australian states, typically an "exit fee" must be paid before a water entitlement can be transferred out of a supply scheme, to protect the revenue base of the supply scheme operator (OECD, 2010).

In places where water metering is already in place, the irrigators are generally charged a fixed service fee in proportion to their maximum entitlement and a delivery fee in proportion to the volume used.

Socio-economic considerations are factored into water pricing decisions so different prices can apply across jurisdictions. There are almost no subsidies to water supply schemes. Price paths of five years were developed to remove the subsidies of the past and implement the rise in prices gradually. This was important so people could adapt to the changes. A small number of schemes are not economically viable so full-cost recovery is never likely to be achieved, as customers simply do not have the capacity to pay the price increases that would be required to achieve it. These continued to receive subsidies from the government but in a more transparent manner (NWI, 2007).

There are programmes in place to promote water saving technologies (see 1.2.2.2).

According to a study from 2005 (Qureshi et al.), water charges paid by irrigators in the MDB to water authorities and supply companies range from 30 AUD to 90 AUD per mega litre (22 EUR to 66 EUR per mega litre).

An article in the International Business Times in November 2010, talked about 120 AUD (88.1 EUR) per mega litre for the agricultural sector and 1,930 AUD (1,416.99 EUR) per mega litre for households. The numbers are based on 2008-2009 and on prices throughout Australia.

1.2.2.1.2 Water trading

In the Murray-Darling Basin water markets are used to move water to places where it can make a greater contribution to the economy. There are registers of water entitlements that are publicly accessible and standards for water accounting. Initially water trading was limited to trades within irrigation systems. However, over time, changes have been made to the trading rules, which have permitted inter-valley and more recently interstate trade to take place. There is a difference between trading in seasonal allocations and in entitlements, which are permanently transferred to the other party. In some areas the interregional water entitlement trading is limited to 4%. This puts a limit on the trading in these entitlements, on the market performance and creates uncertainty for potential buyers and sellers. To make sure that water is allocated

where it has the highest value, Australian Governments have been working together to reduce the differences in water entitlements to lower the transaction costs and enhance trading even more.

These entitlements are bought and sold on the water market. The trading is mainly done between irrigators. Typically, the most trading is being done in the southern part of the Basin but the last years a lot of effort is done to enhance trading in the rest of the MDB. The market prices for buying/selling water entitlements are published to provide greater transparency to the tender process. A consultancy firm, GHD Hassall, provided this market price information to the Department of the Sustainability, Environment, Water, Population and Communities. Prices vary a lot between entitlements and regions. Therefore, we included the overview made by GHD Hassall for the year 2010/11. The prices are given per entitlement share (in AUD/megalitre) only for approved permanent water trades. The prices fluctuate from 120 AUD to 2,130 AUD (88.1 EUR to 1,563.96 EUR) for an entitlement (average prices in one year). The highest prices are for the so called 'high security' entitlements and the entitlements in the southern part of the Basin where the availability of water is less secure. The lowest prices are typically paid for the normal security entitlements. Prices also depend on the season and on the fact if the water is only sold temporarily (seasonal allocations) or permanently (entitlements).

Table 9 Murray-Darling Basin Water Entitlements 2010-2011



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GHD Hassall

Murray-Darling Basin Water Entitlements Summary of Market Prices for Approved Transfers

GHD Hassall provides the Department of the Sustainability, Environment, Water, Population and Communities with water market price information. The following table shows the volume weighted average prices¹ for the year to date 2010/11, the March month and Quarter for approved permanent water trades (which may lag the exchange of contracts by several months). The data used in VWAP calculations is obtained from publicly available sources² such as state water registers and the Murray Irrigation Water Exchange.

Region / Entitlement	25 th and 75 th percentile range of reported prices used in March Quarter VWAP	Volume Weighted Average Price ^{1&3} (\$/ML or Share)			March Quarter VWAP sample volume (shares or ML)
		Mar. Month 2011	Mar. Quarter 2011	Year to Date (10/11)	
Southern Basin – High Security and High Reliability					
NSW Murray High Security ⁵	\$2,050 - \$2,620	\$2,620	\$2,085	\$2,130	2,380
NSW Murrumbidgee High Security	No reported trade	No trade	No trade	\$1,910	No trade
Vic. Goulburn High Reliability	\$1,600 – \$2,000	\$1,925	\$1,900	\$2,035	8,615
Vic. Murray High Reliability above Choke	\$1,500 - \$2,000	\$1,560	\$1,630	\$1,890	4,140
Vic. Murray High Reliability below Choke	\$1,550 - \$2,000	\$1,710	\$1,810	\$1,950	15,495
South Australian Murray Class 3A	\$1,600 - \$1,850	\$1,745	\$1,700	\$1,860	1,210
Southern Basin – General Security and Low Reliability					
NSW Murray General Security ⁵	\$720 - \$935	\$835	\$840	\$1,080	4,900
Murray Irrigation Limited (effective on-river) ⁴	\$800 - \$820	\$780	\$775	\$840	3,545
NSW Murrumbidgee General Security	\$750 - \$855	\$825	\$855	\$960	1,520
Vic. Goulburn Low Reliability	\$100 - \$150	\$120	\$130	\$120	2,005
Vic. Murray Low Reliability above Choke	\$90 - \$150	\$120	\$115	\$125	1,490
Vic. Murray Low Reliability below Choke	\$100 - \$185	\$135	\$125	\$130	1,075
Central and Northern Basin – General Security and Medium Priority					
NSW Lachlan General Security	No Trade	No Trade	No Trade	\$810	No Trade
NSW Macquarie General Security	- \$1,250 -	\$1,250	\$1,250	\$1,250	11,985
NSW Namoi General Security	- \$1,700 -	\$1,700	\$1,700	\$1,700	100
NSW Gwydir General Security	- \$2,210-	\$2,210	\$2,210	\$2,210	600
QLD MDB water sources		Due to a software upgrade, the current permanent trading report is unavailable			

1. A volume weighted average price (VWAP) is the price paid per unit/share of water entitlement across all of those trades with a reported price that is within a reasonable range (see Note 3). It is calculated as the sum of value of all price reporting dealings divided by the sum of their volume/number of shares. VWAP is commonly used in financial analysis as it helps reduce any disproportional impacts of small volume transactions, amongst other things.
2. All VWAPs are rounded to the nearest \$5 for reporting purposes.
3. All data used in these calculations was obtained from <http://wma.dnr.nsw.gov.au/wma/index.jsp>, <http://www.waterregister.vic.gov.au>, http://www.murrayirrigation.com.au/watexch/perm_hist.aspx, http://www.qld.gov.au/water/trading/market_info.html and <http://e-nrms.dwlbc.sa.gov.au/wtr/Prescribed.aspx#>. Murray Irrigation Limited (MIL) prices are those identified by the company. All other data used reflects reported prices and volumes associated with approved permanent dealings. That information is based on self declared prices that are unaudited and these may include related party trades.
4. Due to the reporting of prices that are unlikely to be truly representative of an efficient market price the sample ranges are constrained. High Reliability/Security VWAP samples exclude prices less than \$1,000 per share and greater than \$5,000 per share. The General Security (in the southern basin) VWAP samples exclude prices below \$10 and above \$2,500 per share. Low Reliability VWAP samples exclude prices less than \$10 per share and greater than \$1,000 per share. General security and medium priority VWAP samples exclude prices below \$10 per share and greater than \$5,000 per share. Murray Irrigation Limited (MIL) trades that include Delivery Entitlements have been adjusted to reflect the current access termination fee liability assumed by a new owner with a Water Entitlement Only Account Licence to ensure that prices are comparable with on-river entitlements.
5. The NSW Water Register does not differentiate between trades above and below the Murray Choke.

The volume weighted average prices and Bid – Ask price ranges provided here do not constitute advice and should not be relied on when making any decision. They do not purport to represent true or fair market value. They are based on historical information made available by third parties. The information is not complete and includes declared but unaudited unit transaction prices. GHD has used that information in good faith and does not guarantee the accuracy or completeness of that information.



GHD Hassall

Summary of Bid-Ask Price Ranges in the Southern Connected Murray-Darling Basin

Figures in the previous table represent approved trades, listed on official registers. These may lag the relevant market transaction (or exchange of contracts) by several months.

To provide more up-to-date information on market conditions, the following table reports recent bid (buyers) and ask (sellers) price ranges for water entitlements in the Southern Connected Murray-Darling Basin. This is based on anecdotal information provided by water brokers and information on current offers that are available to non-members of water trading exchanges.

Broker bid and ask price ranges were collated from interviews with over 20 water brokers conducted by GHD Hassall in March 2011. The information provided by brokers has been aggregated and does not identify the feedback of any single broker nor transactions they may have been involved in. Bid and ask price ranges from water trading exchanges were collected from Murray Irrigation Limited and the Murrumbidgee Water Exchange on 31 March 2011. On-line searches of other exchanges failed to reveal non-member/publicly available bid-ask price ranges.

Region / Entitlement	Buyers Bid Prices		Sellers Ask Prices	
	Brokers Mar. Quarter 2011	Water Exchanges March 2011	Brokers Mar. Quarter 2011	Water Exchanges March 2011
NSW Murray High Security	\$1,400 - \$1,600	No bid reported	\$1,800 - \$2,500	No ask reported
NSW Murrumbidgee High Security	\$1,500 - \$1,600	\$1,500 - \$1,700	\$1,800 - \$2,200	\$1,500 - \$8,200
Vic. Goulburn High Reliability	\$1,300 - \$1,600	No bid reported	\$1,700 - \$2,000	No ask reported
Vic. Murray High Reliability (above Choke)	\$1,350 - \$1,600	No bid reported	\$1,650 - \$1,900	No ask reported
Vic. Murray High Reliability (below Choke)	\$1,400 - \$1,700	No bid reported	\$1,800 - \$2,000	No ask reported
South Australian Murray Class 3A	No trade reported	No bid reported	No trade reported	No ask reported
NSW Murray General Security	\$800 - \$850	No bid reported	No trade reported	No ask reported
Murray Irrigation Limited (effective on-river)	\$700 - \$750	No bid reported	\$800 - \$950	\$800 - \$1,000
NSW Murrumbidgee General Security	\$800 - \$850	- \$750 -	\$850 - \$900	\$800 - \$900

According to a study of the National Water Commission (2010) the water trading in the Southern Murray-Darling Basin increased Australia's gross domestic product by \$220 million (162 million EUR) in 2008–09 through reallocations of water used in agriculture. The total production benefits were even more than \$370 million (272 million EUR) in 2008–09. There is, however, a difference in the trade amount of the seasonal allocations and the entitlements. The trading from 2000–2003 was mainly for seasonal allocations (CSIRO, 2007 based on Peterson et al, 2004).

Allocation trade grew by 42%, from 537 GL in 1998–99 to 764 GL in 2007–08, with large seasonal fluctuations. Typically, sellers of water entitlements received cash injections that helped them cope with drought and, in some cases, to manage debt. The sellers could have turned to more opportunistic irrigation or ceased irrigation. The purchasers typically maintained their production or kept permanent plantings alive.

The main buyers of water during the 2007/08 droughts were horticulturalists. Without water trading, it is likely that many long-lived horticultural assets would have been lost. The main sellers were dairy producers. When water prices were high, their allocation sales generated income that was used to purchase additional fodder. Also the producers of rice sold their water allocations because of the difficult rice growing conditions during the droughts.

According to the same study of the NWC (2010) water trading has helped individual irrigators (buyers and sellers) to manage and respond to external drivers (including seasonal water availability, changes in commodity prices and input costs, government water policies, and social trends) by allowing more flexible production decisions. That flexibility improved cash flow, debt management and risk management. Irrigators are even starting to use market derivatives for water, such as leases and forward contracts, to be even more flexible in trading water (CSIRO, 2007). A study from 2006 by the Allen Consulting Group did notice considerable transaction costs when trading on the MDB water market. The lowest at 2.5% of the value of trade and the highest at 21% of the value of trade. However, a lot of effort has been done the last couple of years to lower these transaction costs and it is not clear if these numbers are still valid today.

Following on from environmental problems due to over-allocation of rights resulted from the first years of trading water rights, the government is now buying water rights for environmental purposes. This 'environmental water' is given the same level of importance as water access entitlements for consumptive use. The term 'environmental water' is used to describe both the water needed to cover evaporative losses from the system, conveyance losses and transfer obligations and, also, to describe the water used in the periodic watering of wetlands etc. Currently, it is believed that the effort that is being done to maintain the environmental health of the Basin is not enough. Therefore, in October 2010 the Murray-Darling Basin Authority released a new strategic plan for the integrated and sustainable management of water to secure the long-term ecological health of the Murray-Darling Basin, called the Basin Plan. It entails cutting existing water allocations and increasing environmental flows.

This new plan encounters a lot of head wind. There have been a number of protests about the plan in rural towns. It is criticised because of the water modelling used and mostly because of the amount of water that is planned to be cut off from the irrigators (for some valleys up to 45%). Communities are afraid of possible impact on the agriculture production and the consequential job losses. The fact that even more entitlements would be bought back from willing sellers to ensure the environmental needs in the basin concerned the rural towns. The buy-back system had already dislocated a lot of the local communities (see 1.3.2.2).

The way the new plan was communicated had a lot to do with the negative reactions. The new basin plan came as a shock to the community. After all the commotion, legal advice from lawyers for the Federal Government lead to changes in the plan. The Government believes the plan must give equal weight to the environmental, social and economic impacts of the proposed cuts to irrigation. On the other hand, environmentalists and South Australian irrigators, at the end of the river in South Australia, don't want any changes to be made on the new basin plan. At the moment the new plan is stuck in its reformation process.

1.2.2.2 Factors influencing the impact/effectiveness of water pricing policies

The Australian Commonwealth was the main driver behind the reform of the water policy. Because constitutional responsibility lays with the states, the Commonwealth installed a system of payments to encourage compliance by the states.

Besides the reform of the water policy, the Australian Government is trying to improve the efficiency and productivity of on farm irrigation water use and management. There is the Sustainable Rural Water Use and Infrastructure Programme for 5.8 billion AUD (4.26 billion EUR), aiming at increasing water use efficiency in

rural Australia. The On-Farm Irrigation Efficiency Programme is part of the Sustainable Rural Water Use and Infrastructure. This 300 million AUD (220.4 billion EUR) programme is aimed at assisting irrigators in the Lachlan and southern connected system of the Murray-Darling Basin to modernise their on-farm irrigation infrastructure. The water saved through better efficiency rates is shared between irrigators and the environment. Subsidies are given to programmes but they are not open to individual irrigators. Only water businesses can hand in a project. These projects can include however individual irrigator sub-projects. Individual irrigators may benefit from the subsidies, but only in an indirect way.

To obtain a better view on the actual improvements in efficiency nearly all water use is metered.

Farmers are informed through publications about the price. The water authorities manage websites with relevant information and brochures for the agricultural sector.

1.3 Analysis of water pricing and water allocation policy

1.3.1 Drivers and Barriers

In 2010 the OECD published a report about the environmental effectiveness and efficiency of water use in Australian agriculture. In the report 17 lessons that were derived from the Australian trading system are being discussed. These lessons represent the most important drivers and barriers of the current system (and of the development of the system over the last decade). We highlight the most important lessons.

One of drivers of a successful water policy akin to the Australian model is the **unbundling** of the water access licenses so that access entitlements, seasonal allocations and use approvals can be managed using separate instruments and independent bodies.

The next important lesson is when setting up a trading scheme for water one has to be wary of **over-allocation**. When water entitlements are not tradeable, users tend to hold entitlements to more water than they use, i.e. sleeper water. They hold this sleeper water as a safeguard. However, when a limit is placed on the total amount of water that may be diverted and trading is allowed, irrigators will either use all their entitlements or sell their unused entitlements. In an under-allocated system, the activation of this sleeper water is not a problem. On the other hand, when a system is not prepared for all entitlements to be used and does not account for unmetered use (ex. small farm dams, use of groundwater, ...) the system will be under pressure (over allocated) and stress on the environment will be significant. This is what happened in the MDB. It has become clear that it will be necessary within the MDB to manage all forms of water use with greater precision.

Instead of using an entitlement to a specified volume of water, a unit share **structure** should be used. This reduces the costs of changing a system boundary because in that case any number of shares can be sold without having to first subdivide the holding. This reduces administrative costs.

With the start of the trading system, accurate **license registers** should be obliged. Knowing all the persons who have an interest in the water entitlement at all times is crucial for a low-cost entitlement trading system. The same goes for **metering**. This should be implemented in an early stage of the water policy so administrators can monitor and check if everybody stays within their limits. Water use that cannot be metered should be dealt with through other licenses, for example offset rules that will require those intending to

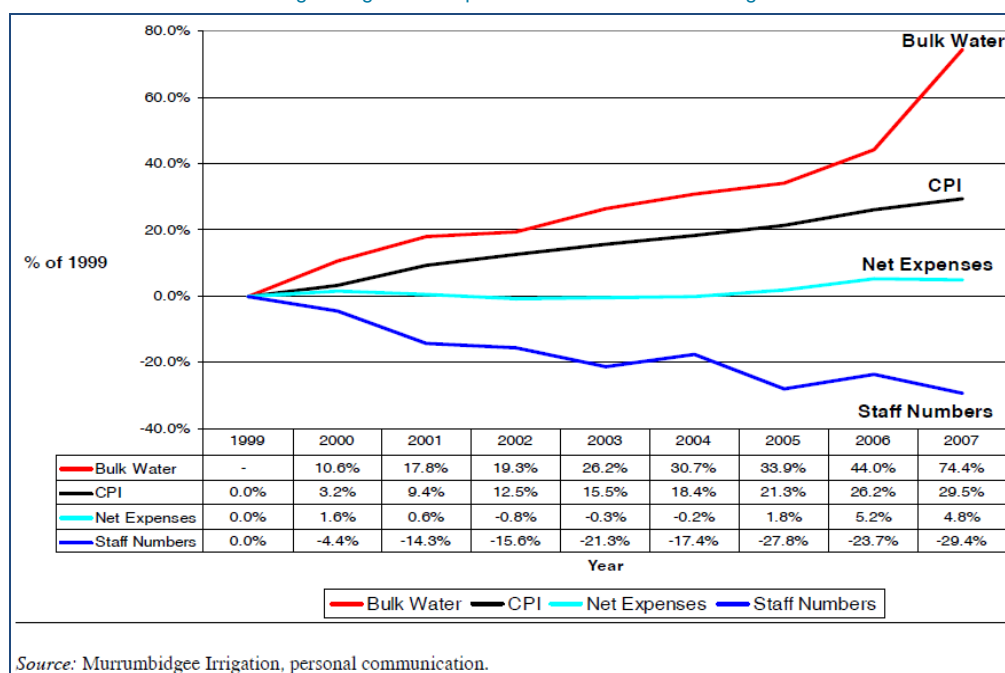
establish a new plantation to first acquire and surrender sufficient water to ensure that the increase in forestry does not erode the reliability of existing entitlements. Similar arrangements are also being put in place to control farm dams.

As in the case of over-allocation, trading can make droughts worse if traders are not allowed to **carry unused water forward** from year to year. Otherwise people tend to quickly use all the water before the year ends. Irrigators should be allowed to choose between leaving unused water on their account, with an adjustment for evaporation losses, or sell it. In that way water users can better manage inter-seasonal risk.

We already mentioned the necessity to secure a certain amount of water for environmental purposes. Within this **environmental water** there should be two levels of security. The water necessary to maintain minimum flows, provide for conveyance and cover evaporative losses needs to be more secure than that used to allocate water for other environmental and consumptive purposes. Attention should also be paid to **groundwater use**.

To augment efficiency all users should pay at least the **full lower bound** cost and preferably the upper bound cost of supplying water to them. Australian experience has found that one of the easiest ways of achieving such a pricing regime is to transfer ownership of water supply assets to a company owned by all the entitlement holders in an area. The general experience is that the transfer of ownership and independent control to local water users has resulted in considerable savings. In New South Wales' Murrumbidgee Irrigation System, transfer of responsibility and ownership of the main supply system in that region enabled growers to reduce the costs of supplying water to them, as can be seen in Diagram9.

Diagram9 : Index of water supply and delivery costs in real terms since the transfer of ownership and control of water supply assets to Murrumbidgee Irrigation compared with New South Wales government bulk water changes



Source: OECD, 2010

Environmental externalities should be dealt with separately and not through the water price policy. In the case of salinity management, for example, Australian resource managers are using salinity charges, interstate salinity trading schemes and off-set policies in order to encourage people to invest and manage land in ways that reduce salinity.

Removal of administrative impediments to **interregional trade** and inter-state trade is necessary for the development of efficient water markets. In the MDB an independent agency is appointed with this task. According to the OECD-report (2010) markets will be more efficient if entitlements are allocated to **individual users** rather than to irrigator controlled water supply companies and cooperatives.

One important issue in a similar water policy is **communication**. When communicating timing and other sensitivities should be considered. A good plan is necessary from the beginning, as can be seen in the MDB where people are getting 'reform fatigue' (Commonwealth, 2011). Currently, a new Basin plan is being developed but there is a lot of reluctance because of the multiple reforms over the last decades. Therefore, the necessity of further reforms should be adequately explained.

Water markets are more effective when **information** about the prices being paid is available and offered to all participants in a timely manner. And as a last lesson, the OECD advises that government should not be involved in the provision of water brokering services. The essential rule for them is that market creators should not be market makers.

The overall message that the OECD report gives is that countries should be careful as they contemplate the development of water markets. The potential benefits are significant but only if early attention is given to the sequencing of reforms and the preparation of the allocation and entitlement regime for trading (OECD, 2010).

1.3.2 Effects of the water pricing policy

1.3.2.1 Direct effects

Water trading has influenced water use in the Murray-Darling Basin at the regional and local levels. However, in most cases, reductions in regional water use due to trading comprised less than 10% of total water use—reductions in water use due to drought were much larger (NCW, 2010).

1.3.2.2 Indirect effects

According to the study (NCW, 2010), where regional water use dropped it did not lead to a proportional reduction in the value of agricultural production—because water moved to those who value it most. Farmers can exploit dry land farming opportunities, substitute water for other inputs (such as fodder) and increase their on-farm water use efficiency. It has been observed that water trading allows some (high-value) industries to maintain production while other (low-value) industries reduce production.

Comparisons of trade patterns and key socioeconomic indicators revealed no noticeable link between patterns of water trading in or out of a region and changes in population, employment in agriculture or weekly household income. At a more finely disaggregated local level, there is some evidence to suggest that water trading did accelerate existing processes of social and economic change in certain areas (NWC, 2010). However, contact with experts suggested that the water policy did have severe social equity implications. This was caused by the buy-back programme that we discuss below.

The National Water Commission's study (2010) says that water markets and trading are making a major contribution to the achievement of the NWI objective of optimising the economic, social and environmental value of water. Water trading had significantly benefits for individuals and communities across the MDB. Water trading has given individual irrigators more flexibility in their water use and production decisions. This flexibility has helped them respond to external factors such as the drought. The environment has also benefited from the net downstream movement of water during the drought.

Recent environmental purchases of water entitlements by the Australian Government are not considered in detail in the report (NWC, 2010) because most purchases were not evident in available trade data. However, other reports have addressed this issue and there is evidence that the buying of environmental water has happened without considering the consequences for the community.

The government was buying water rights from 'willing sellers'. In practice though, many of them were selling their water entitlement to the Government as an option of last resort following many years of the worst drought on record and mounting debts. The lack of a strategic approach in the Commonwealth water purchase programme has also been blamed for the 'Swiss cheese' effect in irrigation districts where it is purchasing entitlements. The term 'Swiss cheese' refers to what happens when some entitlement holders along an irrigation channel sell their entitlements and stop irrigating. The effect of this is to create 'holes' in irrigation areas, reducing the efficiency of delivering water down that channel, stranding assets and increasing the maintenance costs and delivery fees for the entitlement holders who remain (Commonwealth, 2011).

The Senate is currently undertaking an inquiry into the Water Act and to determine if the Act needs to be amended. But all the changing in planning and the non –strategic buying of the government is leading to a reduction in business confidence and increased investor uncertainty.

1.4 Conclusions

In the last decade, together with a climate that became drier, the water use increased exponentially in the Murray Darling Basin. According to Cullen (2007) the long term inflow should be at 10.5 billion m³, where it was only 4.3 billion m³ on average in the period 2001-2007. The water use from consumption reduced the annual stream flow in the Murray mouth by 61 per cent during 2007 and 2008. This meant the river stopped flowing through the mouth 40 per cent of the time. This resulted in a decrease of water availability in the basin, affecting the Basin's natural balance and ecosystems, resulting in severe land degradation and salinisation of the land.

Also the irrigators in the Murray-Darling Basin were affected by this drop in water availability. During the last decade, the economic performance of the agricultural sector in the basin declined, mainly because of the drought. This meant a decrease of their yearly income and a decline in the amount of people they employed. The basin's area is important for Australia's agriculture and accounts for about 40 per cent of Australia's total gross value of agricultural production. About 70% of all irrigation in Australia is located in this basin. The irrigators use on average 4 megalitre water per Ha. The biggest users of water per ha are the fruit trees, nut trees and other berry fruits with 5.7 ML per hectare. They are followed closely by the cotton farms, which use 5.6 ML per hectare. The cotton farms also use the largest total volume of water. Other crops that need a lot of water per hectare are the vegetables for human consumption, grapevines and plants used for decoration. Other crops under irrigation are sugar cane, rice and different pastor and cereal crops.

Within the basin, the agricultural sector consumes about 83% of the surface water. Besides from this surface water, which makes up only about half of their water use, they also use groundwater (27%) and water captured from their own dams, rivers or lakes (26%).

The Australian water policy went through lots of reforms in the last couple of decades. Currently a water trading system is in place. With the water trading system, the government came up with a way to allocate the water where it has the highest economic value. The water trading system has some innovative features like unbundling the management of the licences and the allocations, licensing water shares instead of vast volumes, setting the goal of full costs recovery, reducing transaction costs to a minimum, different levels of security entitlements, ... The unbundling of the water rights, the water licences and the water allocations means that three different authorities are responsible for each of the steps an irrigator has got to go through to get water on his farm.

The allocations are done seasonally and are based on the available water in the dams. Water entitlements are mandatory for all users and no new ones are given anymore. New irrigators need to get their water entitlements on the water market. The trading system has proved to be useful in times of drought in allocating the water to where it has the most value. During the drought of 2007-08 this meant a flow of water entitlements went from the dairy producers and the rice producers to the horticulturalists. Horticulturalists

need water for their long-lived assets, whereas the dairy producers needed the extra money to buy fodder for their cattle.

This appears to be an efficient, progressive system on paper but the construction, that is now in process, for a new basin plan proves that the system is not flawless yet. Especially the over-allocation of the available water is a problem. The amount of water that is set aside for environmental purposes is too limited. The problem is that too much water rights have been distributed, not leaving enough water for the health of the ecosystem. In a system where everybody is given rights without the possibility of selling these rights, there will always be people who don't use all their rights. So these rights that are not called up on are an extra buffer for the ecosystem gets more water. Once trading comes in place, these same people will see an extra income in selling their abundant rights. So, all rights will be exercised and less water than before goes to the ecosystem.

Currently, a new basin plan for the Murray Darling basin is being developed and will tackle the problem of over-allocation. This is being done by buying back water rights (buy-back programme) from farmers. This system has been in place since a couple of years but has been controversially because of the negative effects on the local communities. The local communities suffered because the locals who sold their rights also moved away or stopped their agricultural business, leaving holes in the social system. It also resulted to be more difficult than expected in getting the farmers on board. Because of that, the amount of water rights that the government wanted to buy back was not reached.

For the future even more water restrictions will come in place with the new basin plan. The Australian government will have to come up with a plan that suits both the environment, the community as the economy in the basin.

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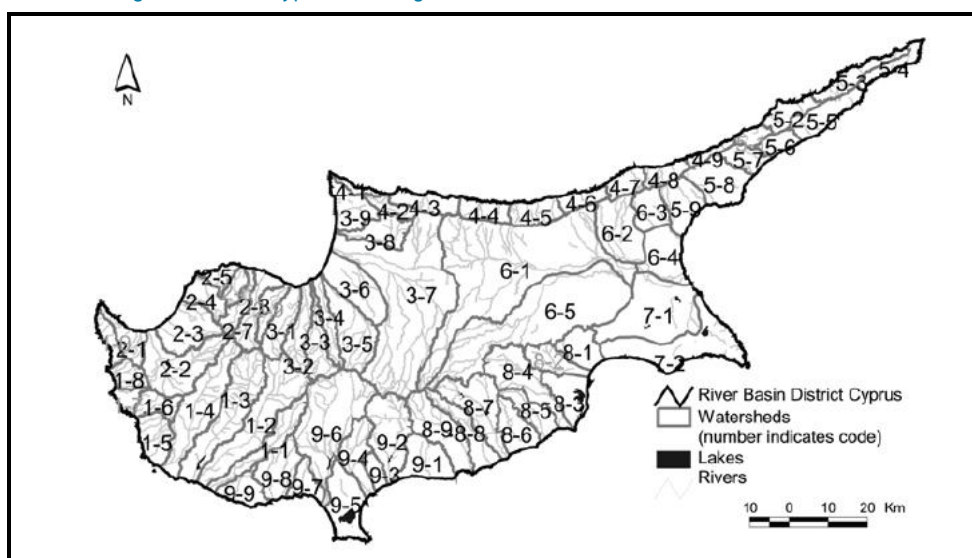
2 CYPRUS

2.1 Characteristics of the case study area

2.1.1 Broad introduction on the area and characteristics of agriculture

Cyprus is an island located in the eastern Mediterranean, 75 km off the coast of Turkey (between latitudes 34° and 36° N, and longitudes 32° and 35° E), stretching 240 km from east to west, and 100 km from north to south at its widest point. Its population amounts to around 850 000. Partly because of its relatively small size (9251 km²), the island is regarded as one single River Basin District (RBD), subdivided into nine hydrological units consisting of 70 watersheds (see the following Diagram). However, “according to the provisions of Article 1 of Protocol No. 10 on Cyprus, the application of the acquis is suspended in those areas of the Republic of Cyprus in which the Government of the Republic of Cyprus does not exercise effective control” (MoA 2010). The area under control of the Government of the Republic of Cyprus encompasses 47 watersheds (MoA 2010). The present report focuses only on this part of the island.

Diagram10: RBD Cyprus including watersheds and main bodies of water



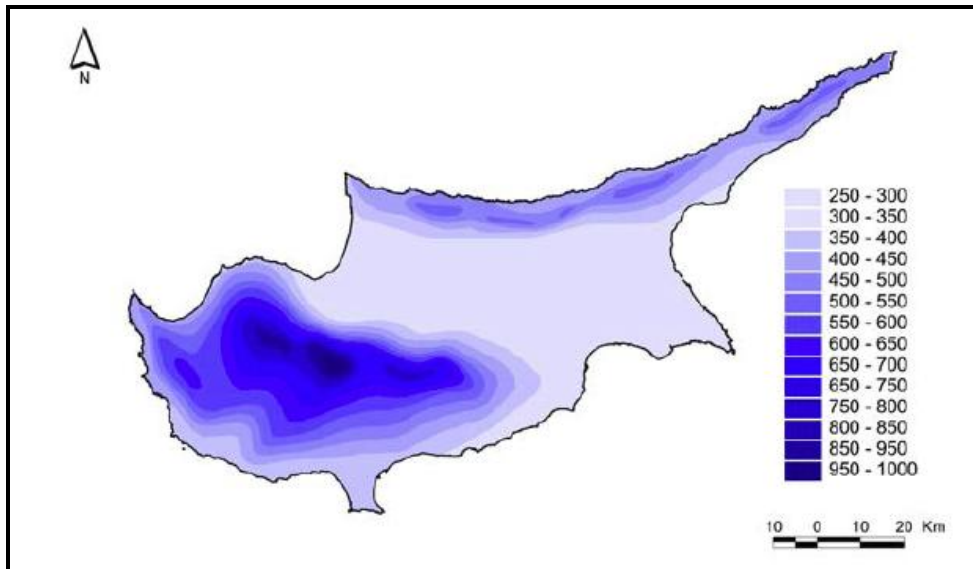
Source: MoA 2005 (Art 5 Report).

The south-western part of Cyprus is dominated by the Troodos massif, with a maximum height of 1953 m the highest elevation on the island, which is of crucial hydrological importance, due to the amount of precipitation occurring here (see above mentioned Diagram). Cyprus has a strongly pronounced Mediterranean climate, with rain (and snow in the Troodos massif) during the winter months (December – February), and intense heat and drought during the summer months. The average annual rainfall amounts to 460 mm/m², with a yearly declining tendency (-14% in the last 100 years) (MoA 2010; WDD 2007).

Cyprus suffers from long and often severe droughts during summer, and is classified (together with Malta) as the EU country with the most acute water shortage. Over the last 40 years, water scarcity became one of the

most severe growing problems that the country had and has to face, due to declining rainfall, accompanied by population growth (locals and immigrants), the growth of the tourism industry, the varying seasonal demand for water, the improvement of living standards, and the increase of water demand for irrigation (WDD 2007; Hadjipanteli 2011).

Diagram11: Mean annual rainfall in Cyprus in mm (1991-2000)



Source: MoA 2005 (Art. 5 Report).

According to the Corine Land Cover report 2000, the total area of arable land and permanent crops was 443.043 ha and equaled 47.89% of the total island area (of which approximately 145 000 ha are under crops). Forests cover 407.858 ha, or 44.12% of the total island area. Other land uses comprise of the artificial surfaces/urban areas (70.233 ha/7.63%), wetlands (1955 ha/0.21%) and water bodies (1201 ha/0.15%) (Hadjipanteli 2011; Corine Land Cover 2000).

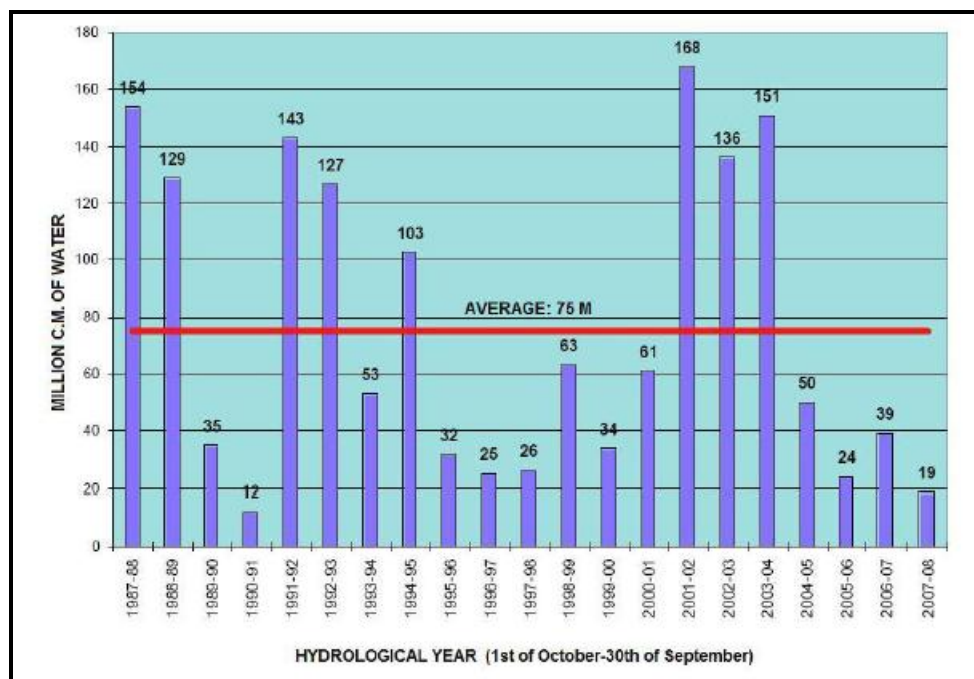
The main water consuming sectors are agriculture (see chapter 2.1.3 for more information) and the domestic sector including tourism. During the 1960s and 1970s, the primary sector (i. e. agriculture) was considered to be of great economic importance, representing up to 18% of national GDP and 20% of total employment in the mid-1960ies. The economic importance of agriculture declined, however, due to the growth of the tertiary sector, and the primary sector today accounts for only 2% of GDP and 7% of the total workforce (Zoumides/Zachariadis 2009).

2.1.2 Water resources and aquatic ecosystems

As mentioned in the previous section, water shortages in the summer months are characteristic for Cyprus, and drought phenomena are one of the matters of highest importance, as surface water availability changes significantly from year to year (WDD 2007). Due to this, the figures available regarding average yearly available water supply do not accurately represent the water situation in Cyprus (see also section 2.2.1 on

restrictions imposed on water use in years of low water availability). The following Diagram, depicting yearly surface water availability in dams and reservoirs, demonstrates this clearly.

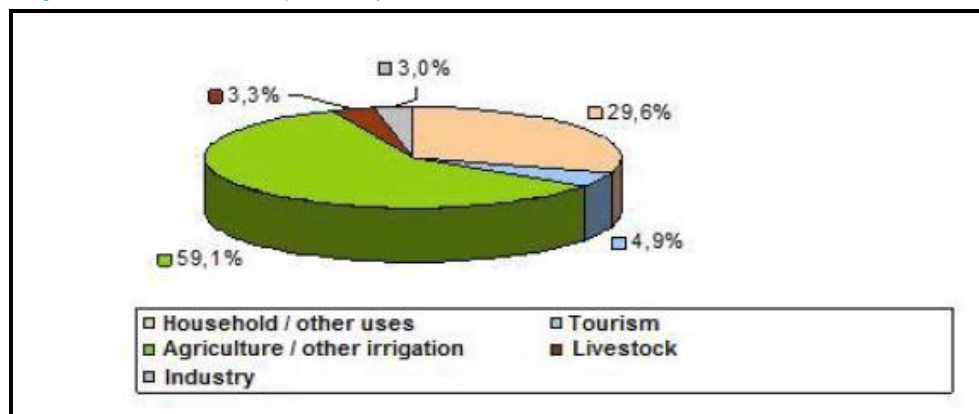
Diagram12: Inflow volume at dams per hydrological year 1987-2008



Source: WDD 2007.

Due to this (and due to the restrictions on water use), both the sources for agricultural water abstraction as well as the amount consumed vary from year to year. Yearly water needs of agricultural activity sum up to an average of 178.5 Mm³; however, as this demand is rarely satisfied, the actual water consumption in agriculture varies accordingly (around 150 Mm³/year), representing around 60% of Cyprus' water consumption (see following Diagram; Hadjipanteli 2011).

Diagram13: Main water uses per activity



Source: MoA 2010.

As there are no rivers with perennial flows along their entire length in Cyprus, it is difficult to estimate the effects of surface water abstractions on river ecology with regard to environmental flows. It is clear, however, that downstream of the dams, environmental damage is caused due to a lack of water withhold in the reservoirs (MoA 2007; MoA 2010).

Furthermore, as the amount of water needed by agriculture is relatively stable over the course of the years, the gap in (surface) water supply and demand is partially bridged by the use of groundwater.

As a result, piezometric levels are observed to decrease rapidly, in some aquifers more than 1m/year, which clearly indicates overuse of the resource (Hadjipanteli 2011). As the Government of the Republic of Cyprus states: *“The present level of abstraction of groundwater for all of Cyprus is estimated to be 130 Mm³/year, of which 10 Mm³/year are made available by artificial recharge. The average yield of abstractions for domestic water supply during the period 1991-2000 is estimated to be on the order of 25 Mm³/year, for irrigation around 102 Mm³/year and for industrial use around 2.5-3.0 Mm³/year. During the last years, the abstractions for domestic water supply decreased to a level of 18 to 20 Mm³/year. The total recommended abstraction from all groundwater bodies is estimated to be in the order of 80 Mm³/year, based on the water balance of each aquifer and their estimated recovery. During the last decade, almost all the groundwater bodies, except the river bedded coastal water bodies, are being overexploited.”* (MoA 2005/Art. 5 Report).

Therefore, the gap between groundwater abstraction and natural replenishment amounts to around 25 Mm³/year. This gap is expected to shrink because of WFD implementation (Hadjipanteli 2011/WDD 2011a).

Main characteristic of Cyprus' aquatic ecosystems is the variability in the discharge regime (for rivers), respectively the water level (for lakes and artificial reservoirs), due to the extreme climatic conditions. According to Article 5 WFD, three river types occur in Cyprus: 159 water bodies are designated the type “large rain volume with non-continuous flow”, 40 water bodies have a “small rain volume with a non-continuous flow” and only 17 water bodies are designated as “large rain volume with a continuous flow”; of these 216 river water bodies, 49 are identified as being heavily modified (MoA 2007; WDD 2011).

As a result of the dry Mediterranean climate, only five natural lakes (brackish or salty) exist on Cyprus. The other non-flowing water bodies are man-made with the objective to provide water for domestic and agricultural needs (Government Water Projects: see section 2.2.1 for more details). The lakes can be characterised as dynamic systems, as the water level depends exclusively on rainfall and evaporation. In winter, they fill up, and the water gets used during the dry season, resulting in falling water levels. Very rarely do natural lakes/reservoirs retain water throughout the year, while artificial ones retain water according to the allocation scenario applied during the year (see below). According to Article 5 WFD, 18 lake water bodies were identified, classified into six lake types distinguished by the factors “salt content”, “connection to river” and “water depth”; out of these 18 water bodies, 12 are identified to be heavily modified, while one is considered artificial (MoA 2007; WDD 2011).

Further aquatic ecosystems on Cyprus are three types of coastal waters (MoA 2007). Twenty groundwater bodies are recorded, one of which is located *“entirely in the area where the Republic of Cyprus does not exercise effective control”* (WDD 2011). Of these 19 groundwater bodies, only 4 are in “good” quantitative status (WDD 2011).

2.1.3 Water use for agricultural demand/supply

As outlined in section 2.1.2, the agricultural sector uses almost 60% of all water resources used in Cyprus. Of these approximately 150 Mm³/year, around 132 Mm³/year are used by irrigated agriculture. Irrigated agriculture represents a share of around 28% of the total area under crops (see the following Table) (MoA 2010/Hadjipanteli 2011).

The crops under permanent irrigation in Cyprus are:

- Citrus (27% of water consumption),
- Olives (20.2% of water consumption),
- other deciduous crops (13.5% of water consumption);
- avocado, bananas, walnut, fig, grape and pistachio.

The crops under seasonal irrigation are:

- potatoes (10.8% of water consumption),
- forage crops (7.9% of water consumption);
- and vegetables, melon, legume, greenhouse crops and strawberries.

The mayor non-irrigated crops are wheat, carobs and other forage crops (Hadjipanteli 2011).

The irrigation period starts in April and ends in October - December (depending on the rainfall conditions). However, there are years when irrigation takes place all year round, as is the case with certain crops (Hadjipanteli 2011).

Irrigation water originates from three sources, namely a) surface water, via distribution networks (mostly closed pipe systems) fed by dams and off-stream reservoirs (Government Water Projects: see below for more detail); b) groundwater, via private and communal boreholes (see below for more detail); and c) tertiary treated effluent from sewage water plants. Although there are desalination plants on Cyprus, the water generated here is exclusively used by the domestic sector (Hadjipanteli 2011).

Table 10: Major Irrigation Crops

	Area (Ha)	%
<u>Citrus</u>		
Oranges	2984	7.38%
Lemons	857	2.12%
<u>Deciduous</u>		
Apples	1274	3.15%
Peaches	714	1.77%
Bananas	250	0.62%
Table Olives	13740	33.97%
Table Grapes	900	2.23%
Potatoes (Spring)	6190	15.30%
Potatoes (Intermediate)		
Potatoes (Autumn)		
<u>Vegetables</u>		
Tomatoes (open)	360	0.89%
Tomatoes (greenhouse)		
Cucumbers (open)	237	0.59%
Cucumbers (greenhouse)		
Water Melons (open)	542	1.34%
Haricot bean (open)	250	0.62%
Colocasia	110	0.27%
subtotal	28408	70.23%
Total Irrigated Land	40449.08	28%
Total Agricultural Land	144461.00	

The Government Water Projects (GWP) are large domestic water works (treatment and conveyance) as well as irrigation schemes, constructed by the Government of the Republic of Cyprus in the period 1960 - 2010 to mitigate the increasingly pronounced effects of water scarcity periods. The GWP encompass reservoirs on almost all major watercourses, conveyors, treatment plants and large-scale water distribution networks, which are maintained through the Water Development Department (WDD). The GWP constitute the major

water resources for domestic and irrigation needs all over the island, providing around 50% of the total annual irrigation water demand (Zoumides/Zachariadis 2009). This Diagram, however, refers to “normal” hydrological conditions, and varies greatly – recent studies show that the mean actual consumption of water from the GWP (measured/accounted volumes) for irrigation is only 26.7% of the total irrigation water needs (Hadjipanteli 2011).

The gap between the water provided by GWP and the actual water demand is partially bridged by using groundwater, which is legally abstracted by a limited number of small-scale Irrigation Divisions and individual farmers outside the GWP that hold abstraction licenses. In years when the water provided by the GWP for irrigation does not suffice to meet irrigation water demand, however, groundwater is extensively used not only outside the GWP, but also by the farmers within the GWP areas, mostly unregulated (Hadjipanteli 2011).

Groundwater abstractions (inside or outside the GWP) are done from legal boreholes and wells, or illegal ones. Since monitoring of groundwater abstractions did not happen in the past, it is impossible to estimate the amount of such illegal abstractions (Hadjipanteli 2011). It is nevertheless obvious that the groundwater bodies of Cyprus face severe over-abstraction problems, characterised by decreasing piezometric levels. It is estimated that around 60% of groundwater aquifers are overexploited, some by up to 40% of their natural (sustainable) replenishment rate (Iacovides 2005; Demetriou/Georgiou 2004).

The state of play of techniques used for irrigation is quite advanced in Cyprus, as the Government of the Republic of Cyprus launched a Water Use Improvement programme in 1965, through which farmers were provided with technical and financial assistance for the installation of low to medium pressure irrigation systems and for the application of proper irrigation schedules. Such irrigation schedules and advanced low to medium pressure irrigation systems are today established and installed on 95% of the total irrigated area, and account for around 75 Mm³/year of water savings. Other advanced water saving methods employed in all or most irrigation schemes are the reduction of distribution conveyance losses, of productive and non-productive transpiration and on-farm evaporation losses, of wind drift and spray losses, as well as run-off and drainage losses. Use of irrigation water is metered inside and outside of the GWP, and water billing is based on the actual consumption at farm level (Hadjipanteli 2011).

With regard to the effectiveness of water saving policies in general, to be discussed in later sections of this report, it is important to note that the advanced irrigation techniques and technology employed in Cyprus already today do not leave much room to improve.

The impacts of irrigation water abstraction on other economic or social sectors depending on water are very limited, as priority is given to the domestic sector (including tourism) during times of water scarcity. The environment, however, is impacted to a great degree, as the falling piezometric levels of groundwater bodies indicate. Environmental damage linked to water abstraction of agriculture furthermore consists of lacking ecological water flow in rivers downstream of dams and reservoirs. These damages are aggravated by

declining rainfall patterns (the mean annual rainfall declined by 30% during the last 40 years; see above). Environmental impacts not related to the abstraction of water, but to agricultural activity in general, is the pollution of water bodies with organic substances, nutrients and priority substances (MoA 2010/RBMP Cyprus).

2.2 Current water policies and practices influencing water use in Agriculture

2.2.1 Water allocation policy in the agricultural sector

Because of the irregularities in Cyprus' yearly rainfall pattern, water allocation policy in Cyprus is a mixture of technical supply enhancement measures and long term and short-term demand management measures, to cope with water-scarce years and drought events (Hadjipanteli 2011).

The water allocation procedure **inside the Government Water Projects** theoretically provide around 50% of total annual irrigation water demand under "normal" hydrological conditions, but in recent years were only able to cover approximately 25% of irrigation water needs – is governed by law. The authority to develop and apply the water allocation scheme is the Water Development Department (WDD) of the Ministry of Agriculture, Natural Resources & Environment (MoA 2010; RBMP Cyprus).

Prior to the beginning of each irrigation period, which lasts from April to October-December, farmers are invited to submit to the WDD their application for the supply of irrigation water from the GWP (including water from tertiary treatment), including information related to the agricultural area and the specific type of crops they plan to cultivate. Based on this aggregate information and taking into consideration the annual water demand per crop per area, the WDD estimates the water needs per GWP for the coming irrigation period. In late spring, at the end of the rainy season, the quantity of available water in the GWP is calculated as well, based on the dam storage levels at that time and the quantities that can be purchased from desalination plants and from the tertiary treatment of sewage. Considering these two assumptions – the expected water availability on the one hand, and the expected water demands in irrigation and other agricultural and non-agricultural sectors on the other hand – the WDD prepares a water demand and allocation scenario, called "Drought Mitigation and Response Plan", which governs the amount of water to be used by each sector (Hadjipanteli 2011).

Hereby, it is important to note that the scenarios are prepared with the participation of the different involved parties, like the local authorities' representatives and the farmers' organisations. According to the Integrated Water Management Law, the such developed scenario is then proposed to a "Consultancy Water Committee", in which another set of stakeholders, both governmental and non-governmental (e.g. the Ministry of Agriculture, Natural Resources & Environment, the Department of Agriculture and other governmental authorities, the Farmers' and the Local Water Authorities' Organisations etc.), participate to provide the scenario with a trans-sectoral legitimization. The scenario is then finally approved by the Council of Ministers and put into force (Hadjipanteli 2011).

With the approval and put into force of the water allocation scenario, each farmer is issued a license/permit for the quantities of water from the GWP he/she is allowed to use, specified for each field under a certain crop in the coming irrigation period, for a certain price. If these quantities are exceeded, the farmer has to pay an overconsumption rate for the extra quantities, and the supply can be disconnected (Hadjipanteli 2011).

As mentioned earlier, the given hydrological situation in Cyprus varies from year to year, and in most years the actually available quantity of surface water falls short of the calculations on which the GWPs' planning is based. Therefore, the water allocation scenario – the Drought Mitigation and Response Plan - developed by WDD and the stakeholder organisations usually imposes some form of restriction on water use, or establishes quotas, mainly in the form of a rationing procedure, giving priority to drinking water needs in the domestic sector, the tourism industry, and livestock husbandry, having regard to the vital aspects of health, social life and welfare. In these sectors/economic areas, usually the water need is fully satisfied (see below for exceptions), whereas irrigation water needs are rarely fully met (Hadjipanteli 2011).

In detail, the priorities and procedure are as follows (water hierarchy):

- First and foremost is the principle that the estimated domestic water needs have to be satisfied by 100%.
- A certain amount of water has to be maintained in the reservoirs, both for environmental as well as for safety reasons (to keep some emergency contingent for the years to come, considering possible droughts).
- A certain amount is left for recharging the respective downstream groundwater aquifer during the coming hydrological year.
- The remaining quantities are allocated to irrigation, according to the farmer's application for the supply of irrigation water (see above). If the quantities available are not enough to satisfy those needs (as usually), water is allocated to the different crops by priority: first priority is to satisfy the water needs of the greenhouse plantations and the permanent crops, to a portion of their normal water needs (varying from 40%-100%); second priority is to satisfy the seasonal crops' water needs (from 0% to 70%); least priority is given to the irrigation of green urban areas (parks, traffic islands, play grounds, hotel gardens etc.), which are categorised under irrigation for the purpose of water allocation as well.

In fact, the drawing of the Drought Mitigation and Response Plan and imposing restrictions on irrigation is the usual practice since the 1980ies; a single exception (regarding the time period 1990-2010) was the year 2004, when full irrigation water demand could be met in the GWP areas by surface water resulting from exceptionally high amounts of rainfall and overspilling of dams. On the other hand, the worst restrictions were imposed in 2001 and 2008, when Cyprus was faced with the most acute and prolonged droughts since the beginning of the 20th century, with severe water shortages and great socio-economic and environmental

impacts. In 2008, even the supply of drinking water to households was limited, and there was a 100% ban issued on the supply of fresh water to agricultural uses (Hadjipanteli 2011).

Before turning to the water allocation procedure outside the GWP, it is important to note that the areas which are irrigated from tertiary treated effluent (which is a highly stable water source in terms of quantity), are almost independent from the surface water storage reservoirs of the GWP and the hydrologic conditions. Therefore, these areas' water demands are usually fully met, satisfying the needs of mostly permanent crops, forage crops and green urban areas) (Hadjipanteli 2011).

Outside the Government Water Projects, irrigation capacity and water use is limited by natural availability, which is further constrained due to the construction of storage reservoirs that withhold water from streams, and because of groundwater over-exploitation and increasing salinity. Regarding water allocation, a number of Water User's Associations (WUA), called Irrigation Divisions/Associations⁷, exists, which hold formal water use rights on their own sources of water. These encompass licenses to operate wells, or abstraction permits for surface waters (mostly streams); the latter, however, tend to be negligible, because of the rainfall/runoff decline occurring in the last decades as well as the construction of the large GWP, drying-out many streams (Hadjipanteli 2011).

Regarding "groundwater allocation", the right to extract water from an aquifer through a well or a borehole is mainly regulated by the issuing of drilling and abstraction permits, as modulated by the relevant national legislation for many decades; however, this old legislation was not effective in mitigating groundwater over-exploitation. Since coming into force of the new Integrated Water Management Law of 2010, the responsibility of issuing such permits lies with the Water Development Department, with more stringent regulations and procedures, adding new conditions on the issuing of drilling and/or abstraction permits, depending on the relevant aquifer's condition (Hadjipanteli 2011).

Generally, when the aquifer is in "poor quantitative status" (according to WFD) or is over-pumped, new abstraction or drilling permits are limited to the irrigation of existing permanent plantations. Additionally, each application for changing an existing abstraction license is reviewed regarding its maximum abstraction quantity, taking into account the extent of the irrigated plantation and the status of the aquifer, with the overall objective to reduce the allowed maximum abstraction quantity (Hadjipanteli 2011).

Furthermore, with the upcoming Art. 9 WFD implementation, the Integrated Water Management Law aims at reviewing the old boreholes and associated abstraction licenses with the objective of applying an abstraction charge reflecting the environmental and resource cost to all groundwater extractions (Hadjipanteli 2011).

⁷ These Irrigation Divisions/Associations usually cover small areas outside the GWP in different local communities, governing the water use in their territory. They are managed by Irrigation Committees, under the supervision of the local district officer, representing the Government of Cyprus. The Irrigation Committees decide on the amount of water to be allocated to the individual farmers (MoA 2010).

2.2.2 Water pricing policy in the agricultural sector

Water pricing in the agricultural sector - as well as the domestic - has a long tradition on Cyprus, reaching back to the operation of the first Government Water Projects (GWP) in the 1960ies. The underlying aim of the pricing schemes then was the recovery of the project's costs, which were in part financed through loans provided by the International Bank of Reconstruction & Development (IBRD) and other financing institutions. Accordingly, the price levels were calculated based on the terms included in the Loan Agreements between the Government of the Republic of Cyprus and the IBRD. From the beginning on, the pricing schemes on Cyprus were designed on a volumetric basis. The calculated prices are recorded to have led to a *"considerable recovery of the project's costs"* (Hadjipanteli 2011a).

Due to socio-economic considerations regarding domestic food security, preservation of rural landscapes, avoidance of unemployment and urbanisation trends, prices of irrigation water were subsidised. Prices were also differentiated from GWP to GWP, because they were applied as soon as each project began operating⁸ (Iacovides 2005; Hadjipanteli 2011a).

In 2004, following the final payment of the IBRD loans and Cyprus' accession to the European Union, a new tariff system incorporating considerably higher prices was introduced, implementing also European legislative demands such as the principles laid out in the WFD. In the irrigation sector, a mayor goal was then to provide irrigation water at an equal price level in all GWP, which was realised after a three-year adjustment period, in 2006 (MoA 2010).

Regarding further provisions of the WFD, especially concerning Art. 9, the Government of Cyprus is momentarily in the process of revising the pricing policies both in the agricultural as well as the domestic sector, to include new concepts such as the polluter-pays principle, and adequate cost recovery including environmental and resource costs into the pricing structure (Hadjipanteli 2011).

2.2.2.1 Current Framework

According to the Integrated Water Management Law of 2010, decisions regarding the price level and tariff structure for water provided through the GWP undergo a decision-making process involving the Ministry of Agriculture, Natural Resources & Environment, the WDD and a "Water Management Advisory Committee", in which farmer's organisations are active members, which together develop a proposal to be assessed by the Minister of Agriculture, Natural Resources & Environment to be finally approved by the Council of Ministers.

⁸ Additionally, "the agreement included references about the methodology of calculation of the cost of irrigation water as well as for the level of charges: they had to be sufficient to recover 38% of the weighted average of unit cost of water. At the same time, the National Law claimed that the irrigation water charges should be less than 40% of the weighted average cost and only under special circumstances could this percentage rise to 65%" (Hadjipanteli 2011a).

As the above mentioned provisions of Art. 9 WFD are to be introduced soon, the principal aim of the present water pricing policy on Cyprus (before the application of Art. 9) is the recovery of the financial costs⁹ of providing irrigation water (Hadjipanteli 2011). Current WDD's studies, however, calculate cost recovery levels that include environmental and resource costs¹⁰ as well, with regard to the implementation of WFD/Art. 9 obligations. Volumetric pricing is furthermore seen as an important management measure which provides incentives to save water (MoA 2010).

The following Table highlights the unit costs for the supply of irrigational water, representing the basis for cost recovery calculations¹¹. "Other sources" refer to non- Governmental small scale projects operated mainly by Irrigation Divisions/Associations.

Table 11: Unit Costs for the Supply of Irrigational Water

Costs	Through GWP (Euro/m ³)	Other Sources (Euro/m ³)
Financial	0.34	0.30
Environmental	0.1	0.16
Resource	0.01	0.03
Total	0.45 Euro/m³	0.49 Euro/m³

Source: MoA 2010 (adapted).

Since the introduction of water pricing policies in the 1960ies, water charges/prices have been applied on a volumetric basis, which still is the case for agricultural, domestic and industrial use. The tariff structures vary, however:

- Water from the GWP (raw water) for irrigation and industrial use is charged on the basis of a flat volumetric tariff with varying price levels, according to its use (see following Table). An overconsumption charge based on the volumes allocated in the Drought Mitigation and Response Plan is applied.
- Water from the GWP (treated water from dams and desalination water) is supplied in bulk to the Local Water Authorities (LWA) with the purpose of providing drinking water to the domestic sector; this bulk supply is similarly charged on the basis of a flat volumetric tariff, whereas the LWA applies a rising block tariff on a volumetric basis to the end consumers.

⁹ Taking into account the capital costs (construction of supply infrastructure), purchase costs from (privately run) desalination plants, distribution and operation & maintenance (O&M), as well as administrative costs (MoA 2010; Hadjipanteli 2011).

¹⁰ Resource costs are defined according to the Guidance Document 1 (WATECO) as the opportunity costs of alternative water uses, in cases where a water body is used over its natural recharge rate; environmental costs are defined as the environmental damage, expressed as the financial opportunity cost (prosperity loss). Environmental damage itself is defined as the deviation of the quality status of water bodies from the good status (MoA 2010).

¹¹ For further information regarding the methodology used to calculate the different cost categories, see MoA 2010.

- Non-governmental/private water suppliers also apply volumetric tariff structures.
- The only exception to the general application of volumetric tariffs is represented by a small number of Irrigation Divisions/Associations, which apply water charges based on time schedules; no additional information was available on these charging systems, however.

The present prices for water in Cyprus are listed in the following Table. As mentioned earlier, the price levels for irrigation water are unified all over the country, but differentiated by use; Irrigation Divisions set their own tariffs and price levels, depending on the individual source and costs of water supply (Hadjipanteli 2011).

Table 12: Present Prices of water supplied by Government Water Projects (before the implementation of Art. 9 obligations)

Description	Unit	All GWP
Fresh raw (untreated) water from GWP (mainly surface water from dams)		
Irrigation Organisations for agricultural production	€ cent/m ³	15,00
Individual consumers for agricultural production	€ cent/m ³	17,00
Industrial consumption	€ cent/m ³	19,00
Livestock husbandry	€ cent/m ³	17,00
Quantities from overspilling of dams	€ cent/m ³	5,00
Urban irrigated areas (playgrounds, parcs etc.)	€ cent/m ³	34,00
Overconsumption charge (exceeding the annual allocated quantity per field)	€ cent/m ³	56,00
Tertiary treated effluent		
Irrigation Organisations for agricultural production	€ cent/m ³	5,00
Individual consumers for agricultural production	€ cent/m ³	7,00
Urban irrigated areas (playgrounds, parcs etc.)	€ cent/m ³	15,00
Groundwater abstraction from aquifers which have been recharged with tertiary treated effluent	€ cent/m ³	8,00
Domestic water from GWP to Local Water Authorities (supply in bulk)		
Domestic water supplied to Nicosia, Limassol, Larnaca and Famagusta area, in bulk (LWA supply distribute water to households and other potable water consumers applying their own tariffs as described below)	€ cent/m ³	77,00
Domestic water supplied to Pafos area.	€ cent/m ³	56,00
Other		
Annual fixed charge	€/da*	1,71
Connection fees		

Description	Unit	All GWP
(a) Water meter installation		full purchase and installation cost
(b) Filter connection to the distribution system	€/da*	5,00
Reconnection fees	€	25,50

*da = dekarion (1000 m²)

Source: MoA 2010 (adapted).

As illustrated in the Table, the prices for water distributed through the GWP varies from use to use, i.e. rates for agricultural production are lower than for the irrigation of urban green areas; also, the price for tertiary treated effluent is considerably lower than for fresh water, to provide incentives for reusing water, due to its positive environmental and resource-preserving effects. Important to note is the relatively high overconsumption charge, related to the quantities of water allocated to each individual farmer during the yearly water allocation process. If overconsumption is not discouraged enough by the high extra charge, it is scheduled to disconnect the supply easily (MoA 2010).

The prices for irrigation water supply are not supported by any direct subsidies, although its provision at a price below full cost recovery levels can be regarded as an indirect subsidy¹² (more on subsidies and cost recovery levels in the following section).

Drinking water supply is provided in bulk to the LWA (municipalities, communities or water boards), applying a flat volumetric tariff; the LWA then distributes the water to the end consumers, charging prices that reflect the individual situation. Although it was one of the newly proposed aims of Cyprus' water policy to unify these prices as well, there are considerable differences in the cost levels between large urban and small rural LWAs (MoA 2010). As a result, during the recent consultation on water pricing and the implementation of Art. 9, it was decided that the pricing policies applied by the LWAs to the final consumer shall be governed by unified regulations and principles, but the prices will be differentiated. On the other hand, the prices of the drinking water supplied in bulk from the GWP to the LWA will be unified for all the LWAs.

The abstraction of groundwater by individual consumers is not charged yet. Thus, the well owner pays the financial costs, but no abstraction charges. As already mentioned, the Integrated Water Management Law of 2010 aims at reviewing the old boreholes and associated abstraction licenses. This procedure involves a new evaluation of the old boreholes, with the objective of applying an abstraction charge to groundwater as well, reflecting environmental and resource costs. This evaluation is in progress since the beginning of 2011. This, however, is a long process that will need a lot of time to be successfully and fully implemented according to the water management authority (Hadjipanteli 2011).

¹² Indirect subsidies are not necessarily in contradiction with „adequate contribution” in the sense of Article 9 WFD.

2.2.2.2 Factors influencing the impact/effectiveness of water pricing policies

As mentioned above, almost directly after the establishment of Cyprus as an independent state, the first Government Water Projects were constructed and operated. At the same time, a “Water Use Improvement Project” was initiated, supplementing the supply side water development projects with demand side measures to promote careful water usage. The Water Use Improvement Project provided farmers with technical and financial assistance for the installation of advanced irrigation systems and proper irrigation schedules. All in all, the financial aid given amounted to almost 50 million Euros, of which 11 million were issued as loans. The amount of water saved due to the installation and proper management of the irrigation systems is estimated to be 75 Mm³/year (Zoumides/Zachariadis 2009/Hadjipanteli 2011).

Important to note, however, is that today actually all farmers in Cyprus irrigate their fields using advanced irrigation technology (see section 2.1.3); that means that the margin for improving water use efficiency is not very high. This is especially true for water use in GWP, where efficiency is generally much higher than on private irrigated land, although advanced irrigation technology is used in both cases (Zoumides/Zachariadis 2009/Hadjipanteli 2011).

Volumetric pricing and water metering is implemented in all GWP, and controlled in fixed time intervals (usually two months, although the procedure varies from GWP to GWP), through farm visits and control of the metering devices.

In specific time intervals (generally 2 months), the farmers in the GWP areas receive the water bill with the charges for the consumption of irrigation water during that period. According to the law, they are given a time period of max. 90 days to pay the bill. Farmers exceeding the 90 days are charged with penalty charges based on a daily base interest rate; failure of payment after another 60 days results in a lawsuit or the disconnection of water supply (Hadjipanteli 2011).

Only since the beginning of 2011, a procedure to control the private abstraction of groundwater more strongly, and to establish abstraction charges, is being implemented (see section 2.2.2). At the moment, however, the amount of water abstracted from groundwater aquifers is controlled and measured only to a very limited extent (MoA 2010/Hadjipanteli 2011).

General knowledge and consciousness regarding water saving is promoted by the Government of Cyprus through awareness raising campaigns and educational programmes. Additionally, water allocation scenarios and other water management issues (such as daily water availability and dam storage levels) are published in the daily press and announced in other mass media (TV, radio and internet) (Hadjipanteli 2011).

As stated above, no direct subsidies on irrigation water are provided. The price paid by farmers for irrigation water, however, do not reflect the price level that would be necessary to even recover full financial costs – the difference between actual price level and cost recovery price levels can therefore be regarded as indirect subsidy to irrigation water supply (Zoumides/Zachariadis 2009). Such “indirect subsidies” were provided to irrigation water supply since the 1960ies, in an effort to improve and sustain rural livelihood, provide food security and minimise soil degradation and desertification (Zoumides/Zachariadis 2009/MoA 2010).

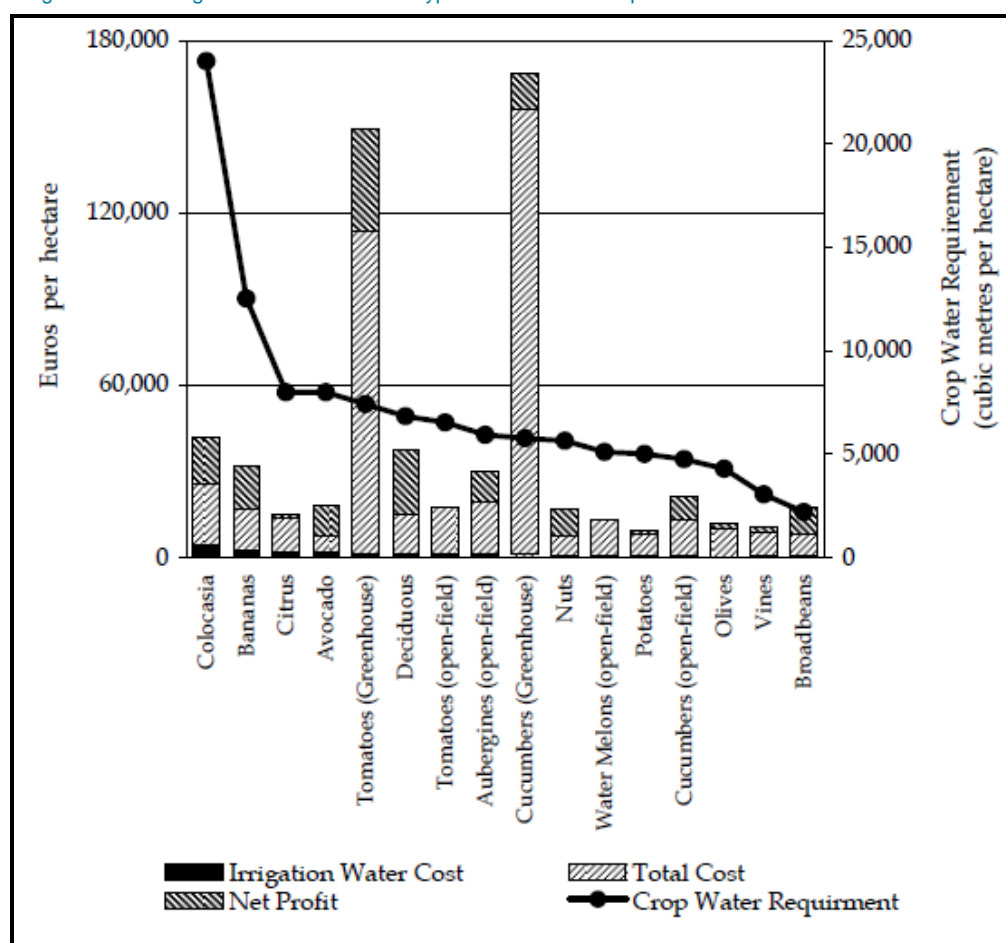
Relatively low water prices – in comparison to domestic water supply, for example – are thought to decrease the incentives to extract and use water unregulated from alternative sources, i. e. groundwater aquifers. Because farmers receiving water from the GWP are charged, and those who have rights for private extraction of groundwater do not face any running costs apart from the operating cost of water pumps¹³ (until 2011), it may be feared that an increase in water prices would result in further unregulated abstraction and mismanagement of groundwater sources (Zoumides/Zachariadis 2009/Iacovides 2005).

Therefore, it has to be stated that in Cyprus the focus for measures to promote a careful use of the scarce resource water lies quite heavily on a wide application of advanced irrigation technologies, and not on high water prices to discourage extensive water use or the growing of crops with high water needs (Zoumides/Zachariadis 2009).

To tackle unregulated groundwater abstractions, the procedure for issuing licenses to drill boreholes and to abstract groundwater is being revised and the changes are to be implemented soon, after the application of Art 9 WFD. On the supply side, water from non-conventional sources, like desalination for drinking water and tertiary treatment for irrigation purposes, further and further substitutes water that used to be abstracted from groundwater aquifers (Hadjipanteli 2011).

The actual share of the water price in the total production costs a farmer faces is an additional important fact to be examined. Naturally, this share varies from crop to crop, and from water source to water source. The following Diagram provides an overview over the costs of water in relation to other farming costs, based on a survey carried out by the Agricultural Research Institute of Cyprus (Markou/Papadavid 2008).

¹³ The costs for private abstraction are not low on Cyprus, however. Farmers have to drill and pump the water from significant depths, leading to high costs (energy pumping costs) (Hadjipanteli 2011).

Diagram14: Farming costs and benefits in Cyprus for selected crops¹⁴


* Crop water requirement (expressed in cubic meters of water per hectare) is defined as the total amount of water needed throughout the lifespan of a given crop under a specific climatic regime, in order to allow normal plant growth or crop yield. This adequate water quantity can be obtained through precipitation and/or irrigation.

Source: Zoumides/Zachariadis 2009.

Regarding the Diagram, it is evident that the share of water in the total production costs is generally quite low, especially when compared to the net benefits per hectare. For example, the net benefits of greenhouse crops (tomatoes and cucumbers) are relatively high, whereas the costs for water seem almost marginal¹⁵. This indicates to a low price elasticity of demand, and probably limits the possibilities of higher water prices in promoting more sustainable water use (Zoumides/Zachariadis 2009).

¹⁴ It should be noted that values shown in Diagram 4.3 (including irrigation costs) provide an average of costs from fields irrigated both from GWP and private boreholes.

¹⁵ In the recently submitted „Reporting Sheets on Economics“, the contribution of irrigation cost in total expenses is stated to range from 0.67% (cucumbers under greenhouse cultivation) to 25.97% (colocasia) (MoA 2010).

2.3 Analysis of water pricing and water allocation policy

The following section sums up the information listed in the above sections, and gives indications as to how effective the agricultural water pricing system in Cyprus is with regard to providing water saving incentives.

2.3.1 Drivers and Barriers

Water pricing and water saving has a long tradition in Cyprus, with significant amounts of money invested in advanced irrigation technologies and other demand-side water saving practices. The amount of water saved due to the installation and proper management of the irrigation systems is estimated to be 75 Mm³/year (Zoumides/Zachariadis 2009/Hadjipanteli 2011).

The water allocation process is based on giving priorities to domestic water uses, including tourism, based on the vital aspects of health, social life and welfare, and also reflecting both the higher cost recovery rates in these sectors (see below), as well as the higher economic output generated. The price for water, in both the agricultural as well as the domestic sector, are not yet unified all over the country, as differences exist between urban and rural areas (regarding domestic water supply), and between area inside and outside of GWP (regarding irrigation water) (WDD 2011).

With regard to cost recovery levels, taking into account both the actual unit costs (financial, environmental and resource costs) of providing irrigational water and the current water prices, the average cost recovery level is calculated as depicted in the following Table:

Table 13: Cost recovery levels for the Supply of Irrigational Water

Supply of Irrigational water (to the consumer level)	56%
Through GWP:	41%
Other sources:	61%

Source: MoA 2010 (adapted); WDD 2011a/WDD 2011b.

It has to be noted here that the results of the cost analysis were aggregated to the Water Service level by weighted (according to water volumes) averages. The cost recovery rates were estimated according to water service providers (and in the case of Water Development Department also according to Governmental Water Projects) and then aggregated to water service level. Furthermore, the financial cost recovery levels of irrigational water supply outside the GWP are assumed to reach 100% (MoA 2010). Because of the different prices of the irrigational water supply to urban irrigated areas, the cost recovery levels presented in the table above deviate slightly from a simple calculation setting price (0.17 Euro/m³) in relation to actual unit cost (0.45 Euro/m³).

The figures presented in the Table need also to be set in relation to the cost recovery levels reached in the domestic sector, which vary between 72% (supply outside GWP) and 99% (supply through GWP).

There is evidence from literature that the choice of farmers for certain crops is to some degree dependant on subsidies/payments provided to support the growing of these crop species (e. g. Gutiérrez/Gómez 2009; Lorite/Arriaza 2009). At the same time, the effectiveness of a water pricing policy in terms of water savings is strongly related to the choice farmers make with regard to whether they grow water-intensive or non-water-intensive crops.

In Cyprus, certain types of crops are supported by payments not related to the area but to the crop. More explicitly, Cyprus chose to grant such direct payments to citrus fruits (Community Funds) and to bananas, deciduous trees, olive trees, table grapes and fodder (State Aid and Complementary National Direct Payments) (Department of Agriculture – personal communication). Therefore, the effectiveness of water pricing with regard to water savings is hampered by EU and national payments to support water-intensive crops.

Other EU policies, however, may positively influence future water pricing policies, as WS&D communication, which was considered during the setting of water pricing policies in light of the current Art. 9 revision (Hadjipanteli 2011). Other EU policies, such as rural development or cohesion policies, have had no influence on water pricing in Cyprus, as not irrigation-related measures have been funded through such programmes.

Beside, low water price levels and a lack of control and enforcing mechanisms regarding groundwater usage seem to influence the effectiveness of water pricing policies in Cyprus to a similar or greater degree.

Before any adaption of price levels to account for adequate cost recovery can take place, however, the issue of controlling groundwater abstraction has to be tackled, to prevent farmers from simply switching to alternative sources, in case water prices increase.

As stated before, the Government of Cyprus, namely the Ministry of Agriculture, Natural Resources & Environment, is currently promoting a new pricing system that will satisfy the WFD/Art. 9 provisions, as the environmental and resource costs are included in the calculation of the cost of water services and thus intergraded in the prices to be applied. According to government sources, the new pricing system will provide adequate contribution to the cost of irrigation water service, taking into account the polluter pays principle, having regard to the effects of the recovery as well as the local conditions (MoA 2010/WDD 2011b). Still in the beginning, however, is also the implementation of new regulations and procedures regarding the control and charging of (unregistered as well as registered) groundwater abstraction.

It can be expected that through this policy revisions, the above mentioned barriers that negatively influence the effectiveness of Cyprus' water pricing policy will be reduced significantly.

At the same time, the general acceptance of the pricing system by the farmers is deemed to be quite high, as there are good and transparent information and awareness campaigns (Hadjipanteli 2011).

2.3.2 Effects of the water pricing policy

2.3.2.1 Direct Effects

As mentioned above, the water savings realised through the whole range of water saving measures implemented by the Government of Cyprus since the 1960ies are estimated to amount to 75 Mm³/year (Zoumides/Zachariadis 2009/Hadjipanteli 2011). The yearly water abstractions for agriculture since 1990 vary, but do not decline significantly over the course of the years. This probably means that the water saving effects realised through the water saving measures took place directly after the installment of the first Water Use Improvement Project. The current water pricing policy, therefore, has had no significant effect on water demand.

With regard to the price elasticity of demand, there has not been any thorough estimation in Cyprus yet (MoA 2010), although the figures presented demonstrate that the share of irrigation water costs of the total production costs in agriculture is very low (see also MoA 2010). This indicates a rather low price elasticity of demand, as other sources confirm (Zoumides/Zachariadis 2009; MoA 2010; Hadjipanteli 2011). Fact is that through the pricing reform of 2004 and the considerable increase in price levels in that time, no change in farmer's behavior could be observed with regard to water usage. This, however, may also owe to the fact that demand and supply for irrigation could not be balanced thereafter, due to low rainfall and the allocation restrictions (Hadjipanteli 2011).

Considering the social importance of the primary sector and affordability issues, the proposal for the new pricing structure assumes that the increases in the irrigation water prices can go up to the level that does not affect the economic value of the main crops (MoA 2010).

One exception to this statement is the steep overconsumption charge, which seriously discourages wastage of water. At the same time, the possibility to switch to other water sources (i.e. groundwater) is seriously limited due to the condition of most groundwater aquifers. Therefore, it can be assumed that the overconsumption charge does affect water demand and encourages water saving.

Other factors influence the decisions which farmers take and which have effects on water demand, such as choosing the cropping patterns or the water sources assessed. These factors are closely related with the general water shortage in Cyprus, as during years of drought events, the negative impacts on agricultural production are substantial, with poor growth of all permanent cultivations and severe losses in both seasonal and rain-fed crops (cereals, legumes and forage crops). Changes in production and cropping patterns are therefore more a result of water shortage than of any pricing policy (Hadjipanteli 2011).

2.3.2.2 Indirect Effects – demand responses of users to water prices

Very limited information on indirect effects of water prices has been identified, though some general statements can be made. First of all, it is quite clear from the analysed sources that the water pricing system in Cyprus has had almost no negative micro-economic effects. As already indicated, the share of irrigation water costs of the total production costs in agriculture is very low. As such, the impacts of the pricing policy on farm income are considered small.

There is no quantitative information available regarding indirect economic effects of the water pricing policy (e. g. modernisation of equipment to avoid losses, change in the cost efficiency of agricultural production). However, in the first Water Use Improvement Project in the 1960ies, significant investments in water saving technologies and techniques have been realised, affecting the performance of the agricultural sector of Cyprus until today, and leaving little room for further (technical) improvements (Hadjipanteli 2011).

Similarly, the information on indirect environmental effects of the water pricing policy is limited. Some sources state that experts fear the farmers to switch to unregistered groundwater abstraction due to rising irrigation water prices (Zoumidis/Zachariadis 2009). The low percentage of water costs in relation to overall production costs and to the net benefits of crops let this scenario seem unlikely, however.

2.3.2.3 Lessons from water savings study

Case studies in the parallel water savings study by a consortium lead by Bio Intelligence Service¹⁶ aimed to provide an illustration of the responses from farmers, local authorities and other stakeholders to reduce pressure on water bodies by agriculture and the successfulness of these responses.

According to the study, Cyprus is regarded as a recognised example of a situation where irrigation efficiency has been increased significantly in recent years. Reference is made to the ambitious national programme with advice and incentives for farmers. A key driver for improving efficiency is to be found in the islands characteristics, with Cyprus being a very dry island experiencing increasing negative impacts from overabstraction, such as salinisation of water bodies.

Some elements were brought forward that have equally been described in earlier paragraphs. The study indicates the importance of enforcement of the legislation in order to reduce the number of illegal boreholes and the clear water allocation hierarchy allowing for a transparent allocation of the available water. The study also further detailed the practice of wastewater reuse (and treatment types) depending on the type of crop irrigated. Guidelines could be adapted and used in other MS that wish to use this technique. It has been

¹⁶ BIO Intelligence Service (2011), Water saving potential in agriculture in Europe: findings from the existing studies and application to case studies, Final report prepared for. European Commission DG ENV

noted that waste water reuse should remain at the bottom of the water hierarchy while the situation for Cyprus is relatively specific (all discharges to the sea environment also limit tourism activities).

2.4 Conclusions

Agricultural water use in Cyprus is heavily influenced by the strongly distinguished Mediterranean climate, represented by cool and rainy winters, and hot and dry summers. Agricultural production is dependent on the replenishment of water resources through rainfall, and on the careful use of water resources. Similarly, farmer's decisions regarding production and cropping pattern are strongly influenced by the varying water availability. Bearing this in mind, the Government of the Republic of Cyprus very early launched water supply and demand management schemes, to provide secure water supply for both the agricultural as well as the domestic sector.

Water pricing on a volumetric basis has been part of the demand side management strategies from the beginning onwards, but the focus of the pricing schemes has been put more on financial cost recovery issues (as agreed in the loan agreements between IBRD and the Government of the Republic of Cyprus) than on giving incentives to save water.

The pricing scheme is flanked by a water allocation mechanism that gives priority of water usage to other sectors than irrigation. The water allocation process at the same time sets limits on the yearly water use by each farmer, at least as the water provided through GWP is concerned, and imposes quite substantial overconsumption charges based on the individual farmer's allocated amount of water.

The impact on agricultural water use of both the water pricing scheme and the water allocation mechanism has to be examined considering the background of this information: farmer's decisions regarding agricultural production (and therefore water use) are strongly dependent on water availability; the focus of the pricing schemes lies more on cost recovery than on water saving; the allocation mechanism sets limits on water use (from GWP), and establishes use limits before an overconsumption penalty is charged, but without effectively excluding the possibility to switch to other water sources (this is primarily achieved by the presently inferior quality of the groundwater aquifers due to overconsumption). Additionally, the current prices of water are relatively low, representing only a small share in the total production costs a farmer faces; and switching to other sources of water (i. e. groundwater) is possible (with restrictions regarding quality of groundwater), as control and enforcement mechanisms are quite weak, and stricter restrictions and the re-issuing of licenses are currently being implemented.

Therefore, it has to be stated that the current water pricing policy in Cyprus has a lesser impact on agricultural water use than the technical measures installed in most irrigation systems.

At the same time, the water pricing system in Cyprus presents some significant strengths, regarding its organisation and technical sophistication: volumetric water pricing is established since the first GWP started

operating, and metering devices are installed and controlled throughout the GWP areas. The general acceptance of the pricing systems is very high, as well as the awareness of the importance of general water saving. Hence, there is still potential for improving the water situation in Cyprus through changes in the pricing scheme and the general water management with regard to water saving.

First, the water prices for agricultural use are low, and have a small share of overall agricultural production costs. Thus, the potential for increasing prices at least to 21 – 25 € cent/m³ without causing negative serious impacts in the agricultural sector is given, as official sources confirm (MoA 2010/WDD 2011b). The effect of higher water prices, however, depends heavily on the access of farmers to alternative sources, and the still unexploited potential for further water savings (mostly through non-technological demand-side measures like change of cropping pattern etc.).

According to *Zoumides/Zachariadis* (2009), the water prices are relatively low partly due to the fear that water users will switch to alternative supply sources (groundwater) the moment prices increase. Thus, the legislation and new regulations currently being implemented to revise the groundwater abstraction permits should be seriously pursued, with the aim of restricting and controlling the easily available access to groundwater sources. At the same time, controlling and enforcement mechanisms should be strengthened as well.

With regard to the low share of water costs in relation to other agricultural input factors, it should be noted that the figures presented (demonstrating the low share of water costs) provide an average of costs from fields irrigated both from GWP and private boreholes. That means that the low abstraction costs from groundwater extraction are included in the water prices; higher groundwater abstraction costs, or restricted access to groundwater sources would probably change the figures in the table significantly, and influencing farmer's production decisions to grow less water intensive crops, or invest in water saving technologies.

The latter, however, are already in a very advanced state in Cyprus, and future water savings can probably be realised more effectively through a change in the cropping pattern, rather than investing in new water saving technologies.

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3 FRANCE - Adour-Garonne

The case study focuses on the Adour-Garonne River Basin (RB) (France). The RB encompasses several regions and departments and some data elements can be presented at these geographical levels.

The analysis of the case study bases on the extensive list of information sources referred to in paragraph 3.6. One of the main sources is the River Basin Management Plan (*Schéma Directeur d'Aménagement et de Gestion des Eaux* (SDAGE) du Bassin Adour-Garonne 2010-2015) and accompanying documents for the basin (RBMP, 2010-2015). This information is further complemented with publications from the Adour-Garonne Water Agency (e.g. annual publication on water demand and contributions from irrigation, Redevance Irrigation) and several specific studies from different stakeholder perspectives on a wide range of topics (collective irrigation, water demand in agriculture, revision of water allocation for agriculture, ...). Experts of the Adour-Garonne Water Agency have further commented on and proposed some small revisions to the text.

3.1 Characteristics of the case study area

3.1.1 Broad introduction on the area and characteristics of agriculture

3.1.1.1 Description of the area

There are six major river basins in France: the Adour-Garonne, the Artois-Picardy, the Loire-Brittany, the Rhine-Meuse, the Rhone-Mediterranean and the Seine-Normandy. France's six major river basins have different climatic, hydrological and socio-economic characteristics. Adour-Garonne is located in the Southwest of France. It borders Spain in the South and the Atlantic Sea in the West.

Diagram15 : Overview of the 6 major River Basins in France



The Adour-Garonne RB embraces two entire regions, *Aquitaine* and *Midi-Pyrénées*, the southern half of *Poitou-Charentes* and smaller parts of *Limousin*, *l'Auvergne* and *Languedoc-Roussillon* (in total 26 *départements*). Adour-Garonne covers 115.000 km² or one fifth of the national territory of France (RBMP, 2010-2015). The Basin counts nearly 7 million inhabitants and population density is thus fairly low (+/- 56 habitants/km²). Two larger cities (over 700.000 inhabitants) are located in Adour-Garonne: Bordeaux and Toulouse.

Diagram16 : Adour-Garonne River Basin : regions and departments



The situation in the Adour-Garonne River Basin can be best compared with a “sink or washbasin” (RBMP 2010-2015, annex 1). There is a dense network of rivers and (smaller) water streams (120.000 km) rising from the two bordering mountain areas, the Pyrenees and the Massif Central. Water drainage happens through the large valleys of Adour, Garonne, Tarn, Lot, Dordogne, Charente (6 sub-basins). The region is also characterised by a large amount of both natural and artificial lakes. The Basin is rich in groundwater resources (alluvial, karstic resources and deeper enclosed groundwater bodies), where the latter two are primarily used for drinking water production.

Yearly (average) annual rainfall amounts up to 90 billion m³ (780 mm) and the average run-off is around 35 - 40 billion m³. These abundant resources are however unequally distributed over the year.¹⁷ Oceanic influences on rainfall are leading to contrasting situations throughout the year (winter – summer). Low rainfall in summer results in severe low-water levels from the end of spring. The central area of Adour-Garonne with limited precipitation and a higher temperature is confronted with large water deficits impacting agriculture, river flows and recharge of groundwater. A variety of artificial basins or water works (*aménagements hydrauliques*) plays a major role¹⁸ in the availability and management of water resources for all water uses: barrages and reservoirs, smaller (uphill) reservoirs, canals. Agriculture takes a central position in the River-Basin, supported by the strong presence of the agro-industry. Freshwater aquaculture is important in Adour-Garonne as it is responsible for around 40% of the total French production (Basins of Marennes-Oléron) and Arcachon. Furthermore, it is of note that the tourism sector is important in different regions of the River Basin. Adour-Garonne delivers a wide range of different landscapes, seaside views, water tourism, (more than 3 million (summer) tourists annually. The sector contributes to the local economic development and water recreation on lakes, rivers and channels (sports, leisure craft, ecotourism) is an important component (RBMP 2010-2015, annex).

3.1.2 Actors and general water management rules¹⁹

3.1.2.1 Basic principles and challenges

The French water organisation relies above all on the Law of 16 December 1964 which organised water management at river basin level, with a multi-stakeholder governance by basin committees, a polluter-pays and user-pays financial mechanism and a 6-year planning of financial actions. The new Law on Water and Aquatic Environments (LEMA) of 30 December 2006 renovated the whole framework defined by the laws of 1964 and 1992 and provided tools for achieving the objective of good status required by the Water Framework Directive. The LEMA proposes several measures to alleviate the chronic imbalances between the available resources and the water demand. Its objective is a “sound and sustainable management of the water resource” which takes into account adaptations to climate change and flood prevention. The LEMA has been reinforced by “Grenelle 1” (2009) and will be further adapted by “Grenelle 2”. Water management is organised according to some basic principles:

- Decentralised management: French water policy is defined and coordinated at the national level and transposes the European Community water policy. Its implementation is organised in a decentralised way (large and small water cycle).
- Integrated approach taking into account all the water uses, the needs of the aquatic ecosystems, the prevention of pollution and the control of natural and accidental hazards.
- Dialogue and coordination of actions: respectively by the Basin Committee (compared to a “Water Parliament”) and the Basin Coordinator *Prefect* for the large water cycle, and by municipal officials for the small water cycle.

¹⁷ <http://www.eau-adour-garonne.fr/page.asp?page=1194>

¹⁸ Water resources are unequally distributed in the Adour-Garonne RB, leading to imbalances between water availability and the different water usages (drinking water, irrigation, industry and tourism). The creation of artificial reservoirs or basins has a long tradition in the policy to improve availability of water resources in the Southwest Atlantic region. For further information, see e.g. <http://www.eau-adour-garonne.fr/page.asp?page=3268>

¹⁹ Unless otherwise stated, this section has been based upon Bommelaer et al. (2011) : Bommelaer, O., Devaux, J., Noël, C. (2011). Financing Water Resources management in France – a Case Study for an OECD Report.

- Use of economic instruments (polluter (or user) pays). Pricing according to the measured volume of water abstraction and consumption (water metering).
- Mobilisation of specific financial resources pooled at the level of the basin: France applies, on the one hand, the “polluter pays” and “user pays” principles and, on the other, that of “water pays for water”. The abstractions and pollution are subject of water taxes (charges) paid with the water bill to the Water Agency of each large river basin. Each Water Agency uses these amounts for studies and actions to improve water resources and aquatic environments.
- A multiyear planning and programming: Water management planning defines the objectives and priorities for action on a river basin scale (SDAGE), and on a sub-basin scale (SAGE). The Water Agencies integrate the objectives of these master plans into 6-year financial plans. The Agencies are currently preparing their 10th Action Plan (2013-2018).
- A clear distribution of responsibilities between public authorities and private operators for the management of municipal drinking water supply and sanitation utilities

French water management had a long focus on water quality aspects. Domestic and industrial pollution has been considerably reduced and today the main challenges are agricultural pollution and new forms of chemical pollution (heavy metals, drug residues). Historically, quantitative management of water resources has not been a major issue in France at national level.²⁰ France is facing more and more frequent droughts and some groundwater tables are overexploited. France developed national and local regulations and strategies for better facing water shortages and floods. The main challenge of the coming years will be to adapt to climate change: adaptation of water resources management and planning, but also adaptation of water uses especially in agriculture where significant water savings will have to be made in irrigation.

3.1.2.2 Actors: role in water allocation and pricing

3.1.2.2.1 National level

The State acts as regulator regarding water policy and takes care of the transparency to the users. The State has a role to guarantee common rights between users, consistency between river basins and access to water for everyone. Policy is laid down by the Ministry of Ecology (MEDDTL)²¹ which proposes and implements the national legislation adopted by the Parliament. The French legislation also transposes the Community water policy. Water policy is highly decentralised and is drawn up in a participative way, either at the level of the river basins, created by the law of 1964, or at the municipal level. The Ministry of Ecology relies on the National Agency for Water and Aquatic Environments (ONEMA)²². ONEMA is responsible for the knowledge and monitoring of the status of water and aquatic environments, control of water uses and participates in local initiatives. The National Water Committee (CNE/NWC) is the organism where water stakeholders participate at the national level. Created in 1964, the NWC had its responsibilities widened by the LEMA with the creation of a Consultative Committee to propose advice on the price of water and the quality of water supply and sanitation public services

²⁰ It is of note that this statement does not apply for Adour-Garonne and some other regions in the south. Water quantity management has been a central element in the policy of Adour-Garonne since the first Water Law (1964) and the creation of the Water Agency in 1968.

²¹ Ministère de l'Ecologie, du Développement durable, des Transports et du Logement

²² This institution was created by the Law on Water and Aquatic Environments of 2006 (LEMA)

3.1.2.2.2 River Basin level

The first level of decentralised management is on a large river basin scale, where river basin authorities are in charge of financing (Water Agencies) and dialogue (Basin Committees). Adour-Garonne is one of the 6 major river basins in France. Basin authorities, where most users and stakeholders are represented²³, can exercise considerable scope in water planning and management and in setting water charges (OECD, 2010). Finding a compromise between the needs of ecosystems and other water uses continues to be a real challenge for the six basin agencies (WWAP, 2006).

The **Basin Committee** orientates the water policy priorities in the basin. It prepares the Master Plan for Water Development and Management (SDAGE) which is then approved by the State government. The Basin Committee follows up the SDAGE implementation. It approves the rates for the taxes levied by the Water Agency and votes the multiyear action plan of the Water Agency (priorities, conditions for financial assistance) which contributes in the financing of the SDAGE implementation.

The Water Law of 1964 created 6 “Financial Basin Agencies”, now called **Water Agencies**. The Water Agencies are public bodies in charge of financing water policy under the supervision of the Ministry in charge of Ecology. The Water Agencies and Water Offices are financially autonomous and have their own financial resources coming from the taxes levied on the water uses. Their field for action covers the quantitative and qualitative management of surface water and groundwater. The Water Agency has three levers for action:

- Environmental taxation: water taxes levied on water abstractions and the emission of pollutants.
- Financial assistances: agencies grant subsidies and loans for action and investments which aim at implementing the water policy orientated by the SDAGE.
- Facilitating water governance in the basin: production and dissemination of information, taking charge of the operation of the basin’s participative bodies (basin committee, topical and geographical commissions, local commissions), preparation of the planning documents, contracts, public consultations and debates, education and training, communication and international co-operation.

²³ Representatives from local authorities (40%), users and associations (40%) and the State government (20%)

Water Agency taxes (source: Bommelaer (2011))

Today, in France, the “polluter-pays” and “user-pays” principles are applied to water resources management. The budget of the Water Agencies comes from taxes on abstractions and discharges of all the users which affect water quality or modify the water regime. 90% of the tax income is reallocated to pollution control and increased availability of water resources. The French Water Law establishes a common framework for all agencies to design the water charges. The aim of the water charges levied by the Water Agencies is to integrate environmental and resource costs, with incentives to the water users to bear the cost related to their polluting discharges or abstractions of water resources. The objective of the “**water abstraction tax**” is to encourage water saving and the tax base is abstracted volume over the year. The rate is modulated according to the economic value of water depending on its use (irrigation, drinking water, industrial cooling, feeding of a canal, etc.) and according to water resource scarcity (abstraction from a balanced or unbalanced zone). “**Pollution taxes**” integrate incentives for preserving water quality. They depend on the discharged pollution and are relevant for livestock farmers. Since 1st January 2008, the water charge system of the Water Agencies somewhat evolved as there are now seven different types of taxes²⁴. For example, for agricultural uses, a new tax (“tax on diffuse agricultural pollution”) is paid by all the distributors of plant protection products according to the quantity of dangerous or toxic substances contained in the commercialised products. Other taxes relevant for the agricultural sector are the tax on non-domestic water pollution (livestock), tax on the abstraction of water resources (see above) and tax for storage in low water level periods (owners of larger reservoirs).

The **rate of the water charges** is defined at the national level by the Parliament. The rate is then precisely calculated and modulated by the Basin Committee according to the priorities and local qualitative objectives given in the SDAGE and SAGEs. The division into seven taxes introduced an uncertainty in foreseeing the income of the Water Agencies. Before, the amounts to be levied were defined by the Water Agency and were distributed among the tax payers (apportionment). This procedure guaranteed some predictability as, even if the consumed water volumes differed from the predictions, the amount which had to be paid by the tax payers remained the same. From now on, the income from the water charges is directly related to the consumed volumes of water or emitted pollution, which involves a greater volatility of income from water charges.

The taxes levied by the Water Agencies feed the budget of their multi-year action plan for six years. This financing programme allows subsidising the investments made by municipalities or industrialists or farmers, to preserve water resources and to improve the performances of the treatment plants. The financing programme gives priorities for action and their financing. It is formulated in a concerted way by the basin committee which gathers the various water stakeholders. The income from the pollution taxes contributes, for the most part, to the total income, which indicates once more that France did not think, until the recent law of 2006, in terms of quantitative aspect of water resources but almost exclusively in terms of qualitative aspect. The introduction of the new taxes should however lead to a positive evolution in the multi-aspect approach to water resources in the coming years. Agriculture has a small contribution of Water agencies tax revenue in France: 3,6% for abstraction tax and 0,5% for pollution tax.

²⁴ Articles L. 213-10 to L.213-20 of the Environment Code.

3.1.2.2.3 At the level of tributaries, sub-basins or aquifers

SAGE, the local adaptation of the SDAGE are made up at the level of tributaries, sub-basins or aquifers within a Local Water Commission (LCW)²⁵. The Commission takes the necessary (contractual) steps to plan and finance the considered actions (“river contracts”, “aquifer contracts” or “bay contracts”).

The “**Water Police**” is an important body in the regulation of facilities, infrastructures, work or activities which can potentially impact health, safety, water resources and aquatic ecosystems. The regulating task covers two aspects, a special administrative framework and a control compliance with regulations. In its administrative role, the “Water Police” provides declarations or an administrative authorisation taking into account the characteristics of the project and the limits laid down by ministerial decrees. For example, concerning an authorisation for abstraction, the prefect’s decree must:

- Define one or several abstraction quantities according to the source and the hydrological context,
- Take into account the abstraction quantity as compared to the other uses,
- Comply with the provisions of the SDAGE and SAGE,
- Impose the measurement of abstracted flows,
- Lay down provisions for the building and maintenance of water intakes,
- Lay down provisions to avoid contact between the different aquifers during drillings.

The Basin Coordinator Prefect (responsible for coordination between region and department policy and WFD river basin authority) has the resources needed for crisis management in particular. He can take measures for limiting or provisionally stopping water uses to deal with accidents, floods, droughts or water shortages. The decisions of restriction are made after dialogue with the users.

Water allocation at department level

The conditions under which users can abstract surface and groundwater resources and the procedure by which the **Prefects** (*Préfets départementaux*, who are the local State representatives) grant (water) use rights are stipulated in the (new) French Water Law of 2006. In certain departments, the use rights are granted annually by the Prefects, but in most of them they are granted for more than one year, the former criterion becoming less and less used in France (OECD, 2010). Any authorisation given for water abstraction²⁶ which includes the maximum volume that can be abstracted can be temporarily or permanently revoked or reduced by the Prefects in case of water scarcity, as required to ensure adequate environmental protection and/or domestic water consumption. Abstraction rules are more stringent in some areas qualified nationally as suffering of chronic water shortage (ZRE, *Zones de Répartition d'Eau*)²⁷. Abstractions in these zones require an authorisation above the threshold value of 8 m³/h instead of 80 m³/h.

The Prefect can also take into account territorial specificities (e.g. areas vulnerable to pollution by nitrates, in areas feeding water intakes but also areas subjected to a quantitative deficit or in polluted areas, etc.). When an authorisation is demanded, the decision to grant it or not is made after an investigation for assessing the potential impacts of the project and consulting the population concerned. The authorisation is granted for a

²⁵ made up by one half of representatives of local authorities, by one quarter of users’ representatives and by one quarter of State representatives

²⁶ Authorisations for abstraction required above 80 m³ per hour, below this threshold a declaration suffices (Office International de l’eau, 2009). A recent publication of the Chamber of Agriculture (2010) summarises that abstractions from rivers always require an authorisation, while boreholes and abstractions from surface water in reservoirs can be either arranged by declaration (low capacity) or authorisation.

²⁷ Decree (décret) of 29 April 1994

defined duration and is not final. It can be withdrawn or modified with a stricter purpose, without allowance, should there be a risk for public health (drinking water), safety (floods) or aquatic environments.

The enactment of the 2006 Water Law also stipulated that the Prefects²⁸ could establish zones in which the authorisation for water extraction is given to one actor ("*organisme unique*") that will further manage allocation to farmers. The implementation of the allocation through *organismes uniques* is obligatory in water deficit areas (ZRE) and possible outside ZREs. This was planned to be installed from the beginning of 2011 but is / was subject of strong opposition from farmers.²⁹

The agents in charge of the water police (decentralised services and ONEMA) control compliance with regulations. These agents report when there is infringement and define sanctions. Sanctions are usually administrative (obligation for compliance with standards or closing down of the facility for example) but in some cases penalties are necessary. The official report is then transmitted to the court and the judge can inflict a penalty, either financial or a sentence of imprisonment in the most serious cases.

3.1.2.2.4 Collective organisation or supply of (irrigation) water

Besides the (initial) allocation process through water abstraction authorisations, it is important to refer to further allocation to water users by different types of (collective) supply systems. In particular, three different systems of water quantity management and supply will be further described: i) ASA (Association Syndicale Autorisée) and ii) EPTB (Etablissement Public Territoriale de Bassin) as bodies with public character and iii) SAR (Société d'Aménagement Régional) or regional development organisation that moved from a public to a private body. There is only one SAR operating in Adour-Garonne : CACG (La Compagnie d'Aménagement des Coteaux de Gascogne).

The ASA³⁰ (*Association Syndicale Autorisée*) is the base organisation structure for collective irrigation systems. ASAs were installed by Law in 1902 and are empowered to manage a single water resource providing (irrigation) water to multiple farmers. Different ASAs within one department are represented and assembled in the Chamber of Agriculture of the department. In parallel, an Irrigators' Association is responsible to represent farmers towards the *Prefect* to communicate requests for abstraction declarations or authorisations and to negotiate potential volumes for irrigation activities. The ASA can as such be regarded as an important political tool for irrigators in a department. Farmers within a department hold regular drought meetings and in consultation with other water uses in the region, these organisms can contribute to the decision on periodical volumes that can be abstracted. Based upon current state of resources, rainfall, crop growth and meteorological forecasts, they organise and propose (to the Prefect) a rotation scheme for water abstraction (*tours d'eau*). ASAs own their investments (installations and infrastructure) and can choose to

²⁸ Sub-basin Co-ordinator Prefects

²⁹ See e.g.

<http://www.agri82.fr/irrigation-hydraulique/actualites/687-irrigation-ou-en-est-on-communiquede-philippe-de-vergnette-president-de-la-chambre-dagriculture>

³⁰ FRSEA (2008). Impacts socio-économiques et environnementaux d'une gestion raisonnée de l'eau en agriculture et agro-alimentaire.

operate or outsource the irrigation system. Financial management is based on the principle of full cost recovery and strict budget requirements (Office International de l'Eau, 2009).

EPTBs have an important role in the availability of water resources in low water periods. Their mission is to harmonise actions in (surface) water management in the hydrographical basin. These organisations initiate and draft low water management plans (*Plan de gestion d'étiage* – PGE, see section 3.1.2.3) where balance between water supply and demand is a central element.

The only SAR (*Société d'Aménagement Régionale*) present in the Adour-Garonne RB is CACG (*La Compagnie d'Aménagement des Coteaux de Gascogne*) which has been installed as a regional development organisation for the Midi-Pyrenees and Aquitaine regions. Its mission concerns different domains: water, the environment and spatial development. The primary mission is to ensure the distribution of water resources in / to regions with chronic deficits. In the domain of water and agriculture, the most important tasks are in infrastructure projects (reservoirs, irrigation networks), water management (recharge of rivers) and water distribution for irrigation.³¹ Water can be delivered under pressure for on-field application (100 Mm³). It also contributes to feasibility studies (technical-economic) for irrigation networks. The organisation therefore manages 225 Mm³ of stock capacity and operates as such one large canal (*Neste system*) and 52 barrages. They are servicing 56,500 irrigated area for +/- 100,000 ha equipped for irrigation. The allocation of water (including abstractions) is arranged by quota (m³/l/s) and information (including advice and meteorological conditions and forecasts) is periodically spread on the website and by SMS.³²

3.1.2.3 (Planning) instruments: Water allocation and management in water deficit areas

The provisions of the Water Framework Directive have been implemented in basin management plans with legal and administrative status, **SDAGE** (Master Water Development and Management Scheme) and **SAGE** (at sub-basin level). These planning documents give the overall orientations of water management in the basin and the objectives to be achieved. The SAGE lays down the objectives to be achieved (water uses, quantitative and qualitative protection of water resources and aquatic ecosystems, conservation of wetlands, etc.) in line with the SDAGE.

In Adour-Garonne, the pressure on water resources is severe in summer periods facing the highest abstractions especially due to irrigation. In order to cope with the adverse affects of such conditions, planning tools like strict **low-water target flow** (**DOE**, *Débit Objectif d'Etiage*) and **low-water management scheme** (**PGE**, *Plans de Gestion d'Etiage*) were put into practice (WWAP, 2006). DOEs are the fixed flow rates at strategic points of the basin during low water periods. PGEs (protocol agreements³³) involve all relevant stakeholders and set the rules concerning how to allocate limited water resources at the basin scale

³¹ <http://www.cacg.fr/gp/Gestion-de-leau/328/0>

³² http://www.cacg.fr/fichiers_bulletin/163724bulletins_9_2011.pdf

³³ Between different partners being the State, the Adour-Garonne Water Agency, farmers and EDF (Energy company in France). PGEs are elaborated in three phases: (i) state of available resources and demand, (ii) choice and further detailing of the management scenario and (iii) redaction and approval of the plan (contractual agreement for all involved parties). (Source: case study Adour-Garonne in WWAP, 2006)

and specifically in water deficit areas (division of water between users and geographical areas). The aim of the plans is to restore and define a sustainable balance (in terms of flows - DOE) between water uses and water requirements for the well-functioning of aquatic ecosystems.³⁴ PGEs also include water saving measures and provisions for the installation of new water reserves and their (collective) management.

ZRE (*Zone de Répartition d'Eau*) is a related concept as it describes areas where a (permanent) deficit between water availability and water demand is identified. ZRE can include basins, sub-basins (or fractions) or groundwater bodies and legal status was defined in the decree of 29 April 1994. These ZRE are primarily defined in order to find concordance between the different water users in the concerned area. The Basin Co-ordinator Prefect can ask the sub-basin Co-ordinator Prefects to modify ZREs but no major changes have occurred since 1994. Water abstraction authorisations are more stringent in these areas. The list of municipalities within a ZRE is determined by the prefects of the department.

Measures can be classified as crisis measures or mid and long term quantitative management of water resources measures (e.g. PGE, increased capacity to stock winter water). The main (and only) measure with short term effect is: restriction or ban on water abstractions by the Prefect (*arrêtes sécheresses*)³⁵ which is decided upon in a multi-stakeholder and frequently assembling organism. Priority for water abstractions is above all on drinking water supply. Restrictions usually are first imposed on irrigation and water use for e.g. gardens or washing of cars.

- In dry periods, information is provided to all stakeholders. E.g. When periods of water scarcity are forecasted early in the year, farmers are still assumed to have a possibility to switch to other less water-intensive crops (sunflower, hemp) instead of maize. In case of severe water shortages, the Water Agency can still conclude agreements with e.g. hydropower producers to supply from their reservoirs.

The new water Law 2006 (LEMA) has also included a provision to adapt water demand to the availability by fixing multi-annual quota for farmers adapted to statistical availability of water to guarantee 8 on 10 years availability of water resources. The allocation can be designated to an *organisme unique*³⁶ but it has already been mentioned that this provision still faces strong opposition from farmers. It is assumed that this allocation mechanism would be able to reduce abstractions for irrigation by 12% (without new capacity) but with problem areas like Poitou-Charentes where the decrease could amount up to 50%.

3.1.3 Water resources and aquatic ecosystems³⁷

Available water resources in Adour-Garonne can be either natural (drainage, surface water and connected groundwater bodies, natural lakes, ...) or of artificial nature (reservoirs, channel, ...). Total average renewable resources in Adour-Garonne (AG) amount up to +/- 45 billion m³, ranging from 35 to 45 billion m³

³⁴ <http://www.eau-adour-garonne.fr/page.asp?page=2464>

³⁵ Agence de l'Eau Adour-Garonne (2011). Quantité et qualité de l'eau: les enjeux liés à la sécheresse dans le grand Sud-Ouest. Dossier de presse, 23 Juin 2011.

³⁶ i.e. a unique body that executes the collective management of abstractions from agriculture.

³⁷ Information in this paragraph is derived from <http://www.eau-adour-garonne.fr/page.asp?page=1194> and RBMP 2010-2015.

according to the source and year. The yearly annual rainfall is around 90 billion m³ (780 mm per m²) but differs significantly between areas³⁸.

Due to the specific characteristics of the Basin (unequal distribution of water resources) multiple artificial basins or reservoirs have (been) developed to improve availability of water resources throughout the area in dry periods.

The **average annual water abstractions** from all resources amount up to 2.5 billion m³. Roughly 40% is destined for irrigation, 30% for the industry sector and the remainder for drinking water supply (RBMP 2010-2015). These abstracted volumes are modest compared to the total annual availability (run-off) of 45 billion m³ but in low-water periods (summer and early autumn) and at certain locations there is persistent and precarious imbalance between demand (irrigation in particular) and minimum (river) flows. It is argued that these deficits will become even more significant when considering the climatic evolution. Abstractions of water from rivers and groundwater bodies reaches more than 700 million m³ during **low-water period** (summer) and 85% of this is allocated to irrigation (RBMP 2010-2015, % varies slightly according to the source). These abstractions (especially for irrigation) are nevertheless still highly dependent on hydro-climatic conditions of the year (e.g. 700 million in 2002 and 1200 million in 2003 for the year). In the same (summer) period, abstraction for the industry sector and for domestic purposes are 250 million m³ each and rather independent of climatic conditions.

Since 1996, Adour-Garonne RB took action to cope with water shortages in dry periods by installing or guaranteeing water reserves that can be mobilised to fulfill minimum low-water flow levels (*Débites Objectifs d'Étiage* or DOE). These reserves can stock volumes of 800 million m³ where 160 million m³ is covered by basins (destined) for hydropower. The reserves support directly or indirectly low-water flows of different water courses. This mobilisation of water resources from artificial basins in Adour-Garonne can be further split up in 4 large categories (RBMP 2010-2015)³⁹:

- Hydropower basins in upstream zones of Adour-Garonne can stock +/- 2,5 billion m³. 160 million m³ is subject of an agreement with EDF as a buffer stock for low-water periods.
- +/- 150 medium sized reservoirs stock a total volume of 350 million m³
- +/- 15,000 smaller dam reservoirs can stock a total volume of 290 million m³.

These additional reserves are still insufficient to cover demand in dry periods and an **average deficit** of roughly 250 million m³ persists. There appears to be no significant evolution and this deficit is rather stable over time. The Adour-Garonne Water Agency confirms the deficit of +/- 235 million m³⁴⁰ for abstractions in the discussion of the low-water management plans (PGE or *plans des gestions des étiages*) and taking into account the target low-water flows at the defined points (*DOE* or *débites objectifs d'étiage*). These target minimum flows also consider the 2015 good ecological status defined under the Water Framework Directive.

³⁸ Roughly 1400 mm in mountain and coastal areas, only 600 to 700 mm or less in central parts (Comité du Bassin Adour-Garonne, 2005, état des ressources)

³⁹ Figures are updated and aggregated after communication with M. Daubas from the Adour-Garonne Water Agency

⁴⁰ It is of note that the deficit of 235 Mm³ follows from comparison with total allocation. In certain regions with more or less sufficient water resources, it is observed that total authorised quantities are significantly higher than abstracted volumes. It is estimated that the deficit compared to the maximum level of abstractions over the past decade is +/- 150 Mm³. (p.c. M. Daubas)

3.1.4 Water use for agricultural demand/supply

3.1.4.1 Agriculture in Adour-Garonne at a glance

The Adour-Garonne Basin is a rural and important agricultural area. The total RB is 115.000 km² and utilisable agricultural land covers +/- 50% of the total area (more than 5 million hectares).⁴¹ Surface destined for agriculture in Adour-Garonne is about 1/5 of the agricultural area in France but Adour-Garonne is nevertheless responsible for +/- 40% of the irrigated area in the entire country of France.⁴²

Total cultivated agricultural area in Adour-Garonne RB is 1,9 million ha. The large planes and slopes of Aquitaine are occupied by large cultivations of cereals (maize). Livestock and cattle breeding is situated in mountain areas and Piémont while poultry breeding is situated in Gascogne and Armagnac. The valley areas demonstrate a more diversified agriculture: fruit and vegetables in mid-Garonne, orchards and glasshouse cultivation in the Agen area or Dordogne, vineyards (Cahors, Charente, Armagnac, ...). The Landes and Gironde area are also hosting forestry and silviculture activities.

It is of note that the largest regions of Adour-Garonne, Midi Pyrenees and Aquitaine, both showed a decline in maize cultivation (irrigated or not) of 50,000 ha each between 2000 and 2009 (DRAAF, 2010). The same trend can be identified in the two Charente departments within the Basin where the surface in maize decreased with more than 20,000 ha. Maize is by far the most important crop in the group of cereals, oleaginous and proteinous crops (SCOP⁴³) with an average share of 85%. Moreover, the production of maize for seed-corn is an activity with a large added value and thus important in the area.

3.1.4.1.1 Agriculture as an economic sector

The contribution of agriculture to Gross Domestic Product (GDP) in Adour-Garonne RB is more important than the average 2.8% for France. It ranges from 4.1% (Midi-Pyrénées) to 5.6% (Poitou-Charentes) and even 6.3% in the Aquitaine region. The number of agricultural exploitations in the RB ranges from 160,000 to 175,000 units (depending on the literature source), resulting in a total 235,000 full time equivalents or 70% of total employment. The strong presence of agriculture in the region also indirectly influences other activities and employment, e.g. groceries, small businesses or schools.

The variety of geographical and meteorological conditions results in a diversity of agricultural practices throughout the Basin. Viticulture is responsible for 12% of the exploitations. Nearly 1 out of 4 exploitations are large cultures of cereals (mainly maize). The economic contribution of large cultures was estimated at 6.7 billion € (2001). The Basin is also characterised by a significant number of exploitations for livestock breeding. Adour-Garonne is responsible for 40% of sheep breeding in France (Midi-Pyrenees as the number

⁴¹ Comité du Bassin Adour-Garonne (2005). L'état des ressources en eau du Bassin Adour-Garonne.

⁴² Ministère de l'écologie et du développement durable (2006). Bassin Adour Garonne – L'eau et l'irrigation. Une étude de cas du WWAP.

⁴³ SCOP: Surface en céréales, oléagineux, protéagineux.

one region). Adour-Garonne represents 25% of goat breeding and nearly 1/5 of the cattle breeding. Livestock farming generated around 4 billion € in the entire Basin (2001).

Aquaculture plays a role in a small part of the RB, with 2 important basins: Marennes-Oléron (Charente) and Arcachon (Gironde), the former being the most important European region with an annual production of oysters of +/- 30,000 tonnes (40% of the production in France). Overall, Oyster farming (including seed) generates annual production between 55 and 75,000 tons or 225 million €. The sector created around 7,500 permanent jobs in 2001. (Fresh water) pisciculture in Adour-Garonne is also important and production is similar to the Bretagne region.

It is of note that in Adour-Garonne, 40% of the farmers produces under some kind of quality label whereas the average figure for France is 27%.⁴¹ The next step in the food supply chain, the agro-industry, is strongly present in the whole Adour-Garonne River Basin and generates a large added value. The region also produces some specialty products with strong brand names linked to the area: caves de Roquefort, Cognac, foie gras, ...

3.1.4.1.2 The importance of irrigated agriculture⁴⁴

Nearly 1 on 4 exploitations in the RB rely on irrigation for their farming activities (36,733 irrigating farms on more than 160,000 agricultural exploitations in the Basin). It appears that these exploitations are likely to be more economically viable as their number decreases less rapidly compared to the average decrease of agricultural exploitations in the area (overall decrease in the number of farms in the two largest regions is more than 30% while the number of irrigating farms has declined at a rate between 14 and 20%). Cultivations that are most dependant of irrigation are maize, fruit and vegetable crops. Early 2000, production value of maize attained +/- 1 billion € and horticulture generated a value of 430 million € in the two main regions Aquitaine and Midi-Pyrenees. A significant share of livestock production (poultry, cattle) is also depending on these irrigated cultures (maize). The additional 3 billion € (largest share for cattle) production value underlines the importance of irrigation for the area.

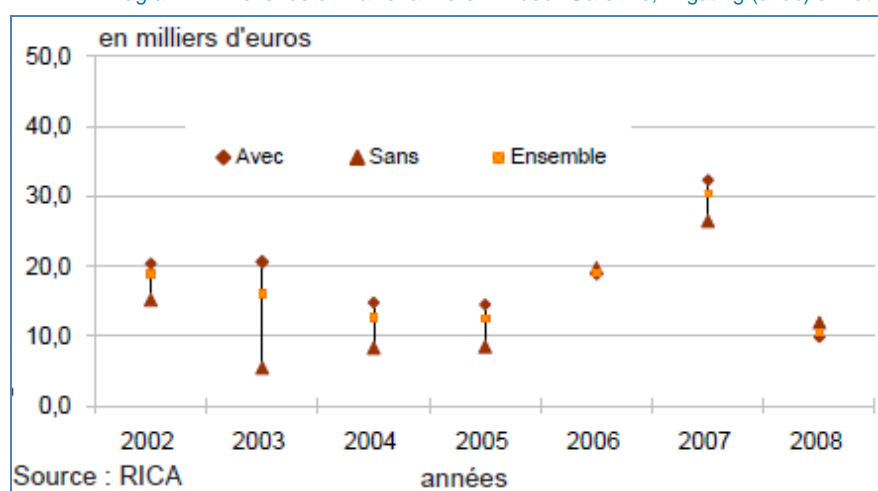
For maize, the most important irrigated crop, some literature sources indicate the added value of irrigation activities. DRAAF (2010) indicates that in areas with capricious rainfall, yields (per hectare) can be divided by two. This also explains why a reduction in irrigated surface for maize inevitably leads to a reduction in maize culture (substitution by non-irrigated maize is assumed to be not economically viable). The 2005 report on the state of the water resources in Adour-Garonne RB describes the difference in farmer's gross margin in the region of Poitou-Charentes for maize, but notes that a same reasoning could apply for cereals in general. Yields for irrigated maize are estimated to be 30% higher on average resulting in higher turnover ranging from 26 to 32%. At the same time, the farmer bears higher costs for irrigation infrastructure between 27 and

⁴⁴ Unless otherwise stated, figures have been derived from Comité du Bassin Adour-Garonne (2005). L'état des ressources en eau du Bassin Adour-Garonne.

31% though these are usually lower than benefits from irrigation⁴⁵. For the Aquitaine region⁴⁶, similar findings were demonstrated (50% higher average production value) though it is stated that the discrepancy in crop return (€) is very different according to the year and case by case (see

Diagram17). Numerous factors contribute to this effect, e.g. higher expenses for inputs (energy, sowing seeds etc.), investment costs and financing costs.

Diagram17 : Revenu of maize farmers in Adour-Garonne, irrigating (*avec*) or not (*sans*)



3.1.4.2 Water and agriculture

3.1.4.2.1 Irrigated area⁴⁷

Total cultivated agricultural area in Adour-Garonne RB is 1,9 million ha. More than one third of this area (650,000 ha⁴⁸) is irrigated land and two thirds of the irrigated crops (area) are maize cultures. Irrigated land in Adour-Garonne is 12% of total utilisable agricultural area.⁴⁹ This maize production and irrigated agriculture in general is a significant portion of the total figure for France (40%), while agricultural area in Adour-Garonne is only covering 20% of total agricultural area in France. Over the past decade, the irrigated area has decreased by more than 10% compared to 2000 (DRAAF, 2010). This trend can be read from

Diagram18 below illustrating the evolution of the irrigated surface in the main regions of Adour-Garonne during this period.

⁴⁵ These costs do not include costs that are related to the quantitative management of water resources (*soutien à l'étiage*).

No full cost approach, but the assumed impact on farmer income is illustrated.

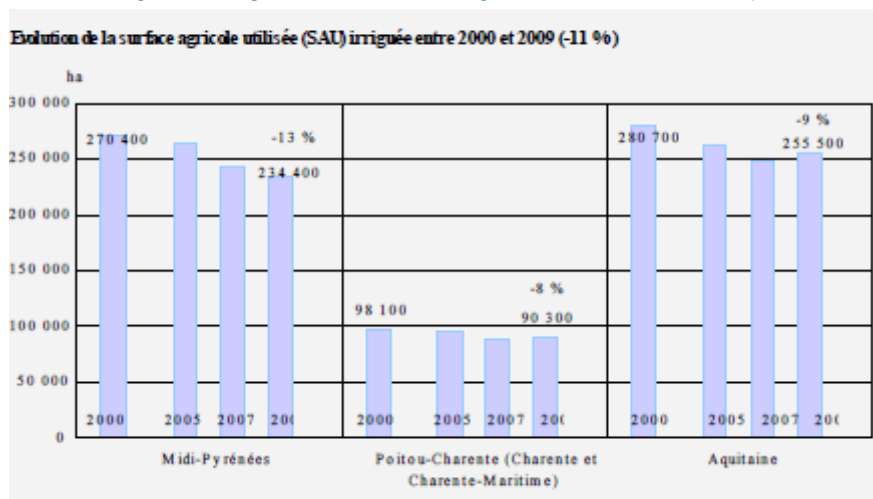
⁴⁶ Agreste Aquitaine (2010). Analyse et résultats – n°39 – août 2010 – irrigation

⁴⁷ Information based on DRAAF (2010) and WWAP (2006).

⁴⁸ Further decline of this area is observed. Most recent figures mention +/- 580,000 ha of irrigated land. (p;c. M. Daubas)

⁴⁹ <http://www.eau-adour-garonne.fr/page.asp?page=1194>

Diagram18 : irrigated surface in main regions of Adour-Garonne RB (source: DRAAF 2010)

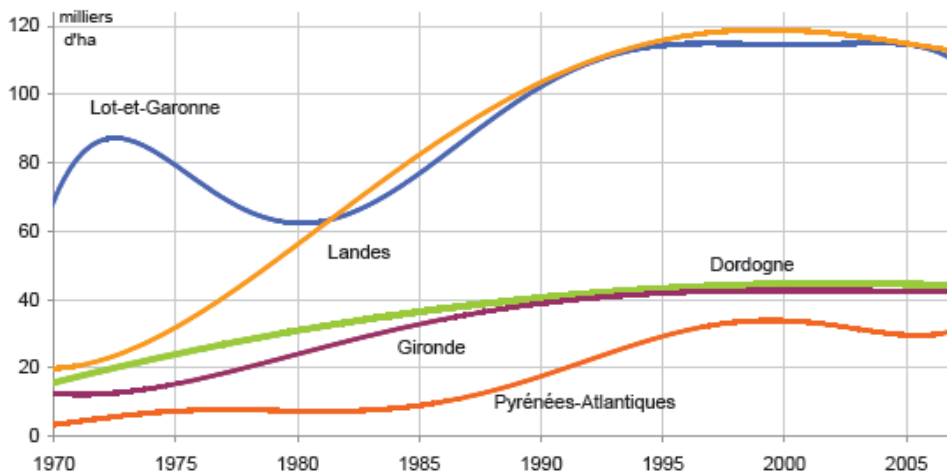


The decrease in irrigated area is mainly due to the decline in surfaces with maize cultures, being the most important crop within the wider group of cereals, oleaginous and proteinous crops (SCOP⁵⁰).

Decline in irrigated area is a rather recent phenomenon, since irrigated land showed a gradual increase for multiple decades. The long term evolution for the Aquitaine region and its departments is illustrated in the following Diagram. The upward trend has been halted in years with unfavourable climatic conditions, e.g. 2003 and 2005 (Agreste Aquitaine, 2010). Since early 2000, more than 15,000 ha of irrigated area disappeared in the Aquitaine region. This is only partly explained by retiring small-scale farmers where exploitations are hardly economically viable. The crop pattern was also changing and more than half of the lost irrigated area has now been transformed to less water demanding crops. The ratio irrigated area to irrigable area (+/-75%) in Aquitaine remains however at a very high level. The ratio is 50% in the rest of France. Irrigated land compared to total agricultural land (i.e. including grassland etc.) is 20% in Aquitaine whereas this is limited to 10% for France at a national scale.

⁵⁰ SCOP: Surface en céréales, oléagineux, protéagineux.

Diagram19 : Long term evolution of irrigated land in Aquitaine region (by department)



It is of note that the same decreasing trend (irrigated area) has apparently not been observed for water abstractions for irrigation. Water abstractions in the main agricultural regions of Adour-Garonne⁵¹ are on average 850 Mm³ per year (2000-2009) but depend heavily on the climate conditions during summer period.

3.1.4.2.2 Irrigated crops

Maize is the main irrigated crop in the Adour-Garonne Basin and takes about 70% of the irrigated surface (figure differs only slightly according to the source). The majority (60%) is maize destined for the grain while the remainder (10%) serves as fodder. Maize represents on average 85% of the total SCOP area (DRAAF, 2010). Other crops that are often irrigated are soy beans and proteinous crops. Besides SCOP, irrigation activities in the Basin are mainly for orchards and horticultural land. The share of fruit and vegetables in irrigated area is 14%⁴¹. Crops for sowing seeds (maize) and tobacco plants are more specialised crops of importance. Grasslands and vineyards could occasionally benefit from irrigation. The irrigated surface of orchards and arboriculture maintained benefiting from (water and cost) savings from a modernisation process to drip irrigation systems. There was nevertheless a general trend to cut trees in the entire area which also weighs on irrigated area for orchards (DRAAF, 2010). Horticultural land (vegetables, both irrigated and other) also shows a decreasing trend, mainly due to strong urbanisation in the areas where these crops are situated.

Tendencies and cultivation of the soil can still differ amongst the main region in the RB. In **Midi-Pyrenees** (CACG, 2009)⁵², irrigated area has been at its maximum in 2003 with 286,000 ha. Like for Adour-Garonne in general, the main irrigated crop is also maize (70%). The other main irrigated crops in the region are the

⁵¹ This figure includes the two regions that are entirely part of Adour-Garonne, Midi Pyrenees and Aquitaine, and the two Charente departments that nearly represents the share of the Poitou-Charentes region inside Adour-Garonne. The trends for these territories are representative for Adour-Garonne RB as a whole. Figure is estimated at 940 Mm³ for the entire RB. (p.c. M. Daubas from Adour-Garonne Water Agency)

⁵² Compagnie d'Aménagement des Coteaux de Gascogne (CACG) (2009). Evolution de la demande en eau d'irrigation de la région Midi-Pyrénées avec les prix agricoles 2007-2008.

cultures of soy beans (more than 40,000 ha and +/- 25,000 irrigated) and peas (15,600 ha and nearly all irrigated). Over the period of 2003-2007, spring and summer crops (maize, sorghum, soy beans, sunflower and peas) have decreased by more than 20% or -129,300 ha in absolute terms. Surface in colza / rapeseed and winter crops (winter wheat or durum) has increased during the same period with nearly 100,000 ha. Total utilisable area has diminished during the same period.

In **Aquitaine**, maize is +/- 75% where 66% is for grains. The other 10% is fully irrigated sweet maize and smaller share for fodder (Agreste Aquitaine, 2010). Besides maize, open ground vegetables like green beans and carrots are the most important irrigated crops. These are gaining importance in the sandy areas (the Landes) in rotation with maize. Flowers and bulbous plants are also benefiting from the presence of irrigation infrastructure. Finally, irrigation is also applied in orchards and for kiwi cultivation, together with the more specialised cultures of tobacco and beet seeds. Main crops in Aquitaine and the importance of irrigation is illustrated in the

Table 14 below:

Table 14 : Main irrigated cultures in the Aquitaine region (maize (and seeds), vegetables '*légumes*' and fruit)

Cultures	Surface totale	
	milliers ha	part irriguée (%)
Total Aquitaine	1350	20
<i>dont maïs grain (y compris semence)</i>	340	50
<i>légumes frais, fraises et melons</i>	46	87
<i>vergers et petits fruits</i>	29	52
<i>maïs doux</i>	20	90
<i>maïs fourrage</i>	61	24

Irrigation activities in Adour-Garonne usually take place from June to mid-September. Limited irrigation activities can occur in spring time (April-June). It is of note that there is a trend where irrigation activities start earlier in the season, depending on the meteorological conditions of the year.⁵³

3.1.4.2.3 Water use in agriculture

Average annual abstractions for irrigation (2002-2009) in the total Adour-Garonne RB are 940 Mm³.⁵⁴ It is of note that these volumes are highly dependent on the weather conditions. Two consecutive years 2002 and 2003 can illustrate the variability of the irrigation water demand. 2002 has known modest abstractions for irrigation (658 Mm³) whereas abstractions in 2003 were at maximum level over the past decade, i.e. 1,216 Mm³. Besides climatic conditions, technical improvements (irrigation equipment) or crop choices could

⁵³ P.c. M. Daubas, Adour-Garonne Water Agency

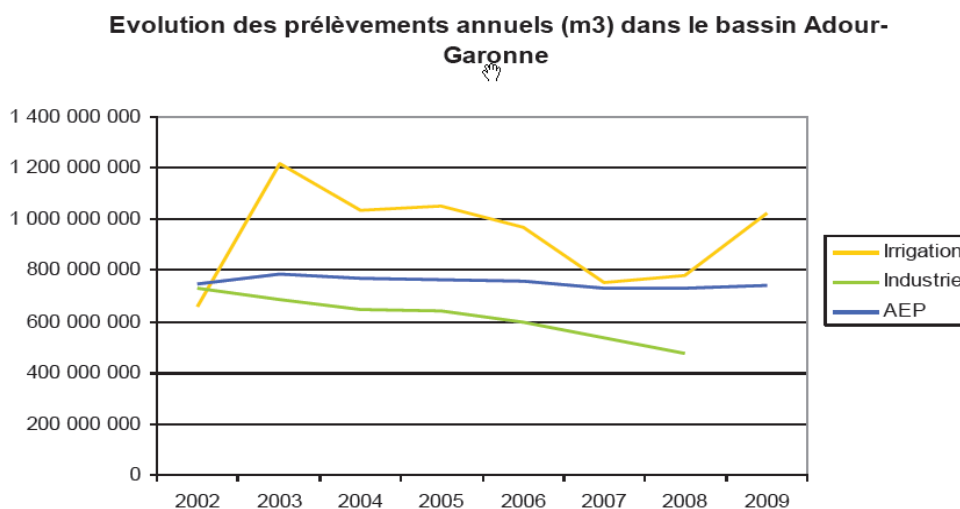
⁵⁴ Agence de l'Eau Adour-Garonne (2011). Redevance Irrigation Campagne 2009

contribute more modestly to the inter-annual variability. In the 2009 irrigation campaign, registered water abstractions for irrigation amounted up to 1,022 Mm³ or 32% higher than the 2008 campaign. These volumes are nevertheless close to the abstracted volumes of irrigation campaigns during the period 2004-2006.

Irrigation accounts for 35 % of the water abstractions in the RB throughout the year (WWAP, 2006). However, this ratio increases to 80 percent during low-water level periods (summer).⁵⁵

Diagram20 confirms the variability of irrigation water abstractions depending on (annual) climatic conditions, whereas other water usages are more stable over time.

Diagram20 : Evolution of the water abstraction in Adour-Garonne RB by sector (cooling water for energy production in Industry)⁵⁶



While irrigation water abstractions are fairly equal to other usages (+/- 35%), the consumptive nature of irrigation water use causes reasonably higher figures for water consumption of irrigation compared to other users. 70% of the water abstractions for irrigation are actually consumed (700 Mm³ out of 1000 Mm³), compared to only 260 Mm³ and 50 Mm³ water consumption for drinking water and industry respectively. Moreover, the pressure from irrigation is more severe as it is concentrated in periods of low-water flows.⁵⁷ In recent periods, water use in irrigated agriculture conflicts with other usages in the Basin, e.g. in Charente where the oyster farms of Marennes-Oléron suffer from the lack of fresh water for their farms in the area (dry estuaries, ...). Alternatively, it might occur that local limited water availability might lead to water shortage for livestock farmers as they are supplied by public water suppliers and drinking water supply has a higher priority.⁵⁸

⁵⁵ <http://www.eau-adour-garonne.fr/page.asp?page=1188>

⁵⁶ Agence de l'Eau Adour-Garonne (2011). Quantité et qualité de l'eau: les enjeux liés à la sécheresse dans le grand Sud-Ouest. Dossier de presse, 23 Juin 2011.

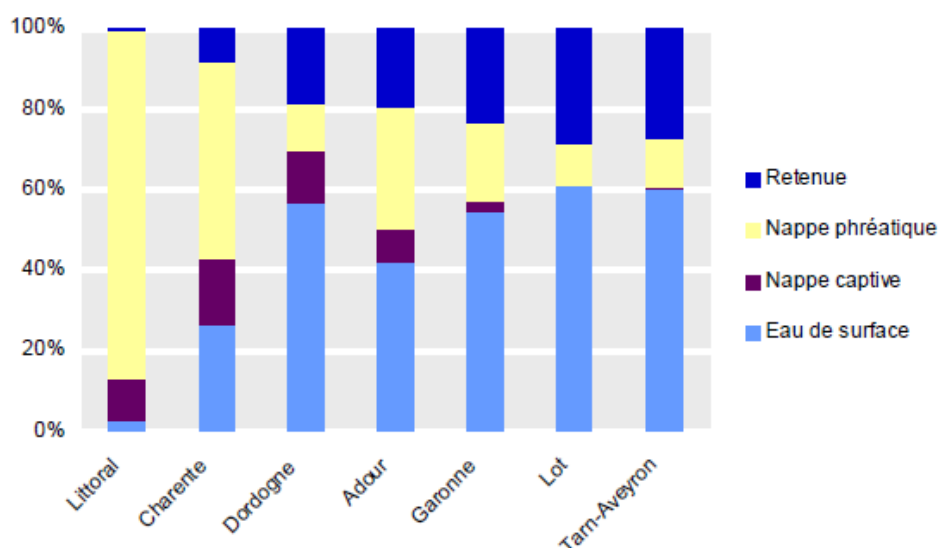
⁵⁷ <http://www.poitou-charentes-nature.asso.fr/CAPEau-Ardour-Garonne.html>

⁵⁸ P.c. M. Daubas, Adour-Garonne Water Agency

3.1.4.2.4 Sources for water abstraction⁵⁹

Surface water abstractions dominate in the entire RB with nearly 60% of the abstractions (17% from stock reservoirs or *retenues*). 35% of the abstractions are from phreatic groundwater and only 7% of the abstracted volume comes from deep groundwater bodies. The share of these sources remains fairly stable over the years. It is of note however that these sources can vary significantly between the different regions, as illustrated in the following Diagram.

Diagram21 : Share of volume abstracted according to the source, by region (for translation, please see footnote)⁶⁰



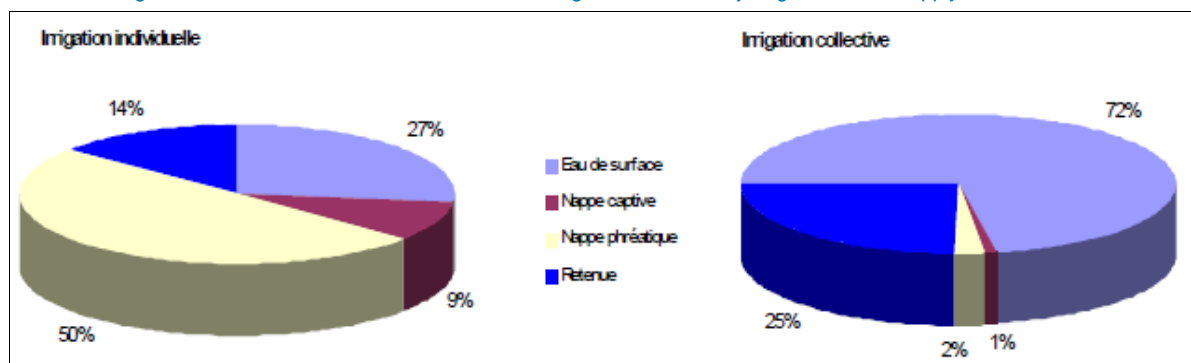
Phreatic groundwater sources are important in the coastal sandy regions of Aquitaine (more than 80% in the Landes). Charente uses groundwater as the most important source (70%), both deep (17%) and phreatic. Deep groundwater sources in the Charente are mainly individual exploitations and nearly all metered. The number of smaller reservoirs (*retenues*) is estimated at +/- 15,000 and stock maximum 290 Mm³. these are particularly important in Tarn and Lot (28% of abstracted volume from this source). In 2009, 177 Mm³ or 17% of total abstractions were allocated to these sources. These reservoirs don't have a direct impact on low-water flow levels and are refilled during winter period.

The source also differs significantly if irrigation is organised collectively or individually (see the following Diagram). Phreatic groundwater layers are easily accessible for individual abstractions, whereas abstraction from higher located dam reservoirs (*retenues collinaires*) already necessitates larger investments. Collective irrigation systems have the capacity to abstract water from rivers and lakes (72%) (or mountain reservoirs – 25%) and distribute the water on a vast territory.

⁵⁹ Unless otherwise stated, information has been derived from Agence de l'Eau Adour-Garonne (2011). Redevance Irrigation Campagne 2009.

⁶⁰ *Retenues* are dam reservoirs. *Eau de surface* stands for surface water bodies. *Nappes* refer to groundwater bodies, phreatic and deeper enclosed (*captive*) layer.

Diagram22 : Share of volume abstracted according to the source, by irrigation water supply



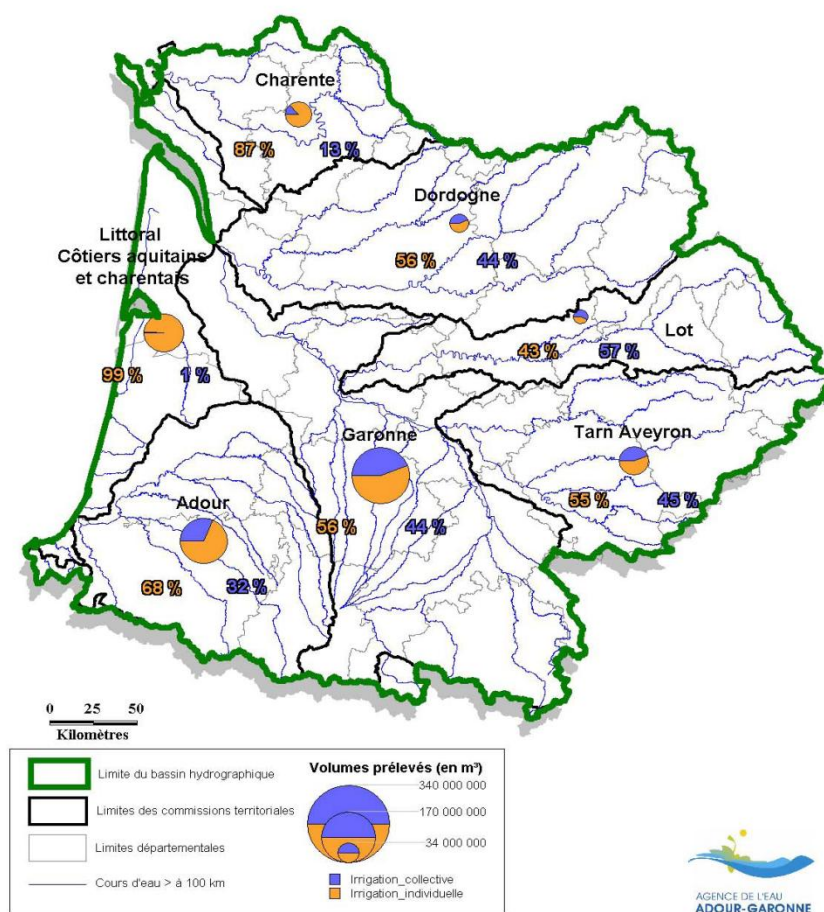
3.1.4.2.5 Water provided and self-supply⁵⁹

In 2009, the abstracted volume for collective irrigation systems was 319 Mm³ or 31% of the total volume in the entire Adour-Garonne Basin. The largest share of irrigation water is thus individual abstraction. There are different types of collective organisations in the RB: *associations syndicales autorisées* (ASA), *associations syndicales libres* (ASL), *syndicats intercommunaux* and larger collective management organisations (CACG, IEMN, SIAHB Vallée de l'Ariège...), etc. OECD (2010) reports that 23.6% of the acreage are serviced through collective organisations. 56.4% are individual abstractions. Increasingly farmers belonging to collective organisations have private wells that are used to complement the supplies of their organisation (20%).

The average image for the RB must be differentiated regionally, which also follows the availability of different sources described in the previous paragraph. Individual irrigation is most important in the coastal territorial Commission and in Charente, with 99% and 87% respectively. The presence of individual irrigation can be correlated to the availability of phreatic groundwater sources. Alternatively, collective irrigation predominates in the territorial Commissions Dordogne, Garonne and Tarn where surface water abstractions are the most important source (region of Midi-Pyrenees). These abstractions would not be possible without the replenishment of surface water in rivers by installed systems like the "Neste system" managed by the CACG (Compagnie d'Aménagement des Coteaux de Gascogne).⁶¹ The Neste system is a complex hydraulic network system of a large channel and multiple water resources (stock of +/- 73 million m³). This system provides water to 17 rivers in the Gascogne area. During the year, the system supports the salubrity of 1,350 km of water courses, drinking water supply to 200,000 inhabitants and irrigation of +/- 50,000 ha in summer.

⁶¹ See e.g. <http://regionrama.com/laregion/haute-garonne/systeme-neste-la-campagne-de-soutien-aux-etiages-2010-sest-achevee/> for a map of the Neste-system.

Diagram23 : regional importance of irrigation systems and volumes abstracted (the size of the circle indicates the level of abstractions)



Sources : IGN 2010

Réalisation : agence de l'eau Adour-Garonne - DER - Unité GQRE - 09/12/2010

3.1.4.2.6 Irrigation techniques⁶²

The predominant system within maize irrigation is the roll-up field sprinkler (*canon à enrouleur*). This technique is favoured by smaller-scale exploitations and it follows however the downward trend in the number of smaller exploitations (period 2001-2006). Ramp irrigation (*rampes*) is mainly situated in the sands of the Landes area where soil characteristics demand significantly higher application rates (see Table 15). Ramp irrigators irrigate more frequently but with lower quantities per turn. Irrigators generate significantly higher yields compared to non-irrigated fields (50% for ramp irrigators in the Landes compared to non-irrigated land). The majority of maize irrigators (58%) apparently bases the irrigation decision on own observations, while 25% follows technical recommendations of the *Chambre d'agriculture* or expert bulletins. The remaining 17% uses guiding tools like gauges and tensimeters. It appears that especially ramp irrigators (more than 50%) follow technical recommendations for their irrigation activities.

⁶² Most detailed information is available for the Aquitaine region (Agreste Aquitaine, 2010).

Table 15 : techniques, application rates (*apport moyen*) and associated yields in maize irrigation (Source: Agreste Aquitaine, 2010)

Type de matériel	Surface en %	Apport moyen (mm)	Rendement (Q/ha)
Pivot, rampe	27	259	122
Enrouleur	66	118	103
Asperseurs	7	143	105
Ensemble	100	159	105

(note: Q stands for *quintal* or 100 kg, unit that is often used for agricultural yields)

In 2007, nearly 70 % of orchards in Aquitaine were irrigated. There is a clear shift to more water saving techniques replacing sprinkler systems. Drip systems and micro jet represented half of the irrigated orchards area in 2007. Especially micro jet has shown significant progression (+46%) between 2002 and 2007. In midi-Pyrenees however, sprinkler systems are still the privileged solution as these are the only answer to frost protection in (early) spring (DRAAF, 2010). It appears that half of the irrigators rely on technical information for irrigation actions and they cover more than 75% of the irrigated orchards (in ha). Multiple sources for technical information are possible, both technical bulletins and information from producer organisations.

Open ground vegetable cultures in Aquitaine (+/- 97% of the surface is irrigated) are usually equipped with basic sprinkler systems (90%) (aspersion). The remainder of the horticultural land is equipped with drip systems. Vegetable crops are often subject of contracts where the irrigation requirement is imposed.

3.2 Current water policies and practices influencing water use in Agriculture

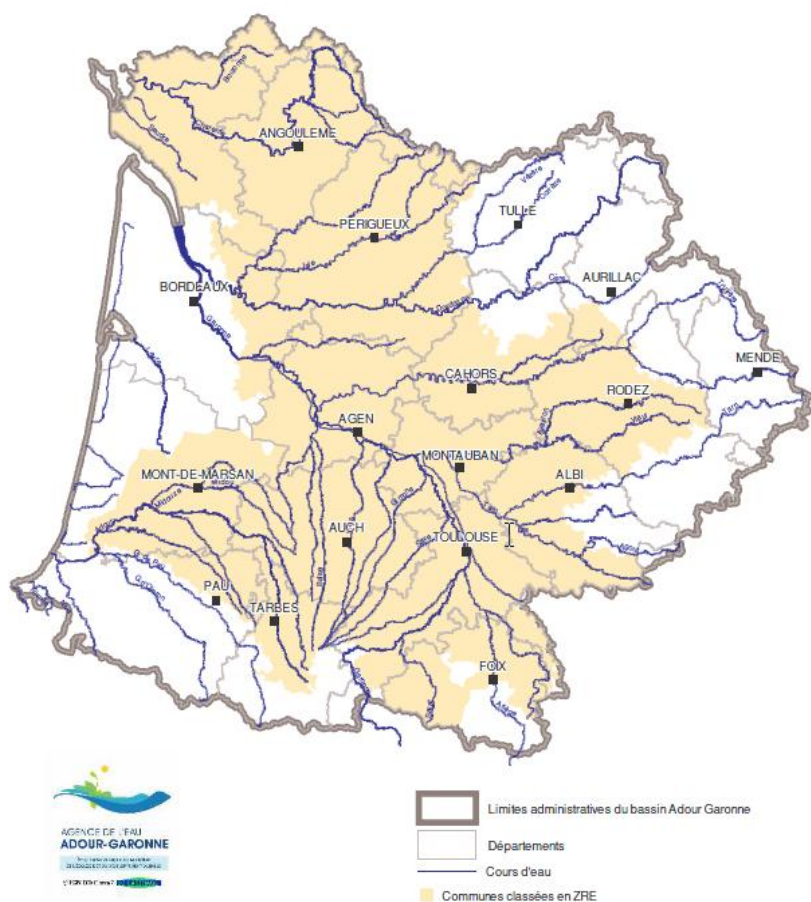
3.2.1 Water allocation policy in the agricultural sector

3.2.1.1 Authorisation for abstraction

For the general water allocation procedure and authorisations, we can refer to paragraph 3.1.2.2.3. Abstraction licenses can be granted to farmers for both groundwater and surface water. Authorisation for abstraction is based upon impact assessment delivered by the department Prefects. These authorisations can be limited or revoked in situations of water shortages. It has been described that the Adour-Garonne is a water deficit area where pressure from especially agriculture is high during the dry periods. 70% of the Adour-Garonne RB has been classified as water deficit area (ZRE) for abstractions in surface water where stricter rules⁶³ apply for authorisations to abstract water.

⁶³ Ministère de l'écologie et du développement durable (2006). Bassin Adour Garonne – L'eau et l'irrigation. Une étude de cas du WWAP.

Diagram24 : Zones (in yellow) classified as ZRE in Adour-Garonne (permanent surface water deficit)



All water abstractions in ZRE require an authorisation from the Water Police when the capacity of the abstraction exceeds 8 m³/hour. This body annually grants authorisations in the form of quota taking into account the water resources availability. As of January 2011, implementation of LEMA 2006 (décret sur l'irrigation pour le Bassin AG)⁶⁴ was about to change the allocation and authorisation procedure for irrigation, where all abstractions for irrigation were to be managed by an *organisme unique*. This system changes annual allocations to individual farmers to multi-annual fixed quota to all irrigation, where volumes are determined in function of statistical availability of water resources 8 out of 10 years (and thus respecting DOEs or minimum low water flows). Besides respecting low water flows (target RBMP 2010-2015), the reform of the allocation process (in ZRE) also aims to reduce the frequency of abstraction restrictions and as such improve the predictability of available resources for agriculture / irrigation. This new system of authorisations could result in 12% less abstracted water for irrigation but leads to unequal impacts for farmers of different regions (e.g. 50% reduction in Poitou-Charentes regions) and important local economic consequences.⁶⁵ The system is still not implemented as of today and the irrigation decree will most likely be adapted before implementation.⁶⁶

⁶⁴ Décret n° 2007-1381 of 24 September 2007. See www.eau-adour-garonne.fr (organismes uniques)

⁶⁵ Agence de l'Eau Adour-Garonne (2011). Quantité et qualité de l'eau: les enjeux liés à la sécheresse dans le grand Sud-Ouest. Dossier de presse, 23 Juin 2011.

⁶⁶ <http://www.agri82.fr/irrigation-hydraulique/actualites/687-irrigation-ou-en-est-on-communique-de-philippe-de-vergnette-president-de-la-chambre-dagriculture>

The Water Police is also entitled to control the abstracted volumes with the granted quota, generally in the critical period between June and August.

The system of user rights or quota is also applied in certain collective irrigation systems (organised by ASA or distribution systems). The latter are larger replenishment or recharge schemes managed by a SAR, e.g. the Neste system managed in concession by CACG or by the State. Collective irrigation systems apply user rights (m³ per hour) or allocate water according to a planned calendar or in function of time period and stocked volume. There are no water markets for abstraction authorisations or permits in Adour-Garonne or wider France.

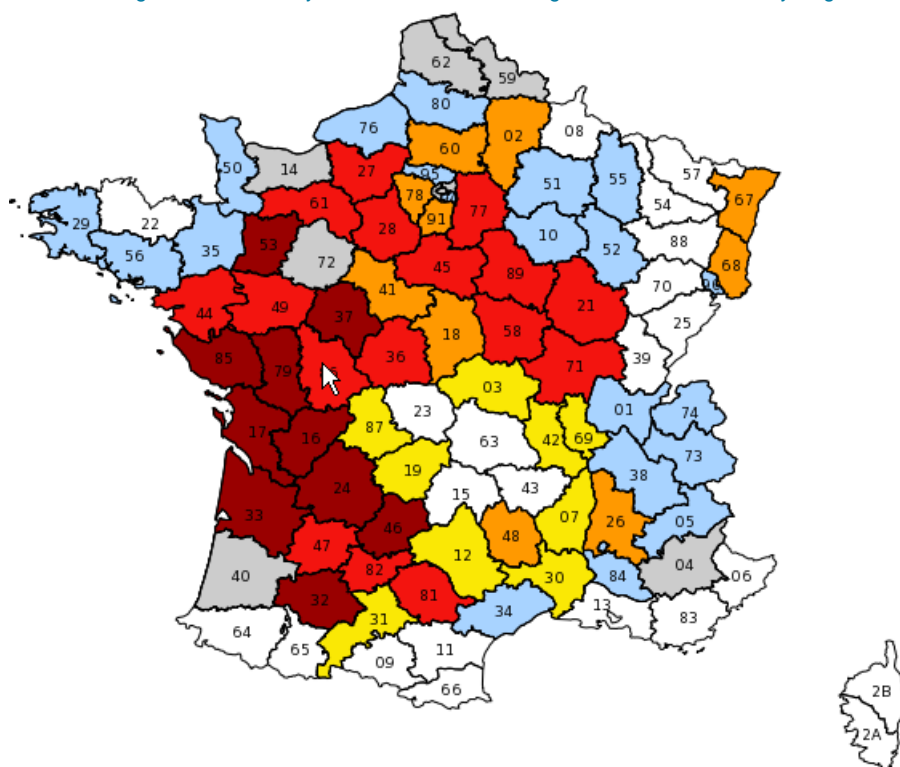
3.2.1.2 Restrictions of water use

In the South West of France (Adour-Garonne), over the past years, meteorological statistics show a higher number of consecutive days without rainfall but monthly precipitation is however not lower. Adaptation to water scarcity and drought should happen in the first place through changing agricultural habits and a shift from irrigated cultures to crops adapted to arid conditions. For several years however, department prefects can issue ordinances (regulations) to regulate different water uses in periods with water shortages.⁶⁷ This right to temporary limit or revoke certain water uses stems from article L.211-3 II-1° of the Environment Code. The general and approved ordinance must be posted at the local government offices and published in two local journals distributed in the department.

Diagram25 gives the example of the current state in France early August 2011 where parts of Adour-Garonne totally banned water abstractions (except for drinking water, i.e. regions in dark red) or limit abstractions for irrigation 3.5 days per week (zones in light red).

⁶⁷ www.eau-adour-garonne.fr/article.asp?id=2133

Diagram25 : Summary of ordinances concerning water abstractions early August 2011



In certain zones, total ban on water abstraction destined for irrigation is frequently installed. Such a ban is rare in principal rivers / axes (Garonne, Adour, Charente, Tarn, Aveyron, Dordogne) but can be installed more frequently in secondary axes where surface water depletion occurs more rapidly. Restrictions vary spatially and in time, starting in the northwest (month of April), to more common restrictions for the majority of departments during summer and maintained in some regions until the end of November. During low water periods in 2009, 327 decisions were made to prohibit water abstractions in 16 departments of the RB. This level is twice the number of restrictions in 2008, giving evidence to the severe climatic conditions in 2009 versus 2008. The Charente department faced largest pressure, with 113 installed restrictions.⁶⁸

3.2.2 Water pricing policy in the agricultural sector

3.2.2.1 Current Framework

When discussing water pricing for agriculture in the Adour-Garonne RB, three pricing systems (or components) will be considered in more detail (RBMP 2010-2015, annex 2): (i) Taxes payable to the *Adour-Garonne Water Agency*, (ii) charges payable to the *providers of water in collective systems*, being the widespread small collective farmer's associations (ASA) and CACG (operating the Neste system), or (iii) the water price for *individual irrigation systems* lying in the abstraction tax and (own) costs for the mobilisation of water resources.

⁶⁸ Agence de l'Eau Adour-Garonne (2011). Redevance Irrigation Campagne 2009

In general, water charges across all irrigation units in France have been increasing over time. Water agencies charge all users, independently of the type of supply, a water tax inspired in the polluter pays principle. The **French Water Law of 2006** imposes the equipment of volumetric metering devices and defines the framework to determine charges that can be levied for water consumption by the 6 water agencies. The water abstraction tax is only a modest fraction of the water price in irrigation⁶⁹. For collective system there is a price to be paid to the provider (canal de provence, CACG, ASA...). Remarkable differences in tariff structures and levels occur even within one basin (OECD, 2010).

3.2.2.1.1 Water abstraction tax (Water Agency)⁷⁰

The polluter pays principle is installed by the water abstraction tax for the Water Agencies (resource cost).⁷¹ According to the Environment Law (art. L. 213-10-9), every person where the activities are leading to water abstractions is subject to a water abstraction tax (*redevance* for the extraction from a water source). According to the 2006 Water Law, the Water Agency fixed a minimum annual abstraction volume of 7,000 m³ that is exempted from the tax. Following the same principle, taxes are apparently not collected for amounts lower than 100 €. In the 2009 irrigation campaign, 42% of the dossiers were exempted from the tax. These exemptions represent however only 4% of the abstracted volume (38 Mm³).⁷²

The tax base is the abstracted volume over the year. These volumes are metered or estimated based on fixed values (per hectare) depending on the irrigation system in place⁷³. The level of the tax has evolved over time, particularly due to the changes introduced by the 2006 Water Law. The base abstraction tax rate for irrigation in 2006 was 0.00445 €/m³, 0.00454 €/m³ in 2007 and 0.00545 €/m³ in 2008. For the 2009 campaign, there was a 5% increase for all uses leading to a tax rate of 0.00575 €/m³. Tax level is expected to increase 80% in the period 2007-2012.⁷⁴

Following to the stipulations in the 2006 Water Law, rates are differentiated according to the state of the water resource. Charges are higher in zones where resources are under pressure (ZRE or water deficit zones), i.e. most of the Adour-Garonne River Basin (see Diagram24). The tax rate in ZRE is increased by 33% but the increase can be suppressed in two particular cases⁷⁵:

- Abstractions from uphill reservoirs (*retenues collinaires*), regardless of the geographical location. The 2006 Water Law no longer foresees exemptions for new reservoirs (< 15 years) that were not subsidised by the Agency.
- Abstractions if there is an installed *organisme unique* for authorisations

⁶⁹ P.c. Thierry Davy: some percentages. OECD (2010) mentions 2-8% share of water abstraction tax in total irrigation cost.

⁷⁰ Livestock farming also pays a pollution tax (environmental cost) to the Adour-Garonne Water Agency (1 million € per year). (Source SDAGE 2010-2015)

⁷¹ Comité du Bassin Adour-Garonne (2009). Le Schéma Directeur d'Aménagement et de Gestion des Eaux (SDAGE) du Bassin Adour-Garonne 2010-2015 et documents d'accompagnement (Annex 2)

⁷² Unless otherwise stated, figures are derived from Agence de l'Eau Adour-Garonne (2011). Redevance Irrigation Campagne 2009.

⁷³ 10.000 m³ per ha for gravitational irrigation systems, 4000 m³ per ha for sprinkler systems and 3000 m³ for other systems.

⁷⁴ P.c. M. Daubas, Adour-Garonne Water Agency

⁷⁵ According to changes in the new Water Law, abstraction in ZRE and subject to low water management plan (PGE) are never exempted from the higher rate. Abstractions for frost protection are always exempted.

There are other situations where the base tax rate can be adapted, e.g. zones with increased salinity, source (deep versus phreatic groundwater bodies) or zones where a system is installed to “recharge” rivers during low-water level periods (*soutien d'étiage*).⁷⁶

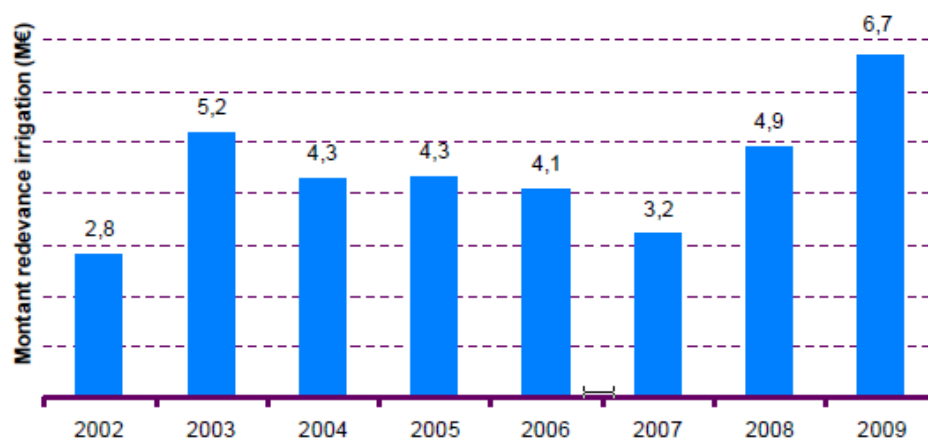
Soutien d'étiage (Garonne)

The water abstraction tax is increased by 0.004 € per m³ for example in the support scheme for the Garonne (during low-water period). The motivation for the higher price is the important financial intervention of the Agency to mobilise 51 Mm³ from hydropower basins at an annual cost of 3 million €. 30% of this realimentation cost of the Garonne is apportioned to the local users and irrigation pays +/- 13% of the total “recharge” cost. This additional charge by the Water Agency is a transitional situation awaiting a new tarification scheme in line with the user pays principle, to be installed by SMEAG (Syndicat mixte d'études et d'aménagement de la Garonne), the body responsible for the soutien d'étiage of the Garonne. This new tarification is expected to be implemented at earliest in 2012/2013. The most important challenge is to identify the real beneficiaries of the system.

Source: Agence de l'Eau Adour-Garonne (2011). Redevance Irrigation Campagne 2009

The total amount of the water abstraction tax for the irrigation campaign in 2009 amounted up to 6,7 million €, or a 37% increase compared to 2008. The increase is largely due to higher water abstractions for irrigation because of climatic conditions in 2009 (+32%) and only partly explained by the higher level of the tax.

Diagram26 : Evolution of the total Water Agency tax revenue from irrigation (M€)



Over the 2009 irrigation campaign, the average abstraction tax was 0.7 c€/m³ in the entire Adour-Garonne RB. This tax ranges from 0.4 c€/m³ in coastal areas (lower rate for groundwater abstractions in sand lands of the Landes) to 0.8 c€/m³ in the Garonne (sub-)basin (*soutien d'étiage*). Most of the abstractions (60%) are annual volumes between 10,000 and 50,000 m³ but represent only 15% of the tax revenue. Large

⁷⁶ It is of note that the earlier mentioned Neste system is another example of such a recharge system. The Neste canal and additional dam reservoirs are managed by CACG and CACG then charges (farmers) for the recharge of surface water bodies in the area (not included in the water abstraction tax).

abstractions (over 100,000 m³) are responsible for 70% of the tax revenue and this category mainly consists of collective irrigation systems and large farmers extracting from easy accessible in the sand bottom of the Landes.

3.2.2.1.2 Collective systems ASA and SAR

Farmers serviced partially or totally through collective organisations are charged in many ways. Two-part or binomial tariffs and flat tariffs appear to be widespread in collective irrigation systems in France. OECD (2010) mentions average volumetric tariffs (**France at national level**) charged by the *Associations Syndicales Autorisées* (ASA) and the *Sociétés d'Aménagement Rural* (SAR) ranging from 0.03 to 0.053 per m³. This present case study evaluated multiple literature sources and mentions (reasonably) higher average water prices for the farmers in the Adour-Garonne basin. This paragraph summarises identified information for the collective systems of the ASA and the only SAR that is established in Adour-Garonne, CACG (La *Compagnie d'aménagement des coteaux de Gascogne*) operating the large Neste canal system.

Regarding the tarification **policy of the ASA**, the RBMP 2010-2015 (SDAGE⁷⁷) argues that, independent of the system in place, the primary objective appears to be cost recovery and secondly the redistribution of the costs incurred to the different users. The plan further notes that these costs are highly variable in time and between systems, depending on the investment cost of the network, age and financing costs (loan payments). The RBMP (2010-2015) describes two widely applied systems and levels of charges⁷⁸:

- Fixed charge based upon the registered or subscribed surface:
 - 39 € per subscribed ha for gravity fed distribution systems (+/- 3,700 ha)
 - 158 € per subscribed ha for pressurised distribution systems (+/- 1,000 ha)
- Two-part tariffs (binomial)⁷⁹, partly variable by m³ and fixed part based upon (i) registered surface or (ii) registered capacity or flow rate. (all the considered ASA provided pressurised distribution systems)
 - 157 € per subscribed ha and 0.082 € per m³ (+/- 8,000 ha covered)
 - 51 € per m³ per hour (capacity) and 0.0568 € per m³ (+/- 30,000 ha covered)

The in-depth analysis of the tariff structures in *Charente River basin* summarised in OECD (2010) confirms remarkable differences in both structure and levels. The study refers to a 2004 CEMAGREF study including 75 associations reporting an average price of 0.11 €/m³ and a 95% interval between 0.09 and 0.12 €/m³. According to CGGREF (2005, citing also the CEMAGREF 2004 study), this average price paid by farmers covers 94.8% of the average cost of water (estimated at 0.115 €/m³, not including neither environmental nor resource costs), while only 5.2% is born by public funds. The part of the average water cost that is covered by the price paid by farmers is composed by a 52% capital cost, a 38% operation cost and a 10%

⁷⁷ Comité du Bassin Adour-Garonne (2009). Le Schéma Directeur d'Aménagement et de Gestion des Eaux (SDAGE) du Bassin Adour-Garonne 2010-2015 et documents d'accompagnement. Annex 2 p 6/13

⁷⁸ Hectares mentioned per system illustrate the relative importance of each system and refer to information that has been included in the cited CEMAGREF study. See RBMP (2010-2015), annex 2

⁷⁹ The French case study report for Adour-Garonne supporting the WWAP (2006)-project mentions a similar pricing system where water availability is assured through recharge from dam reservoirs or barrages. The case study report mentions a fixed part of 25€/ha and a variable portion of +/- 0.005 €/m³ to recover costs to operate the recharge system. Assuming an average consumption of 2200 m³/ha, water price for farmers is about 36 €/ha or considerably lower than these prices. It is therefore unclear (but still likely) that ASA's operate such recharge systems. The report notes that energy costs to generate water under pressure still need to be added which are estimated between 25 and 75 €/ha. Water price might indeed vary significantly if the ASA or the individual farmer manages this activity.

maintenance cost. The water prices include the water supply service and do not include investment costs for on-field application.

Irrigation costs in Haute-Garonne (Midi-Pyrenees)

Large differences between irrigation costs (and indirectly average water tariffs) from different ASA (even within a region) are confirmed in a recent study in Haute-Garonne (Midi-Pyrenees). Irrigation costs are expressed as a price per hectare, by flow and per m³. Costs include a fixed (financing costs, operating costs for distribution and allocation, maintenance, energy connection cost) and a variable part (energy, water abstraction taxes) but do not include costs for the application on field (own costs of ASA). The study compared contribution of some important components in the total cost and the differences between ASAs.

The study indicates that **energy costs** represent between 18 and 80% of the total cost (41% average). It is expected that this price component will further increase in the coming years. It will therefore become key to maintain or develop the irrigation network properly in order to control these energy costs (transport, distribution). This could possibly be by e.g. modernisation of pumping installation (variable speed, energy optimisations e.g. for lower abstracted volumes). This cost is also directly related to the characteristics of the network (length and required pressure).

Financing costs range from 0 to 44% (11% average). For some ASAs this cost is thus significantly while other farmers no longer pay for investments. This component also depends e.g. on recent modernisation of the infrastructure.

Water abstraction taxes payable to the Water Agency are between 0.9 and 11.9% or 5% on average. A large number of ASAs abstract from dam reservoirs where the base tax is lower than in rivers. These reservoirs are not connected to rivers and have no direct impact on low-water flows.

ASAs in the Lauragais area show the highest cost per m³ with 0.233 €/m³ (up to 0.335 € per m³ for the ASA with the highest cost). The other studied areas range from 0.08 (Comminges) to 0,119 (Nord-Toulousain) €/m³. When costs are expressed per hectare, average costs range from 115 to 275 € to even 392 € (high-end estimate for the Nord-Toulousain region)⁸⁰.

It is argued that part of the price variation between the ASA is due to the way they manage quota. ASAs (and their infrastructure) were installed for a certain defined and fixed irrigation water demand. Apparently, when certain farmers consume less than the initial quota, the average price is slightly increased as the fixed part of

⁸⁰ ASA apparently don't possess figures on the irrigated area in their territory. The low-end estimate is based on an application rate of 0.7 l/s per ha which appears to be the average for maize. In certain nord-toulousain regions there's a tendency to irrigate less of the cultivated area but at a higher rate leading to the high end estimate (1 l/s per ha).

the cost for the ASA (financing costs amongst other) remain unchanged and are distributed over a smaller volume (m³) (example of Lauragais area).

Source: Chambre de l'Agriculture de la Haute-Garonne (2010). Gestion de l'eau. Le coût de l'irrigation en Haute-Garonne. Article of 10 September 2010.

In Adour-Garonne, CACG (Compagnie d'aménagement des coteaux de Gascogne) is the only SAR supplying irrigation water in the Adour-Garonne RB. CACG operates e.g. the NESTE canal system in concession of the State and they are charging farmers for two different services⁷⁷:

- The water availability in rivers (gravity fed distribution): Farmers pay a charge based on the registered or projected irrigated surface (flat rate / fixed charge). The charging system relies on quota volumes⁸¹. Farmers pay 50 € per ha for abstracted volumes within the quota. Excess volumes are charged at 0.1 € per m³. Farmers receive a reduction of the tariff when the volume that can be supplied by CACG is below the quota volume (quota volume decrease of 10% leads to reduction in the tariff of 5%).
- Pressurised water supply to the fields: According to CACG, the average tariff for water supply in 2001 was 0.14 € per m³.

3.2.2.1.3 Individual systems

Farmers that individually abstract water only pay an abstraction charge to the Water Agency, which can be differentiated according to the source (see paragraph 3.2.2.1.1). Farmers bear all costs to abstract and distribute the irrigation water themselves whereas this is included in the water price when considering collective systems (e.g. ASAs or CACG). Leray (2010)⁸² includes details on the different cost components of irrigation activities and provides some cost examples of each component.⁸³ The total cost per ha for irrigation amounts up to 690 € per ha per year. This cost calculation is based upon the assumption of 10 ha irrigated land and 20,000 m³ of water and includes all investment costs to abstract water from a dam reservoir (incl. investment costs for the reservoir minus subsidy) and on-field application. The water abstraction tax is not included but at an average tax rate of 0,7 c€ per m³, this amounts up to 140 € or 14 € per ha and thus marginal compared to the total cost (2%). Investment costs take up 75% of the total cost, investments for on-field application of irrigation water take +/- 25% or +/- 170 €/ha. Total cost decrease to 175 € per ha when investments have been depreciated. Energy costs are then responsible for 75% of this cost.

3.2.2.2 Factors influencing the impact/effectiveness of water pricing and allocation policies

The Water Agency tax is based upon the abstracted volume of water. The Agency charges declared volumes from farmers (individual or collective) of which abstractions are generally metered. In Adour-Garonne RB, 95% of the abstracted volume of irrigation water was metered in 2009. This corresponds to 26,671 meters for 37,901 abstraction points (Agence de l'Eau Adour-Garonne (2011)). The remaining 5% of

⁸¹ See SDAGE 2010-2015, annex 2: Reference quota figure of 2000 m³ per ha or 4000 m³ for a registered capacity of 1 l/s

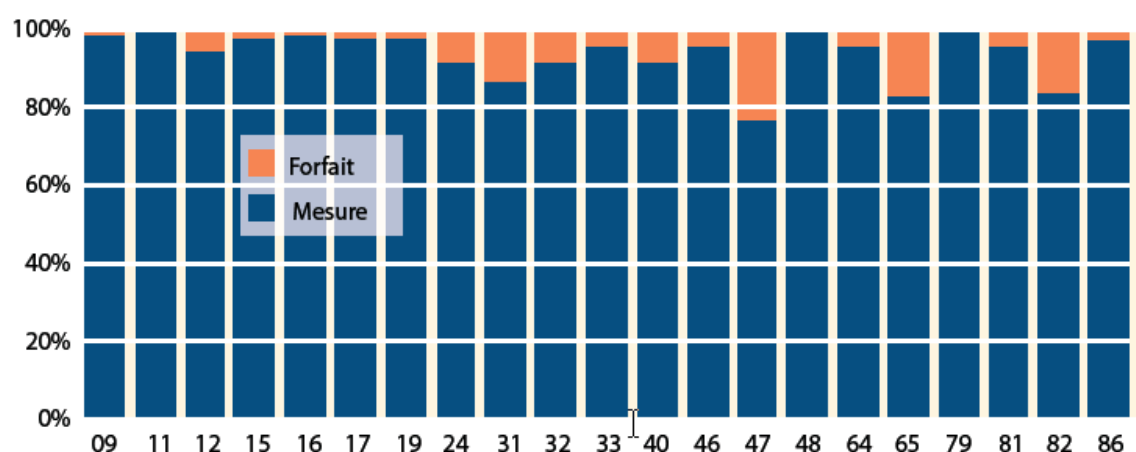
⁸² Leray (2010). Coût irrigation. Chambre d'Agriculture, octobre 2010. Action cofinancée par l'Union européenne avec le Fond Européen Agricole pour le Développement rural en Midi-Pyrénées et par l'Etat (CasDar)

⁸³ The work has been performed in the framework of the CasDar-project: Connaissance, adaptation et amélioration de la gestion quantitative de l'eau avec des collectifs d'irrigants de Midi-Pyrénées.
par le développement et l'utilisation de méthodes et d'outils adaptés

the abstractions is estimated based upon standard application rates per ha depending on the installed technique. In collective irrigation systems, metered volume is even higher with 98%. The requirement to meter water abstractions has been installed in the GAEC (Good Agricultural and Environmental Conditions) to benefit from CAP payments as of 2005.⁸⁴ Furthermore, metering devices are also obligatory in order to benefit from support in the framework of the environmental farming plan (*Plan vegetal environment*). Take-up of this obligation has been facilitated by the **financial aid of the Water Agency** in its financial programme VII (1997-2002) where many of the **metering devices** were supported through the Agency. All these actions led to success with 85% of the volume metered in 2003 and more than 95% of the volume metered in most departments today. Some gaps remain in the departments Lot-et-Garonne, Tarn-et-Garonne, Haute-Garonne, Hautes-Pyrénées.

Diagram27 shows the situation by department in Adour-Garonne RB. Metering as a precondition for volumetric pricing (e.g. abstraction tax) is available.

Diagram27 : regional presence (in terms of volume) of water meters (blue) in the departments of Adour-Garonne RB



Awareness programmes (promoting rational water use) and improvement of agricultural practices towards irrigation are a permanent issue in the collaboration between the Adour-Garonne Water Agency and the farmers' organisations.⁸⁵ One third of the support provided by the Water Agency is destined for these objectives (in line with the limited availability of water resources) (WWAP, 2006). Over a period of 10 years, The Water Agency supported the installation of 24,000 metering devices and 14,000 devices to minimise on-field water application rates.⁸⁶ The Water Agency provided +/- 3.5 M€ support for +/- 15,000 requests. Investments for two types of devices are eligible for support:

- To save water during irrigation: electronic steering of roller sprinklers, refracting devices (*brise-jet*), programmable or automatic (closing) valves or for micro-irrigation.
- To help steering the irrigation decision: soil analysis instruments (tensimeter, capacitive probes, ...), plant or crop sensors, weather stations, guidance software.

⁸⁴ According to the French Ministry of Environment.

⁸⁵ <http://www.eau-adour-garonne.fr/page.asp?page=3684>

⁸⁶ <http://www.eau-adour-garonne.fr/page.asp?page=1634>

The case study report of Adour-Garonne under WWAP 2006 notes that 1 euro paid to the Water Agency as a water abstraction tax levers 3 to 4 euro of support from the Agency for the agricultural sector (in terms of aid for the operation of low water (recharge) systems, dam reservoirs, operational advice or rational water use). The Water Agency also supports specific guidance to irrigating farmers (*conseil au pilotage de l'irrigation*). In 2011, the Adour-Garonne Water Agency will provide 1 M€ financial support to foresee a weekly advice for irrigation (*pilotage de l'irrigation*). Experts estimate annual 10% potential of water savings related to this initiative or 70-80 Mm³. Farmer surveys reveal that uptake of such advice or guiding tools for the irrigation decision is significant but different amongst farmers. The majority of maize irrigators (58%) apparently still bases the irrigation decision on own observations, while 25% follows technical recommendations of the *Chambre d'agriculture* or expert bulletins. The remaining 17% uses guiding tools like gauges and tensimeters. It appears that especially ramp irrigators (more than 50%) follow technical recommendations for their irrigation activities (Agreste Aquitaine, 2010). The Agency also contributes to research⁸⁷ and pilot projects (e.g. water savings for maize irrigation: decrease by 20% over a 3 year period, company Nataïs, European leader in Popcorn distribution).

Restrictions to the use of water for irrigation are common in Adour-Garonne (see paragraph 3.2.1.2). These ordinances are periodically issued by the Prefect. One important drawback of the system is that these decisions usually come after implantation of maize (mid-April to mid-June) and that crop pattern is partly fixed due to the decision on the winter crops in September (Agreste, 2007). These restrictions or allocation decisions are likely to have no or only limited impact on short term farmer's decisions. This decision is largely motivated by early year forecasts or information on the availability of water resources, the economic results of the past year or other resources (maize irrigation demands more manpower).

Leray (2010) notes that it is very difficult to receive an authorisation for new water abstractions from surface water as the area is classified as a zone with permanent water deficit (ZRE). Phreatic groundwater sources are regularly monitored and their potential is listed. The problem of uncontrolled or illegal abstraction is assumed to be low in the Adour-Garonne RB⁸⁸, as the zone is classified as ZRE (70%) with stricter rules and control. Moreover, declared volumes for the water abstraction tax are based on metered results providing solid knowledge on the water demand and abstractions. Agreste Midi-Pyrénées (2006) notes that the discrepancy between declared volumes and volumes based upon agricultural surveys was below 10% in the period since 2001. The Water Police (and Onema) is responsible for the control of abstracted volumes in line with the authorisation. The case report for Adour-Garonne under WWAP (2006) notes that Water Policy might lack the necessary resources to effectively execute their control activities on abstractions. This has however not been confirmed in other sources.

The Water Agency abstraction tax is about 5% of the total irrigation cost, but can differ according to the other costs of e.g. the collective irrigation system.⁸⁹ OECD (2010) confirms that this component takes between 2

⁸⁷ E.g. CasDar project, see footnote 83

⁸⁸ P.c. M. Daubas Adour-Garonne Water Agency

⁸⁹ Chambre de l'Agriculture de la Haute-Garonne (2010). Gestion de l'eau. Le coût de l'irrigation en Haute-Garonne. Article of 10 September

and 8% of irrigation costs (% very dependent on the fact whether the irrigation cost still includes a significant investment component or not). For the main crops in France, irrigation cost is estimated to be about 20% of the total production cost. This total irrigation cost includes all costs. The right to access water (e.g. abstraction costs or supply costs in collective systems) takes a part of this total costs besides infrastructure for on-field application and energy costs (predominant for self-supply).

3.3 Analysis of water pricing and water allocation policy

3.3.1 Drivers and Barriers

OECD (2010) mentions a review of water pricing policies in France showing that policies have been geared towards cost recovery objectives. It appears that there are large capital costs differences accross basins and irrigated areas, creating a large range of capital costs recovery, between 15% and 60%. According to WWAP (2006) and its case report on Adour-Garonne, irrigation charges are still highly subsidised.⁹⁰ CEMAGREF (2002), the most commonly cited source for the analysis of cost-recovery rates, states that irrigation in SARs and ASAs has full O&M cost-recovery rates, whereas capital costs' recovery is only 40% (cited by Plan Bleu, 2007). In paragraph 3.2.2.1.2, we indicated the difference amongst collective systems. There is a long history of financial support from the Water Agency for investments in (dam) reservoirs. The focus of aid has shifted from large reservoirs (more than 2 Mm³, usually for river feeding in low water periods) in the late 1960s to smaller and intermediate sized reservoirs (after 1972). The latter type of reservoirs are predominantly destined for agricultural / irrigation purposes. The number of reservoirs in Adour-Garonne RB for water abstractions for irrigation is estimated at +/- 15,000 (300 Mm³). Since 2003, subsidies are only granted to investments in 'substitution' reservoirs⁹¹, on condition that these are identified in the low water management plan (PGE) and organised collectively at subcatchment level.⁹² This policy of subsidised reservoirs has been severely criticised by several stakeholders (mainly environmental organisations) as farmers tend to be the most important beneficiaries (socio-economic justification in feasibility studies) while the investment is heavily supported through public funding of the Water Agency. Moreover, these organisations further refer to the water demanding cultivation of maize made possible through these reservoirs and the environmental consequences: migration barriers for fish, soil degradation and use of fertilisers and pesticides associated with large (maize) cultivations.⁹³

2010. Confirmed by p.c. M. Daubas Adour-Garonne Water Agency

⁹⁰ Revenues collected for irrigation water were assumed to be far from adequate for meeting the real cost of providing services in 2002 (€3.83 million collected versus a full cost of €107 million). It is of note that this publication seems to compare the revenue from the water abstraction tax (resource costs) with (hypothetical) total costs for self-supply without the costs for the application on field (+/- 107 million €). Based upon average unit costs for farmers ranging between 0.09 and 0.16 €/m³ (see page 24, Comité du Bassin Adour-Garonne (2005))

⁹¹ The principle of substitution gained importance after 1997: irrigators with valid water abstraction authorisations in water courses suffering from water shortages decide and agree to shift their abstractions to a newly created reservoir instead of the water course

⁹² Agence de l'Eau Adour-Garonne (2008). Adour-Garonne, Revue de l'agence de l'eau. Des retenues collinaires pour l'irrigation. Septembre 2008.

⁹³ See for example <http://www.poitou-charentes-nature.asso.fr/CAPEau-Ardour-Garonne.html> and http://seaus.free.fr/IMG/pdf/Loi_sur_l_eau_et_FNE.pdf

The Water Agency abstraction tax on water use by irrigators is inspired on the polluter pays principle. This ecotax on water abstraction tries to internalise environmental and social costs, but the level of environmental cost recovery is quite low (OECD, 2010). It is difficult to compare revenues with costs of the Water Agency as these revenues are earmarked for multiple purposes and uses. The RBMP 2010-2015 mentions a 64% recovery of the total annual capital investments of the Water Agency for the agricultural sector (39 M€), noting that the investment amount is underestimated and uncertain. No details on the estimated level of environmental and resource costs related to agriculture in the RBMP. The instrument is evaluated rather as a political contribution of users rather than an environmental cost recovery charge (OECD, 2010). Farmers only pay pollution fees for water used in cattle production but not in crop production. The level of cost recovery is uncertain as there is no clear figure on the subsidies for livestock exploitations (Comité des Bassins, 2005). Cost recovery for operational and maintenance costs is assumed to be close to 100% for both self-supply (energy, maintenance) and collective systems.

The price of irrigation water is low compared to drinking water. The drinking water price amounts up to 3.44 € per m³. This includes the sanitation tariff and the water quality can't be compared with water predominantly used in the agricultural sector. The price for the supply of drinking water only (households) is around 1.70 €/m³. Prices for industry are ranging from 0.75 to 1.1 €/m³.⁹⁴ The water price for irrigation water supply amounts up to 0.10 € to 0.15 per m³⁹⁵ and 0.015 € per m³ for the "recharge" network. The impact on farmer income of the pricing policy is fairly low and does not influence on behaviour. Decisions are much more inspired on and related to water availability and allocation. Water quantity management measures (PGEs, restrictions to irrigation) and water savings (modernisation of equipment, irrigation advice, collective irrigation systems, ...) have resulted in respecting DOEs (8 out of 10 times) in all past years, except in the dry year 2003. Some conflicts between uses remain as oyster farmers for example complain about lack of (quality) water partly due to irrigation and agriculture, whereas they argue to contribute much more to local GDP.

A potential weakness of the system in place in Adour-Garonne follows from the combination of the low water price relative to the total production costs and the high prices for cereals. A decline in water intensive crops (maize in particular) could be expected from a significant water price increase and decrease of sales prices for these crops (CACG, 2009). For certain deficit areas (e.g. Poitou-Charentes) in particular, a more decisive policy would be needed to encourage a shift to non-irrigated crops. Irrigated area has decreased but there is still a persistent gap between supply and demand. Allocation of scarce water resources is done by the use of authorisations and quota instead of water tariffs. Metering is in place but still difficult to control and enforce (capacity).

⁹⁴ Figures are based on calculations for different reference companies with different annual water use. See study Arcadis (2008). *Vergelijking van de kostprijs van waterlevering en afvalwaterzuivering voor de gebruikers in verschillende Europese landen*. Study executed for the Flemish Environment Agency.

⁹⁵ 200 to 250 € if expressed on a per hectare basis (p.c. M. Daubas)

Farmers' acceptance of the systems in place is fairly high as the water tariff has no significant impact on revenues. The Water Agency supports farmers in irrigation practices (devices to save water or to steer irrigation decision, recharge systems in dry periods, dam reservoirs, ...). Access to water (dry periods, restrictions on irrigation) is a more important constraint in the decision process of farmers. A study of INRA (see Agreste Midi-Pyrénées, 2009) on the impact of water shortage in Midi-Pyrenees states that the profit of farmers can be reduced by 50% in case of a ban on irrigation water. It is of note that this loss could be reduced to +/- 15% if forecasts announce a high possibility of such a ban before mid-July allowing farmers to modify irrigation choices. It has been detailed that the intended revision of the authorisations for water abstractions (and installation of *organismes uniques*) has not been supported by farmers because of the significant consequences in certain areas of Adour-Garonne. This proposed change will require accompanying measures to mitigate the impacts in the most affected regions. Irrigating farmers are asking to foresee accompanying measures or spreading over time to make it acceptable for the more sensitive regions (15% of the Basin). Some of these effects have been detailed in paragraph 3.3.2.2.⁹⁶ According to FRSEA (2009), farmers are satisfied on the functioning of the ASA and collective management of irrigation. In particular, they refer to the pluviometric monitoring and the strict control of water levels in small rivers which allows almost real-time response to adapt volumes to abstract. The structure also appears to be beneficial for (long-term) stakeholder cooperation and agreements. It is noted that the distribution of their forecasts might be still improved to further ameliorate responsiveness and efficiency.

3.3.2 Effects of the water pricing and water allocation policy

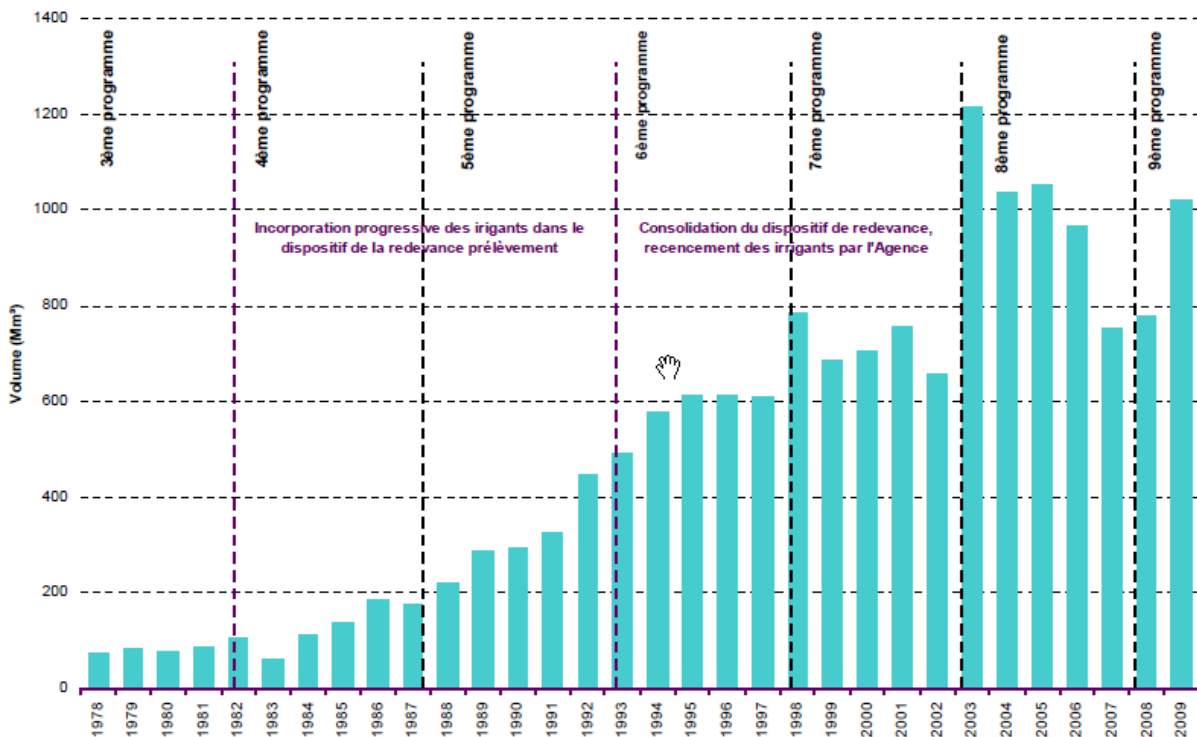
3.3.2.1 Direct Effects

Abstracted volumes for irrigation changed drastically over the past 30 years from 75 Mm³ in 1978 to a peak value of 1,216 Mm³ in the dry year 2003. Variations in volume are depending on multiple parameters (meteorological conditions, technical reasons or economic conditions). The Water Agency also relates some fluctuations to the installed policy and the water abstraction tax (*redevance*). The different time periods in Diagram8 are each characterised by substantial improvement in the knowledge of abstracted volumes which makes it difficult and uncertain to compare between time periods (e.g. change in the standard application rates per ha used for calculations, voluntary declarations, metering). After 2003, more than 80% of the volume was metered which makes it more or less relevant to only consider the evolution over the last decade. According to the Adour-Garonne Water Agency⁹⁷, the history of the evolution of the declarations learns that the climatic conditions are predominantly influencing the volumes for irrigation water. 2007 and 2008 have been years with fairly modest demand for irrigation while this demand has increased again in 2009.

⁹⁶ For further reading, see: Agence de l'Eau Adour-Garonne (2011). Révision des autorisations de prélèvement d'eau pour l'irrigation sur le bassin Adour-Garonne. ACTeon, BRGM, CEMAGREF en partenariat avec CACG, ARVALIS, CETIOM et INRA.

⁹⁷ Agence de l'Eau Adour-Garonne (2011). Redevance Irrigation Campagne 2009

Diagram28 : evolution of declared volumes of water for irrigation (to the Water Agency)



Over the past decades, irrigation has been considered as an insurance to secure stable returns. This trend has resulted in the development of capital (and water) intensive crops (large cultures). The changing regulatory and social context (and to a lesser extent economic and climatic) have lead to a decline in irrigated area since +/- 2000 (see paragraph 3.1.4.2.1). Farmers risk to be confronted with lack of irrigation water in periods of water shortage (ordinances from prefect to restrict or forbid irrigation, conflict with other uses). Capital intensive crops have put pressure on farmers in terms of large investments or quality contracts for their products which require irrigation in order to obtain minimum return. It appears that these farmers have no viable economic alternative to easily change the crop pattern (Agreste Midi-Pyrenees, 2009). They adapt to the situation by limiting the irrigated acreage but using the same volumes of water to the reduced area (see also DRAAF, 2011). Alternative crops and less water intensive or sensitive in dry periods are winter cereals and sorgho. The latter has a negative image as it sometimes lacks demand (comparable to maize, also fodder crop). Sunflowers are also a substitution crop for maize. (Agreste Aquitaine, 2008)

Water pricing policy was not found to be a determining factor in farmer's crop choices or reduced application rates. The level of the water abstraction tax charged by the Water Agency is volumetric but the level of the tax provides no incentives to save water.⁹⁸ For individual irrigators (+/- 60 % of the irrigation water), there's no other charging instrument. Investment costs (pump, irrigation infrastructure) and energy costs are far more important than this. Pricing in collective systems can differ significantly between systems. Most systems apply binomial tariffs though fixed can still exist for gravity fed systems. Fixed systems can influence

⁹⁸ Office international de l'eau (2009).

the irrigation decision but do not promote lower application rates per ha. Binomial tariffs also don't contribute to reduced water use if the water price is low compared to total production cost, if the variable part is small compared to the fixed costs of irrigation or if no alternatives are available. A study on water demand for irrigation in Midi-Pyrenees⁹⁹ confirms that the marginal value of water is still positive in a context of limited water rights (e.g. +/- 0.20 €/m³ for different studied agro-economic modeling scenarios). Changes in farmer's behavior (crop pattern and associated irrigation water demand) would result from a combined increase in the price of water and significant decreases of the prices of maize and soy beans.

Two evolutions are still of note in the availability of water resources and the allocation to different users. Two decades ago, the estimated annual water deficit amounted up to 600 million m³. This deficit is now estimated at around 235 Mm³ or reduced by more than 50%. According to the Water Agency, several measures have contributed to this decline, i.e. water quantity management (e.g. PGEs), stabilisation or slight decrease of irrigated area, water savings, ... An important factor is however the significant growth in the number of barrages and (dam) reservoirs that support low-water levels or provide irrigation water. Total capacity of these reserves have grown from 150 Mm³ in 1984 to more than 800 Mm³ today (more or less equal to the abstracted volume for irrigation in a normal year) . The Water Agency provided more than 160 Mm³ funding over this period. 37 new projects are considered for a total volume of 50 Mm³. Environmental impact of these new reservoirs still needs to be analysed and the realisation also more on more depends on local and social acceptance.¹⁰⁰ A second potentially important (future) evolution is the new authorisation procedure for water abstractions for irrigation water and the installation of an *organisme unique* to manage these allocations. Paragraph 3.2.1.1 briefly described that such a change could lead to 12% reduction in abstractions for irrigation with large regional differences. This changes face strong opposition from the agricultural sector as the methodology to determine the fixed quota is contested and the sector indicates the local socio-economic consequences requiring (support) measures to reduce the impact. It is of note that environment organisations also express their doubts on the authorisations through *organismes uniques* in terms of effective control of abstracted volumes in line with the quota (if the body would be the Chamber of Agriculture for example).¹⁰⁰

3.3.2.2 Indirect Effects – demand responses of users to water prices

Impact on farm income from the pricing policy is likely to be low. This is illustrated with positive marginal value of water in different agro-economic modeling results (see e.g. paragraph 3.3.2.1). Farmer income is however more influenced by allocation of available resources or quota systems in place. According to a study of the statistics department in 2006 (INRA), an average exploitation in the region Midi-Pyrenees suffers a 54% decrease in profit in case of an irrigation ban.¹⁰¹ The AG Water Agency¹⁰² has recently analysed socio-economic impact of the revised authorisation system for irrigation water abstractions. Detailed modelling has

⁹⁹ Compagnie d'Aménagement des Coteaux de Gascogne (CACG) (2009). Evolution de la demande en eau d'irrigation de la région Midi-Pyrénées avec les prix agricoles 2007-2008.

¹⁰⁰ <http://www.poitou-charentes-nature.asso.fr/CAPEau-Ardour-Garonne.html>

¹⁰¹ Agence de l'Eau Adour-Garonne (2011). Quantité et qualité de l'eau: les enjeux liés à la sécheresse dans le grand Sud-Ouest. Dossier de presse, 23 Juin 2011.

¹⁰² Agence de l'Eau Adour-Garonne (2011). Révision des autorisations de prélèvement d'eau pour l'irrigation sur le bassin Adour-Garonne. ACTeon, BRGM, CEMAGREF en partenariat avec CACG, ARVALIS, CETIOM et INRA.

been performed for 6 smaller basins and results have been extrapolated to Adour-Garonne. The study concerned the impact of initial volumes that would be allocated in line with the fixed quota (depending on e.g. DOE, laid down in PGE) and the impact of modified definitive volumes including the effect of accompanying measures (additional reservoirs / stocked resources, ...). The study suggests large differences between regions and studied scenarios (depending on e.g. irrigation strategy, economic and climatic conditions). Impact on gross operating margin in normal year (agricultural prices and climate) ranges from -9% to -34% in the most impacted area and without accompanying measures. Regional are a.o. influenced by the availability of alternative crops e.g. restricted by soil type. Farmers in Seudre (clay – limestone soil) have the possibility to switch from irrigated maize (fodder) to non-irrigated maize and an increase of the cultivated surface while sandy soil types are not suitable for non-irrigated maize.

A study by FRSEA¹⁰³ conducted in 2008 describes the socio-economic consequences from collective irrigation systems and more in particular effects associated with the construction and management of dam reservoirs / artificial reserves. The study underlines the farmer's benefits from the installation and collective management of such reserves in terms of stable and increased yields, development of specific cultures (tobacco, fruit and vegetables, production of seeds, strawberries).¹⁰⁴

Improved yields not only result from the irrigation decision but also depend on the applied techniques, modernisation of infrastructure. Pressure on water resources and e.g. higher costs for energy provide incentives to increase efficiency of irrigation activities, and different projects are running to face these pressures in for example collective systems (CasDar, APPEAU, ...). Within CasDar, three collective systems (ASA) have been studied to assess the adaptation of irrigated crops under several changing conditions. Base for modelling was close to the current situation as these ASA actively participated to the project. Certain relevant changes in the current agricultural conditions have been studied:

- increase of the water price with 15% over a three year time period: 10 to 30 € per ha loss in gross margin.
- availability of water in each specific context (including forecasts): lower authorised volumes lower the gross margin by 20 to 40 € per ha or even 60 € per ha in dry years.

Change in crop pattern can compensate only part of these losses. Maize will remain the main cultivation where it is already the case. Crop diversification in a part of the irrigated area (20 to 25%) with cultures like soy beans, sunflower and cereals helps to limit the risks of meteorological variability. These crops allow to change irrigation habits without totally compromising yields. More water is then available for maize except in dry years.

The project also generated a simulating tool to model irrigation strategies in different scenarios (irrigation calendar). The tool predicts the outcome a strategy in varying circumstances in terms of water use, yields, gross margin, etc... This might support farmers in their strategy as different decisions can be compared.

¹⁰³ FRSEA (2008). Impacts socio-économiques et environnementaux d'une gestion raisonnée de l'eau en agriculture et agro-alimentaire.

¹⁰⁴ Example of the ASA Sainte Gemme Martailac & Grezet-Cavagnan in Lot-et-Garonne.

Since the area is classified as water deficit area (ZRE), declaration and authorisation of abstractions is more strict and the problem of illegal abstraction is assumed to be within limits. The Water Police in AG has executed nearly 13,000 controls in 2009 with 10% non-conformities.¹⁰⁵ These figures encompass both administrative and field controls and only part of the latter go to abstraction authorisations.¹⁰⁶ It is not feasible to have a clear picture on illegal abstraction (e.g. non-authorised boreholes) based on this information. The annual report of the State Audit Office (*Cour des comptes*)¹⁰⁷ states that despite an increased number of (and time spent for) controls the number of (administrative) sanctions has decreased. The dissuasive effect of the level and probability of the sanction appear to be rather low.

3.4 Lessons from water savings study

Case studies in the parallel water savings study by a consortium lead by Bio Intelligence Service¹⁰⁸ aimed to provide an illustration of the responses from farmers, local authorities and other stakeholders to reduce pressure on water bodies by agriculture and the successfulness of these responses.

In the Adour-Garonne river basin, the presented initiatives for water savings mainly use a socio-economic approach, including regulating the use of water, providing advice for irrigation scheduling, an example of self-organisation by farmers to smoothen abstraction, but also storing water in dams and releasing it in scarce periods or testing a new governance scheme. The study further refers to two types of behaviour in water deficit situations or areas. One is the adaptation and reaction to reduced water availability through changed cropping patterns (sufficient water for the remaining crops); and the other is a more preventive approach, such as the situation for water turns, to benefit from the water as long as possible.

The main system for reducing water use lies in the implementation of regulatory limitations to water use, activated depending on defined minimum river flow thresholds. It has been argued that the thresholds for river flows could probably be spread among other MS as a useful way to deciding when to limit water use. Other systems in place focus at ensuring water use for farmers for as long into the season as possible e.g. scheduling initiatives or irrigation scheduling by farm advisory services (Chambres d'Agriculture). While this does not save water, it can lead to flows during a longer period, benefitting both the farmers and the environment. Advice for scheduling irrigation is already in place in several other places, but could continue to be strengthened to improve efficiency of irrigation. However, in dry periods, its efficiency may remain to be demonstrated.

¹⁰⁵ http://info.eau-adour-garonne.fr/newsletters/articles/numero_11/les_chiffres_police_eau.pdf

¹⁰⁶ Ministère de l'Ecologie, de l'Energie, du Développement durable et de l'Aménagement du territoire. Police de l'eau. Rapport d'activité 2008.

¹⁰⁷ Cour des comptes. Rapport public annuel 2010.

¹⁰⁸ BIO Intelligence Service (2011), Water saving potential in agriculture in Europe: findings from the existing studies and application to case studies, Final report prepared for European Commission DG ENV

3.5 Conclusion

On an annual basis, the Adour-Garonne River Basin has abundant water resources due to high rainfall mainly in winter time. Total water abstractions are modest compared to the total annual availability but in low-water periods and at certain locations there is persistent imbalance between demand (during low-water periods +/- 85% for irrigation purposes) and minimum (river) flows. Deficits are expected to be even more significant when considering the climatic evolution. Variations in volume are nevertheless highly dependent on the hydro-climatic conditions of the year (especially for irrigation, e.g. ranging from 700 million to 1,200 million m³ in two consecutive years 2002-2003). Adour-Garonne RB has the largest share of irrigated agriculture in France (40% of irrigated acreage compared to 20% of the agricultural land of the entire country). Nearly 1 on 4 exploitations in the RB rely on irrigation for their farming activities. Cultivations that are most dependant of irrigation are maize, fruit and vegetable crops.

Current policy focuses on managing scarce water resources through a mix of demand side and supply side measures: planning instruments (low-water management plans (PGE) and *Zones de répartition d'eau* (ZRE)), promotion of rational water use, creation of additional water resources (basins). PGE and ZRE evaluate the availability of resources (state) and try to establish long-term equilibrium between supply and demand basically by stricter policy on water abstractions (allocation). Stakeholder participation and consultation between different water users are key features in the planning. The Water Law 2006 foresees the obligation to designate the allocation of water for agricultural uses (multi-annual basis) in certain areas to an *organisme unique* but the system has not found its entry yet (2012). Strong opposition from farmer's organisations stem from significant reductions of allocated volumes in several parts of the RB.

Water pricing has been installed through the Water Agency abstraction tax (polluter pays) and by collective systems (ASA, CACG) supplying water for irrigation (financial cost recovery). Water Agency abstraction taxes can be differentiated in water stressed areas or where support systems for low-water periods are installed. The level of this tax is too low to provide incentives for sustainable water use (some percentages of total irrigation cost; this tax is the only water tariff for the important share of individual abstractors in AG). Farmers (even in neighboring) collective systems can face very different water tariffs both in level e.g. depending on the modernisation of the irrigation infrastructure and thus capital costs and tariff structure leading to different or no incentives to water savings.

The annual water deficit has been reduced by more than 50% the past two decades. Several factors have contributed to this evolution: water quantity management (e.g. PGEs), stabilisation or slight decrease of irrigated area, water savings, ... The most important factor however seems to be the significant growth in the number of barrages and (dam) reservoirs that support low-water levels or provide irrigation water. Farmers benefit from the installation and collective management of such reserves in terms of stable and increased yields, development of specific cultures (tobacco, fruit and vegetables, production of seeds, strawberries). Further water savings are still expected from irrigation advice (irrigation decision and on-field application) and e.g. research projects to improve efficiency in collective systems. Increasing energy costs and

uncertainty on resource availability (allocation) are the key drivers for further water saving initiatives. Agricultural organisations (*chambre d'agriculture*) provide guidance to irrigators with periodical advices.

The rather limited impact of current (pricing) policy towards sustainable water use is illustrated to the decreasing trend of irrigated area since 2000 which has not been followed by a decreasing demand for irrigation water. Farmers tend to reduce the irrigated area but apply the same water volume to the remaining water intensive crops. These farmer's decisions have been driven by high cereal prices (maize), long-term contracts and associated capital investments and the lack of alternative crops generating sufficient and reliable income. Alternative crop choices and associated water savings have not been stimulated by current pricing and allocation policy. While irrigation cost is about 20% of total production costs, it appears that farmer's decisions are not changing under current policy. Energy costs and own investment costs together with output prices are more visible for farmers and significant evolution thereof is more likely to lead to changing decisions.

3.6 Sources

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4 MEXICO - Lerma Chapala

For this case mainly literature is consulted as well as a national expert, consultant Ricardo Sandoval Minero, who worked for the Guanajuato State Water Commission from 1998 until 2006. Literature sources were given by Dr. Luís Gabriel Torres González, Professor and researcher at the CIESAS (Centro de Investigaciones y Estudios Superiores en Antropología Social) in Mexico, and Dr. Filip Wester, from the University of Wageningen. Literature sources, however, were not recent. Therefore, the National Water Commission was contacted to get a view on the current situation in the basin. Mario López Pérez from the National Water Commission reviewed the case study but he had no additional information on the current state of the basin.

4.1 Characteristics of the case study area

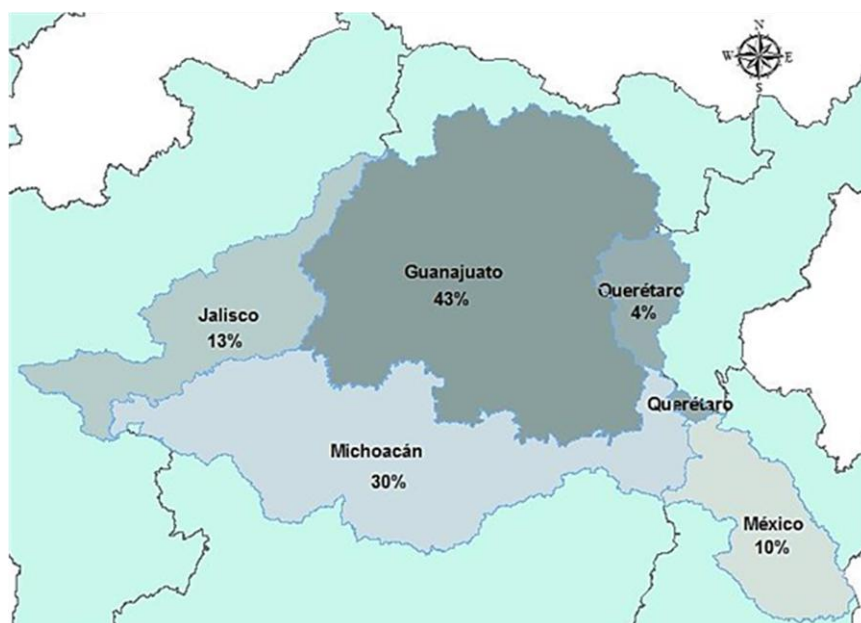
4.1.1 Broad introduction on the area and characteristics of agriculture

4.1.1.1 Location of the area

The Lerma-Chapala basin (Diagram29) is located in the central/western part of Mexico and covers a surface of 54,451 km², roughly 2.75% of the Mexican territory, over five different states (Table 16).

Lake Chapala is the core of the basin. It is the largest natural inland expanse of water in the country and the third largest in Latin America. It is 77.1 km long at its longest point and 22 km wide at its widest point. The River Lerma is the main river in the hydrographical system and is over 700 km long. The river starts in central Mexico's high plateau at 3,000m altitude and ends in Lake Chapala. The lake has an average depth of 7.2m and a maximum depth of 16m (World Bank, 2006).

Diagram29 Lerma-Chapala Basin, Mexico



Source: CONAGUA, 2006

Table 16 Divisions of the Lerma-Chapala Basin over the different states

State	Proportion of the basin's surface
Querétaro	4%
Guanajuato	43%
Michoacán	30%
México	10%
Jalisco	13%

Source: Wester (2008)

Seasonal agriculture uses up 37% of the basin's surface area, followed by irrigated agriculture with 20% of the surface; reported pasture land makes up 14%; non-arboreal forest vegetation takes up 12%; forests and disturbed forests use up 8% and 4% respectively; bodies of water make up 3% (including Lake Chapala) and other uses account for 2% (website Unesco, 2004).

4.1.1.2 Main climate conditions

The climate is semi-arid to sub-humid, with rainy summers. The area receives average annual rainfall of 722 mm but this quantity varies a lot over the years. Much of the rain is concentrated in the southern part of the basin, in the mountainous region, while the central and northern parts of the basin receive less rainfall. Average monthly temperatures vary from 14.6°C in January to 21.3°C in May. Some parts of the Basin have had extreme droughts, other parts deal with regular floodings (website Unesco, 2004).

4.1.1.3 State of the Basin hydrology and ecosystem

The Lake Chapala is highly polluted because of the lack of a good sewage treatment system, the industry and increased run-off of sediments. The latter led to water turbidity and more important, the loss of depth in the lake which causes a higher degree of evaporation (annual average evaporation of 1,900mm). Every month, except in July and August, there is a deficit between rainfall and potential evaporation (Wester, 2008). It is a shallow lake which makes it highly vulnerable to the changes in the climate. According to environmental NGOs, the lake currently stands at only 37 percent of its total volume (World Bank, 2006).

Lake Chapala is also an important ecological ecosystem. The Lake attracts many migratory aquatic birds and 39 species of fish. The pollution caused a decrease in fish stocks and some are now on the verge of extinction. The remaining fish are contaminated, which is a threat to human health (World Bank, 2006). Water Hyacinth and other aquatic weeds are invading the lake and the dams. The conclusion is that the basin's ecosystem is suffering.

Not only the pollution is threatening the basin, but also the overexploitation of the water is disturbing the hydrological cycle of the basin, as more surface water and groundwater are extracted than is renewably available. The fact that Lerma-Chapala is a closed basin is only aggravating the problems. Under 4.3.2 we'll discuss some figures about this overexploitation.

4.1.1.4 Economic data

The economic relevance of the region can be expressed as the amount of Gross Regional Product. Lerma-Chapala basin accounts for about 11.5% of national gross product (2009). Mexico's economy is export-oriented: overall exports were US\$291,300 million (216,351 EUR) (2009 estimated). Mexico is the 9th automobile world producer, almost 50% coming from the Lerma-Chapala Basin. In 2003, the basin produced 53% of all Mexico's manufacturing goods exports – 143 million USD (106 million EUR) per year (Cotler et al, 2006). In 2006 this was estimated by the World Bank at 192 million USD (142.6 million EUR). GNP per capita was US \$13,541 (10,057 EUR) (2009 estimated, IMF). Inflation has been kept reasonably low for the past fifteen years. Inflation rate at consumer prices was 4.1% in 2010 (*estimated, Banco de México; Index Mundi*) and 3.6% in 2009¹⁰⁹.

Table 17 The Lerma Chapala Basin main economic features

Economic Sector	Percentage of Lerma-Chapala Basin GDP (%)
<i>Manufacturing industry</i>	22.8
<i>Community, social and personal services</i>	21.1
<i>Trade / Commerce, Restaurants and Lodging</i>	19.3
<i>Financial Services, insurance, real estate and leasing</i>	12.6
<i>Transportation, storage and communications</i>	11.1
<i>Construction</i>	7.2
<i>Agriculture, cattle raising, forestry and fisheries</i>	5.0
<i>Electricity, gas, water and mining</i>	1.5
<i>Imputed banking services</i>	-0.6
Total	100

Source: CONAGUA 2011. All data proceeds from INEGI, 2009

The economic activities in the area of the river basin are diverse, ranging from agriculture to beverages, pulp and paper, leather goods and (petro)chemical products. The agricultural sector consists mainly in the cultivating of maize, sorghum, wheat, barley and garbanzo (World Bank, 2006).

Further, this basin is home to around 10.44 million inhabitants, over a tenth of the country's population. Most of them have a medium or low socio-economical level (INE, 2003). It provides Guadalajara, Mexico's second biggest city, with 65% of its urban water supply. Over 2,000 locals depend on the lake's fish for their source of revenue and the Lake Chapala is also an important touristic asset for the region. In the period 1990-2000

¹⁰⁹ Information from Mario López Pérez from the National Water Commission

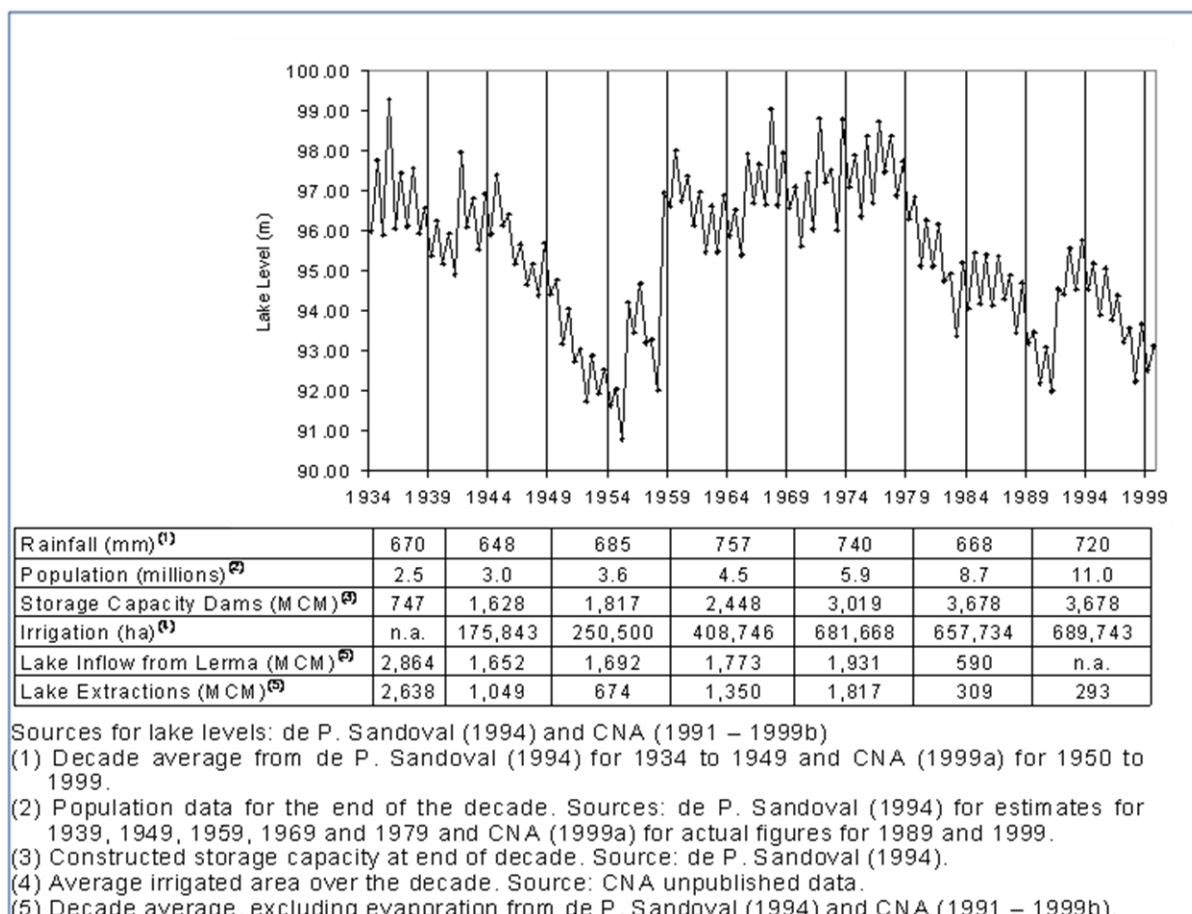
on average 760,000 tourists per year visited the Lake (Wester, 2008). In general the basin is an important economic area for the country for its diversity in activities and its strong industrial sectors (INE, 2003).

4.1.2 Water resources and aquatic ecosystems

The average annual runoff in the basin is between 4,740 million m³ (World Bank, 2006) and 5,513 million m³ (Wester, 2008). Lake Chapala has a maximum storage capacity of 8.13 km³. The total discharge of the River Lerma from its drainage basin into the lake is about 1.5 billion m³/year.

The levels of the lake Chapala have shown big variations during time. Whenever a series of dry years occur, even when subsequent rainy years usually allow the lake to recover its levels, this has been each time slower and more difficult. Today, the reduction of the levels at Chapala lake have more severe consequences than some decades ago, since more people and economic activities depend on the basin's adequate management. In Diagram30 the fluctuations of the water level in Lake Chapala are shown. In a basin with a significant hydrological variability, average balances are less relevant.

Diagram30 Evolution in water levels of Lake Chapala, Mexico



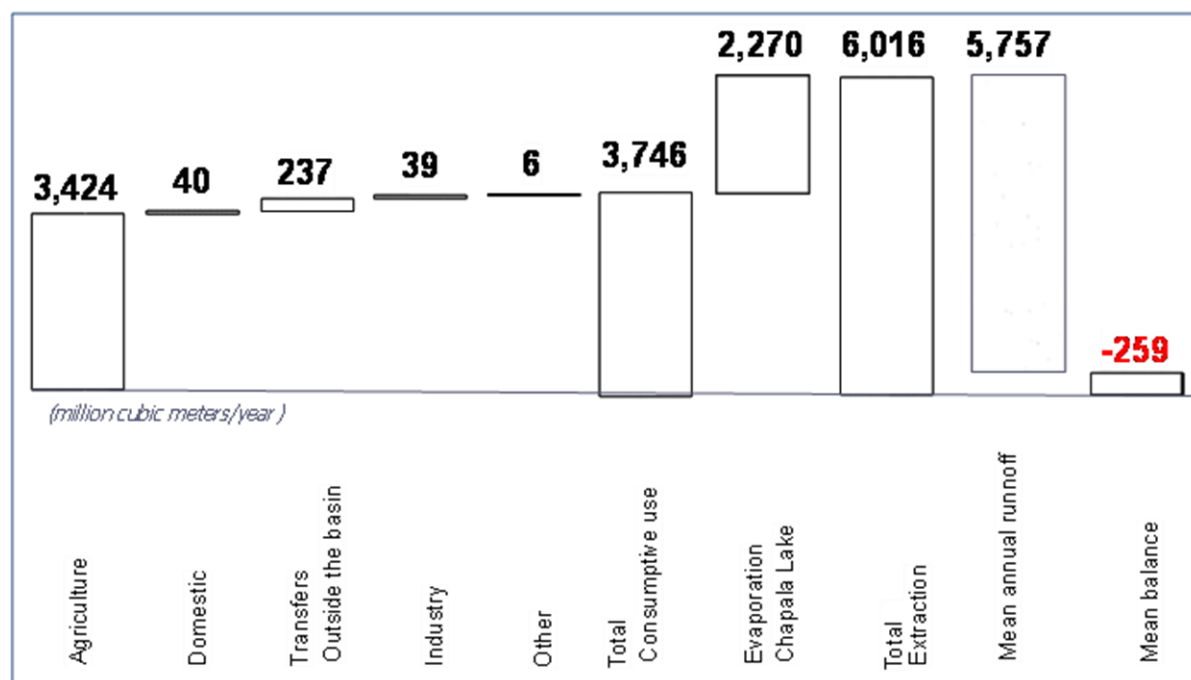
Source Wester (2008)

There was growing pressure due to the development of agricultural projects and urban growth during the last five decades. The Chapala lake has gone through severe episodes of scarcity which have put in danger its ecological, economic and water supply functions.

Under average conditions, the surface runoff generated in the upper and middle sections of the basin is entirely used up. As a consequence, when water levels are low, it stops flowing in certain parts of the River Lerma ('basin closure'). This happens several months a year. In that case not everyone in the irrigation districts is receiving enough water. The shortage of the resource is the worst in the sub-regions of the Lerma system. This caused serious conflicts among users (Unesco, 2004). According to Wester (2008) the use of surface water is exceeding the supply (river runoff) in all but the wettest years. According to the World Bank (2006) the water scarcity gap between the available surface water and the demand for it, is between 1.6 and 1.8 billion m³ per year. Because of the over-exploitation of the groundwater aquifers and the lakes, this gap is actually an underestimation of the problems.

In Diagram31 we see a calculation of the deficit for the year 2003 from the official authorities. According to expert sources this deficit has not disappeared since.

Diagram31 Surface water scarcity gap in the Lerma-Chapala Basin, 2003



Source: National expert based on official data, 2003

The same goes for groundwater. There are 37 aquifers identified in the basin, according to official sources only 20 of them are overexploited. In the literature and through our expert, Ricardo Sandoval Minero, we find that all the groundwater aquifers are overexploited. Because of the overexploitation, aquifers in Guanajuato are at 100 m depth. According to available geohydrological studies, approximately 5,200 hm³ of underground

water is extracted each year through the 14,650 active wells in the area (Website Unesco, 2004). Wester (2008) says there are even more wells, up to 17,500. These groundwater wells have low efficiency rates, due to their high electricity consumption and low water yields. According to INE (2003), about 4,850.94 million m³ of surface water is used in the basin and about 4,181.07 million m³ groundwater.

The over-exploitation of the groundwater is about 1,200 – 1,300 million m³ per year. Yearly the average static levels in all the aquifers drop with 2.03m, with extremes up to 5 m per year. There is also a deterioration in the quality of the groundwater, the drying up of natural springs and artisan wells and a reduced base flow of most rivers especially in the dry season (FAO, 2005).

4.1.3 Water use for agricultural demand/supply

4.1.3.1 Irrigated agriculture

In the basin there are 8 Irrigation Districts (DRs) and 16.000 Irrigation Units (UR). Nearly 52% of all reservoirs are presently dedicated to irrigation districts and units. Hydraulic infrastructure meant for fluvial and flood control, of paramount importance, due to erratic rainfall behavior only represents 3% of all hydraulic works, although flood control capacities do also exist in most large dams. More than 97% of all reservoirs and dams were already constructed and operating by 1992.

The main water using sector is the agricultural sector (World Bank, 2006), with 85% of the total water use (Escobar, 2006) or 6,606.70 million m³. The irrigated agriculture covers 20% of the basin's area (about 830,000 ha) and is the main user of water. The primary sector employs 52% of the catchment area - approximately 2,100,000 hectares, of which 39.5% use water for irrigation, approximately 830.000 ha (600,000 permanently and 230,000 occasionally).

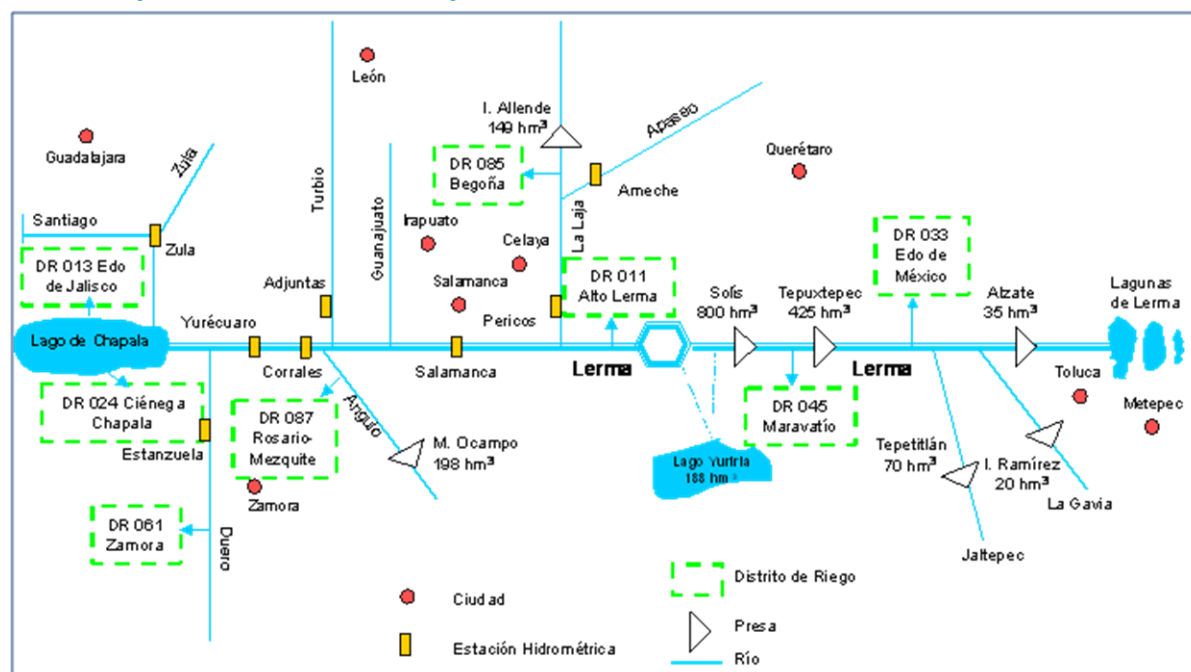
As seen in Diagram30 the irrigated area has boomed significantly since world war two. About 415,000 ha are provided with surface water and around 380,000 ha are irrigated with groundwater.

Groundwater exploitation on large scale exists since the 50's, with the introduction of tube well technology. The agriculture sector is the biggest user of the groundwater. In 1990's the agricultural sector consumed 75-85% of the extracted groundwater in the state of Guanajuato.

66% of the irrigated area is small-scale irrigation and 34% are large irrigation systems, also known as irrigation districts or 'distritos de riego'. Every irrigation district is divided into irrigation units (módulos). These units vary from 1,500 to 50,000 ha in size. Today, the basin has 8 irrigation districts and 16,000 irrigation units. It is a bureaucratic division rather than a physical division.

Diagram32 gives a graphic presentation of these divisions.

Diagram32 The distribution of the irrigation districts in the basin



Source: Wester (2008)

Not all the agricultural land in the basin is irrigated. Actually, most agricultural areas are rain-fed. Table 18 presents the irrigated and the rain fed agricultural areas for the five states in the basin. Table 19 presents the main crops and the area that is used for growing them. Corn is the main crop in the basin for rain fed agriculture as for irrigated agriculture. Corn is followed by sorghum and, of lesser importance, wheat and alfalfa. It is remarkable that the majority of the surface is rain fed agriculture. This is in the area with a sub-humid climate.

Table 18 Irrigated and rain fed agricultural areas in the Lerma-Chapala Basin

State	Total (km²)	Irrigated (%)	Rain fed (%)
State of México	3642.63	19.39	80.61
Guanajuato	9557.8	42.36	57.64
Jalisco	3347.91	13.38	86.62
Michoacán	4586.15	30.76	69.24
Querétaro	838.81	31.82	68.18

Source: Cotler et al., 2006

Table 19 Main crops in the Lerma-Chapala Basin

Crop	Total surface		Irrigated agriculture			Rain fed agriculture		
	Km ²	%	# municipalities	Surface km ²	%	# municipalities	Surface km ²	%
Green alfalfa	690.85	1.29	50	690.85	1.29	0	0	0.00
Forage oats Green	593.11	1.11	35	155.85	0.29	63	437.26	0.82
Barley in grain	727.19	1.36	37	594.6	1.11	10	132.59	0.25
Beans	1511.85	2.82	43	245.77	0.46	70	1266.08	2.36
Corn in grain	11450.95	21.37	99	2155.23	4.02	173	9295.72	17.35
Sorghum in grain	3701.96	6.91	70	1776.32	3.31	89	1925.64	3.59
Wheat in grain	1022.95	1.91	60	863.6	1.61	23	159.35	0.30

Source: Cotler et al., 2006

4.1.3.2 Irrigation techniques

The surface water from the lake reaches the irrigator through canals. There is not a lot of information available on farm irrigation techniques.

In the report of the World Bank (2006) the average efficiency rate for agricultural water use is estimated at only 45%, what is quite low. However, this is an average efficiency rate for Mexico according to the Ministry of Agriculture (2002). Hidalgo and Peña (2006) report an efficiency rate of only 35%. Table 20 gives the efficiency yields for the main crops in the basin and compares them with the national average. There is some variation in the yields. In the upper part of the basin, where the restrictions are higher, the efficiency rates tend to be better.

Table 20 Agricultural yield classification (Natural breaks)

YIELD (Tonnes/Ha)	ALFALFA (Green)	OATS (Green, forage)	BARLEY (grain)	BEAN	CORN (grain)	SORGHUM (grain)	WHEAT (grain)
National average*	43.367	22.249	5.693	0.917	3.506	3.395	5.289
Regional average	59.78	15.57	4.69	0.90	3.87	5.44	4.13
Yield classification	mean	low	mean	mean	mean	mean	mean

Source: SIAP-SAGARPA (2002), in Cottler et al., 2006

We did find some past programmes run by the government with the aim of improving the on farm irrigation productivity. In these programmes mostly low pressure surge valve pipes for furrow irrigation were installed.

When groundwater is used, people normally use their own infrastructure and pay for this themselves. However, large subsidies have been given to agriculturalists with legal wells for groundwater. The money was provided to buy low pressure conduction systems, drip and sprinkler irrigation and soil leveling (FAO, 2005). Because of these subsidies irrigation systems of 54,600 farmers improved. This accords to 251,602 ha of irrigated land.

4.1.3.3 Economic importance of agricultural sector

Unesco (2004) does mention that the area's industrial and agricultural production per capita is higher than the national Mexican average.

There are a lot of small family farms in the area which depend heavily on the agriculture. There are limited farm income possibilities so when farmers are faced with too little water to grow their crops, a lot of them sell their land and immigrate to the bigger cities.

4.1.3.4 Pressure from irrigated agriculture

As discussed, there is growing pressure due to the development of agricultural projects and urban growth during the last five decades in the Lerma-Chapala Basin.

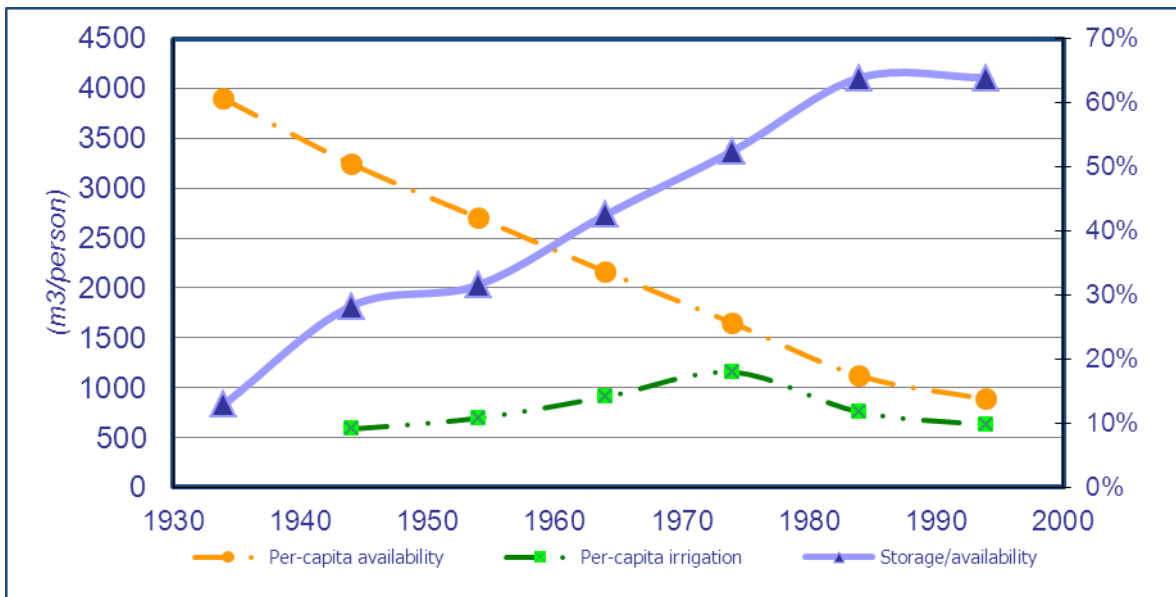
The surface water in the Basin is mainly used for agricultural purposes, i.e. irrigation. This causes conflicts with the cities and the industry¹¹⁰. The cities and the industrial sector are forced to get their water from groundwater aquifers. In Guanajuato, aquifers are at 100 m depth because of the over-exploitation. This makes it costly to extract groundwater and the cities and industries would like to get more surface water as well.

There have been disputes with the water use of the city of Guadalajara. This is Mexico's second largest city and gets 65% of its water from Lake Chapala. When the lake nearly dried up, storage water from the dam was released to ensure the water supply of the city, resulting in farmers protest. Farmers saw it as 'their water' and did not want to share. The same disputes took place when water was released from the dams to ensure the health of Lake Chapala's ecosystem.

The next graph shows the trends in the increase of irrigation and demand pressures in the basin. It's remarkable that the storage capacity has surpassed 50% of the mean available volume in the basin, while per-capita availability has been dramatically reduced through the last decades.

¹¹⁰ Source: Ricardo Sandoval Minero

Diagram33 Increase of irrigation and demand pressures in the basin



Source: Wester (2008)

The groundwater is also mainly extracted by the agricultural sector for irrigation purposes (Wester, 2008). Because of that cities and other industries don't feel that they are responsible for the deterioration of the groundwater or the surface water in the Basin and awareness programmes are not having the supposed effect.

Also within the agricultural community there are differences in the pressure from less water availability. The poorer farmers rely mainly on surface water and don't have the money to pay for pumping up groundwater. When water availability is lower than average they are the ones who suffer the most. In that case, they sell their land to bigger landowners and immigrate to the cities.

4.1.3.5 Illegal abstraction

It is thought that there are a lot of illegal wells and that even the legal ones extract more than they are allowed. However, no data are available on this. The same goes for the surface water abstractions. As we will see in the next chapter, there are limits on the use of surface water but a lot of farmers ignore the limited use of it.

4.2 Current water policies and practices influencing water use in Agriculture

4.2.1 Water allocation policy in the agricultural sector

The last couple of years Mexico shifted its water policy towards an IWRM (integrated water resource management). This is a framework that improves the management of water resources based on four key principles which were adopted at the 1992 Dublin Conference on Water and the Rio de Janeiro Summit on Sustainable Development. These principles are:

- (1) fresh water is a finite and vulnerable resource essential to sustain life, development, and the environment;
- (2) water development and management should be based on a participatory approach, involving users, planners, and policy makers at all levels;
- (3) women play a central part in the provision, management, and safeguarding of water; and
- (4) water has an economic value in all its competing uses and should be recognised as an economic good (ICWE, 1992).

IWRM is only a framework so the implementation differs from country to country depending on the local situation and the importance that is given on the different aspects of IWRM (economic, environmental, and social aspects). Although the implementation varies across countries, IWRM can be broadly characterised by a number of key trends. Firstly, there has been a shift away from command-and-control instruments towards the use of economic instruments.

Secondly, it led to a more flexible, decentralised approach and an increase in the involvement of the local levels. According to the OECD (2011), basin-level governance is critically important to good water outcomes. The OECD (2011) indicates that IWRM also implies that there is an increasing stakeholder collaboration and the involvement of local communities in water security decision-making.

4.2.1.1 The allocation of surface water

Mexico is a Federal Country. The water resource management is under federal jurisdiction, with the National Water Commission ("CONAGUA"). The National Water Commission is a decentralised, administrative, normative and technical agency of the Ministry of the Environment and Natural Resources (SEMARNAT), in charge of managing and preserving Mexico's water and its inherent public goods to achieve sustainability. This agency is responsible for water policy, granting water concessions, standards for water quality, collecting water taxes and water investment programmes. It is the main water authority in Mexico. There is also a Basin Board, which has consultative duties, with representatives of the users in the five states that share the basin, the federal government and the state governments.

In the spirit of IRWM, the National Water Commission established Water User Associations ('COTAS') and made them responsible for irrigation management. All farmers that are registered as water users are in theory a member of the COTAS. However, not all farmers participate in the COTAS, they are run by delegates. The COTAS are structured following the divisions in irrigation districts and irrigation units. There are 45 COTAS in the Lerma-Chapala Basin¹¹¹.

The National Water Act has been in force since 1992 and is the legal base for the volumetric allocation system for the basin's surface water. This determines the volume to be used each year based on the runoff generated the previous year. All individual users (agricultural producers, big industry, cities) have to get a water title to have the right to extract surface water (also for groundwater, see further).

Each November, the National Water Commission (NWC) decides how much water will be allocated in the next year to each district. This allocation depends on the water levels in the dams from the runoff (inclusive Lake Chapala) at the time and the rain predictions for the rest of the season. This estimation of the rainfall in the year to come, is an imperfection in the system as it is almost impossible to estimate this correctly, leaving room for over-allocation. Two irrigation districts (085 and 087) depend on then water levels in Begoña dam and Melchor Ocampo dam, respectively.

First of all, they look at the volume in Lake Chapala: lower than 3,300 hm³, between 3,300 hm³ and 6,000 hm³ or more than 6,000 hm³. In the first case they apply a 'critical' policy, in the second an 'average' policy and in the last an 'abundant' policy.

After deciding the policy, they look at the surface runoff in each state. Depending on the chosen policy and the surface runoff in each state, the allocations to each irrigation scheme are calculated. A part (1,440 hm³) is always set aside for evaporation of Lake Chapala. A fixed volume is allocated to the irrigation scheme if certain thresholds are passed. If the surface runoff is below these thresholds than a fixed volume is deducted from the irrigation scheme's allocation, even if this volume is available in the district's reservoir. Table 21 is an example of this allocation policy in the Alto Río Lerma irrigation district.

¹¹¹ Source: Ricardo Sandoval Minero

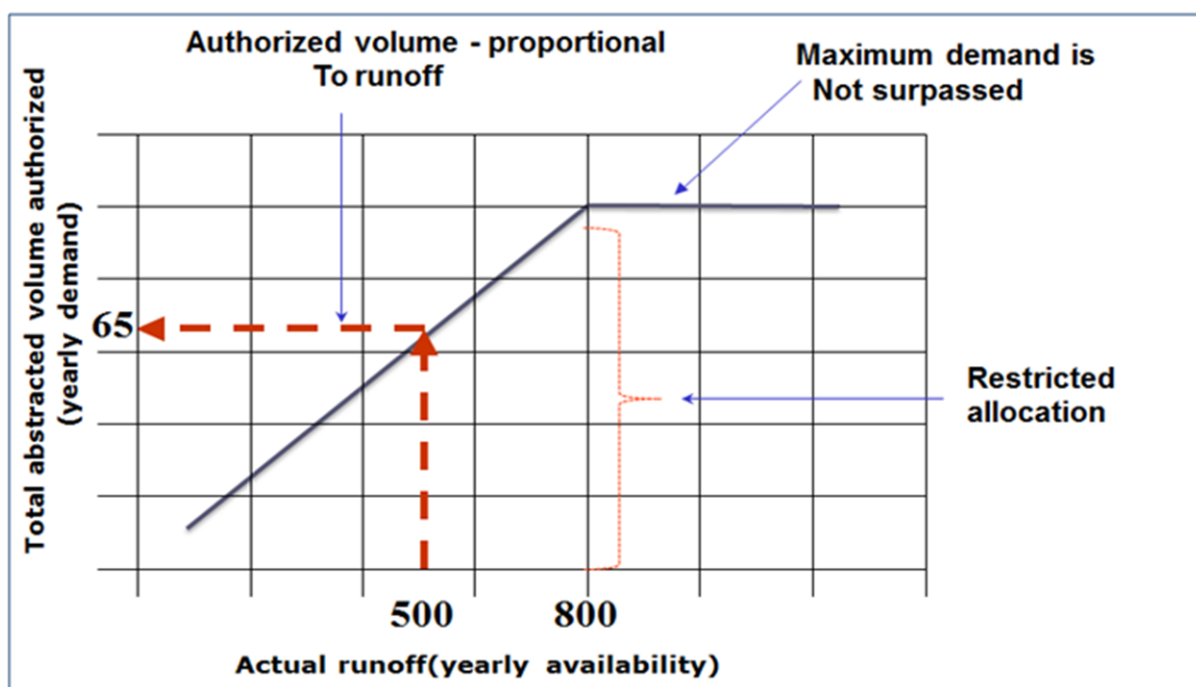
Table 21 Water allocation principles for the Alto Río Lerma Irrigation District

Lake Volume	Chapala	Surface Runoff Generated (SRG) in the State of Guanajuato (hm ³)	Volume Allocated (VA) to Irrigation District (hm ³)
Critical		if SRG between 280 and 1,260	then VA = 94.2% of SRG – 262.8
		if SRG > 1,260	then VA = 924
Average		if SRG between 144 and 1,125	then VA = 94.2% of SRG – 135.6
		if SRG between 1,125 and 1,400	then VA = 924
		if SRG > 1,400	then VA = 955
Abundant		if SRG between 19 and 1,000	then VA = 94.2% of SRG – 17.9
		if SRG between 1,000 and 1,200	the VA = 924
		if SRG > 1,200	then VA = 955

Source: Wester (2008) based on National Water Commission (1991)

A graphical presentation of the general allocation rule is presented in Diagram34. The allocation model tends to minimise restrictions to established irrigated areas (according to their water rights titles) while guaranteeing a minimal runoff to the Chapala Lake in the specific hydrologic context as determined by a set of precipitation, dam storage and runoff data and calculations.

Diagram34 Allocation system in the Lerma-Chapala Basin



Source: Wester (2008)

However, the water allocations are not solely based on scientific data. They are also negotiated with the irrigation districts. These districts have communicated to the National Water Commission, prior to the allocation decision, how much water they want the next year. These demands are negotiated with all the districts.

Once an irrigation district knows how much water will be allocated to them in the next year they start an internal negotiation process. Each district is divided into irrigation units, which all have one representative in the district council. In these councils they decide on how much water each unit gets. These decisions are mainly made top-down and based on how far the modules are located from the dam, the amount of surface, the irrigation calendars. Within the district an irrigation plan is made every year. They decide together which crops to grow next year, based on the water allocated to them. Part of the production is sold in advance. This organisational structure has proven to be successful¹¹².

Once the volumes have been determined, there are no intra-seasonal or temporary restrictions on the water allocation. The only way the government restricts the water use is through the annual allocations. In a year with low rainfall some irrigators even ask for an advance in next year's water instead of restricting the water use. The only restriction comes from the units and districts themselves. In times of drought they decide which amount of land will be irrigated in the units. During the drought of 1999-2000 some units decided not to irrigate at all, another few decides to limit the irrigation area to only 3 ha per farmer. This is decided by a committee. The problem here is, as said before, that the poorer farmers suffer most of this¹¹³. Water restrictions are not welcomed by the irrigators. They protest them and sometimes block dams and main roads.

4.2.1.2 The allocation of groundwater

In 2003, the CONAGUA published the average annual water availability and high-res maps for 188 aquifers of which 34 were located in Lerma-Chapala Basin. All of them are overexploited. There is a long tradition of just using the groundwater without any limitations. On the contrary, for a while the government even promoted the exploitation of the groundwater aquifers (FAO, 2005). Once the National Water Act was passed in 1992, it became mandatory to have a legal permit to subtract groundwater, issued and controlled by the National Water Commission. Users are granted a specified annual volume, based on discharge of the well and the irrigated area. The titles are written down in a Public Register of Water Rights (REPDA, Registro Público de Derechos de Agua) and the rules on unutilised volumes, transferring rights and the conditions by which one can lose the rights are specified in the National Water Act and its Regulation. A licence can last for between 5 and 10 years, must be renewed and can be modified by the authority according to the capacity of the aquifers.

¹¹² Source: Ricardo Sandoval Minero

¹¹³ Source: Ricardo Sandoval Minero

In theory, to decide on the amount of groundwater allocations the NWC relies on studies about sustainable yields for groundwater aquifers. In practice, however, every aquifer is over-allocated and no more new wells should be approved. The NWC have been revising and cancelling titles which have not been renewed. Right now, they trying to lower the water rights from the past and normally, no new agricultural wells are allowed anymore. In practice however, there are mechanisms that give the agriculturists the possibility not to act upon the volumes granted in their permits and, since no effective system exists to measure and verify every abstraction, this system is being abused regularly (see further). So, in terms of reducing water extraction, not much has been accomplished¹¹⁴.

Although the amount of water that can be extracted is fixed in the license and the holders of the titles are obliged to have a water meter and report the pumped volumes to the NCW twice a year, in practice there is no control. People pump up more than allowed and the control of illegal wells remains highly difficult. The NWC fails to control the exploitation because of lobbying, political influences, a lack of legal power and a lack of personnel (FAO, 2005).

The allocation policy in the groundwater area is less successful than for the surface water. As there is every year a scarcity gap, the latter is not a successful system either in preventing over-allocation.

In the basin there are 40 aquifers with an annual recharge of 4126 hm³ and total annual abstraction is 5,373 hm³, through 30,000 water wells. The difference between annual recharge and abstraction (-1,247 hm³/year) indicates severe over pumping (30% of the total annual recharge): 68% of all aquifers are overexploited, mostly located in Guanajuato (-1,481 hm³/year), in the State of Mexico (-175 hm³/year) and in Querétaro (-58 hm³/year)¹¹⁵.

4.2.1.3 Trading water

There is a limited amount of trading in allocations in the Lerma-Chapala Basin. The government tries to stimulate it with some economic incentives but in reality trading is only used as a last option, for example when the aquifer is to becoming too low to be exploited by the farmers. In that case they sell their land with all the water attached to it. There are hardly any sales of seasonal allocations.

The trading in entitlements is stimulated so surface water, that is now allocated for 97% to the agricultural sector, can be bought by cities, as they have big problems to cope with lesser water and more people.

Trading does occur frequently between irrigation units of the same district. Legally it is restricted but it is overlooked by the authorities.

¹¹⁴ Source: Ricardo Sandoval Minero

¹¹⁵ Source: Mario López Pérez, National Water Commission

No prices on these trades were found in the literature but according to Ricardo Sandoval Minero a title for a groundwater well can cost between 0.60 to 1.00 USD (0.45 to 0.74 EUR¹¹⁶) per cubic meter on an annual basis. That means, for instance, that a well serving 30 l/s (approximately 950,000 m³ per year) could cost from 600,000 USD to 950,000 USD (445,984.63 EUR to 706,025.97 EUR).

4.2.2 Water pricing policy in the agricultural sector

Current Framework

There are different aspects to pricing. First of all, there is the price for getting a license. There is a small fee to register the water right. Every year a fee is to be paid but the agricultural sector does not have to pay this annual fee, in contrast to cities and other industrial sectors.

Secondly, there is the price of water itself. These water charges are not paid by the agricultural sector neither. Not for surface water and not for groundwater.

The last price that can be paid for water, is the price of supplying the water, a service fee. For surface water major infrastructure components are owned and operated by the NWC; distribution canals and systems are operated by the units and districts and the agricultural sector does pay a price for this service. The irrigation service fees are determined by the irrigation unit or district and approved by the NWC. It should fully cover the costs of the unit and pay a percentage to the NWC for the dams, the canal system and so on. This comes at a variable and a fixed rate. The part they pay for the irrigation infrastructure is, with 75% government funding, heavily subsidised. The farmers pay to the unit or district, who in turn pays the NWC.

In contrast, the households (cities) and municipalities do pay for their water rights and water charges for surface water. According to an OECD study the average domestic water price in Mexico is 0.49 USD/m³ or 0.36 EUR/m³.

For extracting groundwater we can see the same scenario. Nothing needs to be paid and because of the well is typically individually owned, the farmers only have the costs of drilling the well and pumping up the water. When pumping groundwater, the farmers do have the cost of the electricity for the turbine pumps but even this tariff is highly subsidised, even when subsidies have been steadily reduced over the years.

It is however the only resource the government can apply to lower the groundwater extraction. The federal government tried to lower the groundwater use through different electricity tariffs for legal wells and limiting the electricity use for this tariff. It was however not a measure from the NWC. It came from the federal energy agencies and was not directly linked to NWC policies.

¹¹⁶ Currency rate November 2011

In December 2002 the Rural Energy Law was passed. Under this law the prices for energy use were raised. Farmers with a valid groundwater concession could get their energy at one of the lower tariffs but their use (in kWh/year) was limited per well. Once above this limit another, higher tariff is in place. The law has helped a bit but again the lack of enforcement and rent-seeking surrounding the granting of water concessions limited the success of this law.

As in Australia, the federal government has also tried to limit the groundwater use by buying back the concessions of the past from willing sellers. Again the lack of law enforcement has created a perverse effect. Some farmers sold the concessions for their dried up wells to the government but used the money to deepen the wells. Other farmers sold only a part of their concessions but pumped up the same amount of water as before. The same happened when selling their entitlements to other water users, for example urban developers. As the ground rights doesn't have to be sold together with the water concession, they sell their concession. The urban developer asks the NCW permission to drill a new well on their urban and but the farmers keeps extracting water from their agricultural well. The system of buying concession titles is also used to legalise old, illegal wells¹¹⁷.

As a whole, the water businesses in Mexico don't manage to cover their costs and need subsidies from governments to do the necessary investments. It is not sure if they want to move to a scenario where costs are completely recovered, from both cities as agriculture. Tariffs differ from town to town, resulting in very divers levels and structures of tariffs.

We didn't find any recent information on water tariffs in the Lerma-Chapala Basin. In the OECD study (2010) we did find a few examples of water tariffs in Mexico but these are relatively old references.

Diagram35 Examples of irrigation tariffs in Mexico

Area (State)	Fee/charges)	Types of crops	Comments	Source
Distrito de Riego 011 Alto Río Lerma (Michoacán and Guanajuato)	0.22 \$/m ³ 0.42 \$/m ³ 0.028-0.034 \$/m ³ 0.051 - 0.057 \$/m ³	Broccoli Strawberry Grains (Surface) Grains (Groundwater)	See above the evaluated shadow prices	Florencio- Cruz <i>et al.</i> (2002)
Module II	21.57 \$/ha 42.49 \$/ha	Fruits & Veg Tomato	Two recently transferred districts	Arredondo Salas and Wilson (2004)
Module IV (Sinaloa, Culiacán Region, Dist 10)	58.10 \$/ha 84.84 \$/ha	Fruits & Veg Tomato		

¹¹⁷ Source: Ricardo Sandoval Minero

4.2.2.1.1 Factors influencing the impact/effectiveness of water pricing policies

There is hardly any water metering in the basin. Inspections are carried out but there are too little for the amount of landowners in the region. In Guanajuato alone there are over 25,000 little landowners. As a solution for the widespread overuse of groundwater sources, the government installed the COTAS with the intention of self-regulation. These water user associations didn't get any actual legal power, hence they were powerless to make a difference. Farmers are informed about the water policy through their COTAS (Water Users Associations), in which they can elect representatives. It is also through these COTAS that the farmers pay the water service fee to the NWC¹¹⁸.

Some state governments invest in programmes that increase productivity of the agricultural sector. For example, the government of Guanajuato invested in the Fertirrigación programme, intended to restore aquifers and increase agricultural productivity. The programme provided over 7,000 users with precision plot leveling and another 28,000 users with irrigation equipment, mostly low pressure surge valve pipes for furrow irrigation. Farmers were very keen in participating because the government paid 50% of the equipment cost that would reduce their water use. Unfortunately, this didn't lead to less water use. There was a significant rise in productivity but as they now had twice as much water available as before, farmers expanded their land use under irrigation instead of lower their water use.

There are communication programmes in which the government encourage rural communities to limit domestic water use. The communities are invited to form water committees that provide others with information and encourage participation.

As with the control on the metering, there is hardly any control on permit limits.

4.3 Analysis of water pricing and water allocation policy

4.3.1 Drivers and Barriers

For decades, too much water has been used in the Lerma-Chapala Basin. This means that the policy that has been implemented in the early '90 had limited effectiveness. Even when agriculture has been restricted in its use of surface water, no significant benefits have shown in the restoration of Chapala lake or reallocation of surface water to other activities, with higher economic benefits. A better water price policy, that covers all the costs, would help, as could be seen with the higher electricity prices. On the other hand, groundwater has been over drafted while costs rise both to farmers, cities and industries.

As main barriers there are the low efficiency rate in irrigation water use; a high social, cultural and productive heterogeneity making natural resource management very complex; a lack of coordination between user

¹¹⁸ Source: Ricardo Sandoval Minero

groups and the government; and poorly functioning hydro-climatologic measurement and monitoring networks (Hidalgo & Peña, 2006).

The weaknesses of the current system are mainly the lack of legal power and control. The National Water Commission established Water User Associations ('COTAS') in the hope that they would be self-regulating and lower their water use. Because of the lack of legal power, the COTAS couldn't live up to expectations. The lack of resources to implement metering and inspect the actual water use gives an unlimited entitlement to the water users.

The allocation of next year's water based on last year's rainfall is another weakness of the system because it doesn't take into account the actual rainfall at the moment that the allocations are being used. For example, 1998 was a very wet year, hence the 'average' allocation policy was followed for 1999. In 1999 however rainfall was at a historic low. With the allocations too high for the little amount of rainfall, the Lake's water levels dropped to their lowest level (Wester, 2008). This year is again a year with very low rainfall because of that agricultural producers are demanding extra emergency water and demonstrating to make the rules more flexible.

A positive note on the water policy is the transfer of the irrigation management to the units and districts. Because the decisions on how much hectares will be irrigated and which crops will be grown are taken on a local level, they take the specific local issues better into account. However, this decentralisation of power by the National Water Commission is not going far enough because it doesn't put a lot of the responsibility at a regional level, resulting in a weakness instead of a strength of the system. Farmers ask for the transfer of more legal power to the local level.

Further, there are little restrictions for farmers at the moment, although they also suffer from less water in the basin. In the irrigation districts the farmers themselves developed an initiative to switch to less water demanding crops. They shifted from wheat to barley, chickpea, safflower or canola.

In recent years, the situation has improved and the basin's hydrology is getting more healthy. In 2004 a new Water Allocation Agreement was signed that considers hydrological, economics, social and environment criteria and uses a dynamic basin simulation model together with an optimisation model based on a genetic algorithm to decide how allocate the water to all users, including Lake Chapala. Agriculturists are now sure of 50% of the maximum volume concessioned to them by the federal government. A lot of effort has gone to communication and negotiation with stakeholders, making them aware of the problems and together looking for solutions. Plans are under way to improve the sanitation infrastructure and to modernise the irrigation systems. All this was in the light of IWRM. It took them 30 years to improve the situation. (Hidalgo & Peña, 2006). Unfortunately, besides this brief article no more information could be found on the changes the Mexican water policy had been through in the last couple of years.

4.3.2 Effects of the water pricing policy¹¹⁹

4.3.2.1 Direct effects

Farmer behaviour has only changed because of changes in the electricity prices. As said before, some changed to different crops but overall no less water is used in the basin. Maybe applied volumes have been respected but when efficiency gains are made they are used to irrigate more land. This while the system is already over-allocated and a lower water use would be welcome. this is a destructive effect. Farmers are mainly trying to maximise their short term gains.

4.3.2.2 Indirect effects

There are some social effects, not because of the water policy but because of the water scarcity. As discussed the poorer farmers can't afford to pump up groundwater and so, in times of water scarcity, they sell their land and move to the cities or migrate to the US. More people in the city increase the water problems over there.

4.4 Conclusions

The Lerma-Chapala basin is located in the central/western part of Mexico and covers five different states. The climate is semi-arid to sub-humid, with rainy summers. According to the OECD (2011), the Lerma-Chapala basin is one of the world's most stressed basins. On the one hand the water is highly polluted because of the lack of a good sewage treatment system, the industry and the sediment run-off; and on the other hand there is a water shortage because of the increase in population, industry in and agriculture in the surroundings of the basin. The Lerma-Chapala basin accounts for about 11.5% of national gross product, or 142.6 million EUR in 2006. The economic activities in the area of the river basin are diverse, ranging from agriculture to beverages, pulp and paper, leather goods and (petro)chemical products. Seasonal agriculture uses up 37% of the basin's surface area, followed by irrigated agriculture with 20% of the surface. The agricultural sector consists mainly in the cultivating of maize, sorghum, wheat, barley and garbanzo. Corn is the main crop in the basin, as well for rain fed agriculture as for irrigated agriculture. The average efficiency rate for agricultural water use is estimated at only 45%, what is quite low. However, this is an average efficiency rate for Mexico. In the upper part of the basin, where the restrictions are higher, the efficiency rates tend to be better. In the basin there are 8 Irrigation Districts (DRs) and 16.000 Irrigation Units (UR). Nearly 52% of all reservoirs are presently dedicated to irrigation districts and units

The water resource management in Mexico is under federal jurisdiction, with the National Water Commission ("CONAGUA"). The National Water Commission is a decentralised, administrative, normative and technical agency of the Ministry of the Environment and Natural Resources (SEMARNAT). This agency is responsible for water policy, granting water concessions, standards for water quality, collecting water taxes and water investment programmes. Many attempts have been made to improve the water governance in the Lerma-Chapala Basin, such as irrigation management transfer, stakeholder participation and allocation

¹¹⁹ Source: Ricardo Sandoval Minero

mechanisms. Those are the key elements of the so-called integrated water resource management (IRWM). Mexico gained international recognition for its efforts in the water policy area. The National Water Commission established Water User Associations ('COTAS') and made them responsible for irrigation management. The COTAS are structured following the divisions in irrigation districts and irrigation units. There are 45 COTAS in the Lerma-Chapala Basin.

Each November, the National Water Commission in Mexico decides how much surface water will be allocated the next year to each district. This is based on scientific data (i.e. water levels in the dams and lake, precipitation forecasts based on the last year's rainfall, surface runoff) and negotiations with the irrigation districts, which communicate to the Commission how much water they want. The allocation of next year's water based on the rainfall of last year, leaves however room for over-allocation. When a wet year is followed by a dry year, this allocation system makes things even worse. Following the district allocation, negotiations take place internally to allocated water to the sub-irrigation units. This allocation is top-down and based on how far the modules are located from the dam, the amount of surface and the irrigation calendars. Each district develops a yearly irrigation plan where members (farmers) decide together which crops to grow next year based on the water allocation. In theory this sounds like a good allocation system. We have found no evidence that this system is or is not fully implemented in practice. Groundwater abstraction is allowed with a permit that specifies the annual volume allowed, which is based on the discharge of the well and the irrigated area. Licenses can last between 5-10 years.

The use of surface water is exceeding the supply (river runoff) in all but the wettest years. The water scarcity gap between the available surface water and the demand for it, is believed to be between 1.6 and 1.8 billion m³ per year. As the groundwater aquifers are also overexploited, with about 1,200 – 1,300 million m³ per year, this gap is actually an underestimation. The groundwater use is a rough estimation as there are a lot of illegal wells and it is thought that even the legal ones extract more water than allowed. As a consequence, water sometimes stops flowing in certain parts of the River Lerma ('basin closure').

The main source of the water problem in the Lerma-Chapala basin is the lack of control on the amount of water extracted. There is hardly any water metering in the basin. Inspections are carried out but there are too little for the amount of landowners in the region. In Guanajuato alone there are over 25,000 little landowners. The government hoped to counter the problem by installing the COTAS with the intention of self-regulation. These water user associations didn't get any actual legal power, hence they were powerless to make a difference. Any water restrictions are not followed by the farmers and any effect of more efficient irrigation techniques goes lost in expanding the irrigated area. When the government wants to decrease water use, farmers protest.

The water pricing policy in the basin does favorise the agricultural sector. Every year a license fee is to be paid. The agricultural sector however, does not have to pay this annual fee, in contrast to cities and other industrial sectors. Water charges are not paid either by the agricultural sector. Not for surface water and not

for groundwater. The service fee that agriculturists pay for supplying the water, is 75% funded by the government. In contrast, the households (cities) and municipalities do pay for their water rights and water charges for surface water. According to an OECD study the average domestic water price in Mexico is 0.36 EUR/m³. The only pricing policy that limits the water use of the agricultural sector is the price for electricity, necessary to pump the water up and around. In December 2002 the Rural Energy Law raised the prices for energy use. Farmers with a valid groundwater concession could get their energy at one of the lower tariffs but their use (in kWh/year) was limited per well. Once above this limit another, higher tariff is in place. The law has reduced the water use a bit but again the lack of enforcement and rent-seeking surrounding the granting of water concessions limited the success of this law. The water businesses in Mexico don't manage to cover their costs and need subsidies from governments to do the necessary investments. It is not sure if they want to move to a scenario where costs are completely recovered, from both cities as agriculture. Tariffs differ from town to town, resulting in very diverse levels and structures of tariffs.

The water policy has no real effects on the irrigators, as the policy itself fails to limit the water use or cover the costs. Within the agricultural community the effects of the decrease in water availability differ. Richer farmers pump up groundwater when surface water is scarce. The poorer farmers however, rely mainly on surface water and don't have the money to pay for pumping up groundwater. They usually sell their land when groundwater aquifers have dropped to low and emigrate to the cities or to the USA.

Today, the transition of water management from the government to the states and the water users, is still in progress. Huge projects for transferring water from neighbouring basins are also underway for some smaller cities, while Guadalajara is expected to bring water from a farther source in Santiago basin. According to the OECD (2011) the situation has improved recently because of the implementation of the integrated water resource management framework. The creation of a separate agency for the Lerma-Chapala Basin and a basin plan, together with the decentralisation of the institutional power and the stakeholder participation, improved the water use in the basin and hence the hydrological state of the basin. This has as a consequence that lately the water levels in the lake Chapala are rising, the water quality has improved and the irrigation is done more efficient.

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5 THE NETHERLANDS: Scheldt river basin

The case study takes a closer look at water policy towards the agricultural sector in the Scheldt River Basin District (RBD) in the Netherlands. The basin has been selected after an analysis of different criteria (allocation, pricing systems, innovative trends, upcoming pressure on the basin, etc.) by literature and interviews. Considering the specificity of freshwater availability (salinisation) and agriculture in the Scheldt Basin, the case study also addresses some elements for the broader Southwestern Delta area.

The key questions for this case study have been addressed by analysing different literature sources listed in paragraph 5.5. One of the main sources is the River Basin Management Plan (RBMP) for the Scheldt basin (RBMP 2009-2015), complemented with perspectives from stakeholders groups, research papers and articles. Regional Water Authorities (Water Boards) also supplied information on the current state of water pricing and allocation. Expert contacts in the Basin only resulted in limited additional information. The document has been revised and commented by the national water authority (*Rijkswaterstaat Waterdienst*) and Regional Water Authorities (*Scheldestromen* and *Brabantse Delta*).

5.1 Introduction and background to the case study (area)

5.1.1 Description of the area¹²⁰

The Scheldt rises in France, flows through three countries (France, Belgium and the Netherlands) and is approximately 350 km long. The Scheldt river basin has a surface area of 22,000 km², of which 3,200 km² is located in the Netherlands. The Scheldt river basin as a whole has a population of almost 13 million, of whom 470,000 live in the Netherlands. Population density in the Dutch part of the Scheldt Basin (230 inhabitants per km²) is fairly small compared to the average figure for the country (480 inhabitants per km²).¹²¹ The Netherlands is located in the delta of four major rivers. The Scheldt is situated in the southwestern part of the country and borders Belgium in the south.

¹²⁰ Based on the RBMP (2009-2015)

¹²¹ Commissie Regionaal Waterbeheer (RBO Schelde) (2004). Karakterisering stroomgebied Schelde. Art 5 reporting.

Diagram36 : Location of the River Basins in the Netherlands¹²²



The Netherlands is a flat and low-lying country, with approximately 26% of its surface area located below sea level. Due to this mainly flat relief, the Scheldt District's rivers are lowland waterways with broad valleys and slight water currents and drains. The Scheldt and a number of its tributaries are subject to tidal movement. The tidal waters coming from the river mouth invade the estuary.

A striking characteristic of the Dutch part of the Scheldt river basin is its large water surface: almost 35% of the area is covered by water. The (surface) waters in the Dutch part of the Scheldt river basin can be roughly divided into polder waters and large water bodies. There are a lot of polder waters, given that the land part of the Scheldt river basin consists almost entirely of polders¹²³. In many low-lying polders, salty groundwater rises up as seepage water. This often makes the water of many polder waters brackish. Five groundwater bodies are situated in the Scheldt river basin. A distinction is made between groundwater above and below the 'Boomse Klei', a virtually impermeable clay layer. The groundwater in the shallow sand layers in the

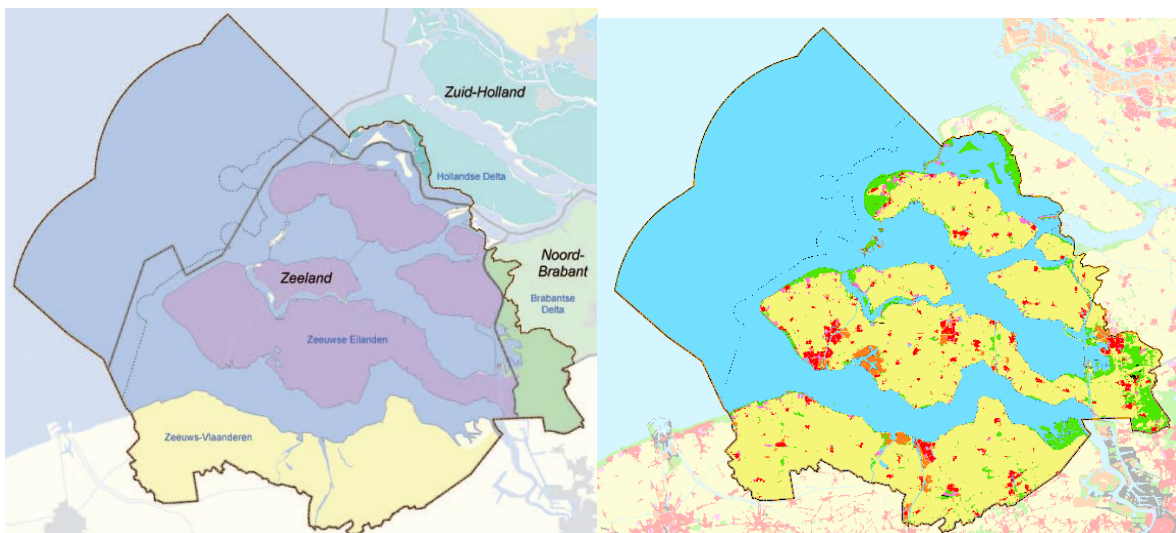
¹²² <http://www.rijksoverheid.nl/onderwerpen/waterkwaliteit/naar-een-betere-waterkwaliteit>

¹²³ Coastal polders and river polders are areas reclaimed from the waters, respectively the sea and the river / lakes.

Scheldt river basin is mostly salty. Only in elevated areas and in places where the sand layers reach up to ground level has the groundwater become fresh as a result of precipitation. This is the case in dune areas, creek ridges and aeolian sand. Groundwater is abstracted for drinking water in four locations: the dunes of Schouwen-Duiveland, in Zeeuws-Vlaanderen, and in two locations in western Brabant. No surface water is extracted for drinking water in this river basin.

The Dutch part of the Scheldt river basin covers the province of Zeeland and small parts of the provinces of Noord-Brabant and Zuid-Holland. Principal land uses in the Scheldt Basin are illustrated in the map on the right in Diagram37 below. Three quarters of the land is used for agriculture (mainly arable farming) (area marked in yellow), 10% is urban area consisting of space for living, industry and recreation (area marked in orange and red). Nature area is marked in green. A relatively small part of the land (3%) is nature reserve and 4% are forests.

Diagram37 : Provinces in the Scheldt Basin and Dutch Regional Water Authorities (*map on the left*); Land use in the Scheldt Basin (*map on the right*). (Source: RBMP 2009-2015, maps)



Another typically Dutch phenomenon is the large-scale damming up of tidal outlets to protect the country from flooding (IJsselmeer dam, Delta Project in the southwestern Netherlands and in the Lauwersmeer). The construction of dams impacted the state of water resources by creating freshwater lakes.

Industry is the largest contributor to GDP, chemical industry in particular. Recreation and tourism have grown over the past decades and aquaculture is rather significant with +/- 6000 hectares of mussel beds.¹²⁴ Considering the significant land use of agriculture, its contribution to GDP is rather low (only 3%) but slightly higher than the national average.

¹²⁴ <http://www.isc-cie.org/en/international-river-basin-district-.html>

5.1.1.1 The Southwestern Delta territory and (salt) water management¹²⁵

The southwestern Delta includes the entire Scheldt Basin, the Western part of the Meuse RB and a part of the Southwest area of the Rhine RB. The Delta is demarcated by the Nieuwe Waterweg/Nieuwe Meuse, the Biesbosch and the Scheldt estuary. It is a complex system of interconnected and mutually influential fresh- and saltwater waterways. Some waterways are stagnant, others are tidal. The Rhine, Meuse and Scheldt converge here. Water distribution is largely regulated by the Haringvliet sluice gates, which are operated in such a way that the Nieuwe Waterweg can discharge 1,500 m³/s for as long as possible. In this way, water management authorities attempt to counteract saltwater incursion and prevent salinisation¹²⁶ of the Hollandse IJssel, the most important water inlet point for the mid-western part of the Netherlands.

Diagram38 : Southwestern Delta territory including the Scheldt RB (Source: Arnold et al, 2011)



Lake Volkerak-Zoom serves as a good example of the decreasing availability of freshwater¹²⁷ and the ongoing discussion on 'saltwater-freshwater management'. The discussion is particularly relevant for agriculture as irrigation is one of the main reasons to preserve the status of the lake as a freshwater source (de Vries et al, 2009). The lake was created in 1987 as a result of the decision to keep the Oosterschelde in an open connection to the sea. By disconnecting the Lake Volkerak-Zoom from the Haringvliet and flushing the system with freshwater from the Hollandsch Diep and the rivers in the province of Brabant, a freshwater lake was created. Since 1994, excessive amounts of nutrients and a long retention time in this lake have created optimal conditions for blue-green algae blooms. Blue-green algae adversely affect the aquatic environment by producing toxins and impact multiple users: residents, tourists and farmers that can't use

¹²⁵ Section has been derived from Arnold, G., Bos, H., Doef, R., Goud, R., Kielen, N., van Luijn, F. (2011). Water management in the Netherlands. Joint publication of the Ministry of Infrastructure and Environment, Directorate-General Water and Rijkswaterstaat, Centre for Water Management.

¹²⁶ Ground water in the northern and western parts of the Netherlands is slowly becoming saltier. This process called salinisation takes place in two ways. The salt forces its way inland via surface water, known as external salinisation, or it works its way up through the soil in groundwater, which is called internal salinisation.

¹²⁷ The lake is mainly situated in the Meuse RB. Some important farming regions in the Scheldt RB benefit from the freshwater resources of the lake explaining the inclusion of the lake Volerak-Zoom in this case study on the Scheldt RB.

freshwater from the lake for irrigating their crops. Research results led to the conclusion that the necessary improvement in water quality can't be obtained if Lake Volkerak-Zoom remains a freshwater lake. Only if the lake is salinated again and limited tidal dynamics are restored, water quality will improve sufficiently for the algal blooms to disappear. Different studies have been executed in order to explore future scenarios for the southwest Delta and possibilities for agriculture when e.g. the freshwater resource Lake Volkerak-Zoom disappears.¹²⁸ The area is as such considered as a test area for changed farming practices (salt tolerant crops, aquaculture, developments in freshwater savings or alternative supply, closed loop systems¹²⁹ for water use, ...) (Deltares, 2009).

Salinisation and agriculture in the Delta area

Salinisation is (only) a problem if users are hindered or damaged by the fact that the chloride content in the water rises above a certain concentration. Salinisation is a direct threat to agriculture. Agriculture is best served by water with a low chloride content. What farmers or horticulturalists will accept, depends, however, on the crops they grow. For example, fruit trees are more sensitive to higher chloride content than sugar beet, potatoes or grain. Halophyte farming (salt-tolerant crops) is, of course, indifferent to salinisation, but this sector only accounts for a limited market. Within the sector, there are possibilities of making use of brackish water, for instance to produce crops that are rich in protein as an alternative to imported animal fodder.

In areas where salinisation is already a problem, alternative sources of freshwater are being considered to combat further salinisation. Farmers adapt their farming decisions by creating their own freshwater basins or shifting to more salt tolerant crops. They also try to take part in the decision making process (water levels, strategy) of water management authorities, e.g. through farmer's organisations.

Source: Arnold et al, 2011

5.1.2 Actors and general management rules

5.1.2.1 Basic principles and legislation¹³⁰

The new Water Act (2009) has integrated eight previous sectorial water acts of the Netherlands. The Water Act highlights integrated water management based on the 'water system approach' addressing all relationships within water systems. The Water Act is framework legislation that is being implemented on the basis of secondary legislation i.e. by governmental decree (the Water Decree) and ministerial regulation (the Water Regulation).

¹²⁸ Examples of studies in this context are e.g. Velstra, J., Hoogmoed, M., en Groen, K. (2009). Inventarisatie maatregelen omtrent interne verzilting STOWA en Leven met Water or de Vries, A., Veraart, J., de Vries, I., Oude Essink, G., Zwolsman, G., Creusen, R., Buijtenhek, H. (2009). Vraag en aanbod van zoetwater in de Zuidwestelijke Delta – een verkenning

¹²⁹ Closed loop systems are being used in e.g. horticulture: irrigation water is re-circulated and water savings and savings on fertilisers can as such be achieved. Disinfection techniques need to be applied in order to prevent the spread of pathogens. See e.g. <http://lv.vlaanderen.be/nlapps/docs/default.asp?id=392>

¹³⁰ Unless otherwise stated, information has been based on Arnold et al (2011)

A key feature of the Water Act is that as many activities as possible are governed by general regulations. These stipulate in advance what is permitted and what not. However, it is not possible to lay down all details in general regulations. For **human activities in water systems**, the Water Act has introduced the *integrated water permit*, replacing six permits from previous water legislation. These include a wide range of activities such as discharges of polluting substances into surface water, the extraction of groundwater or the construction of a dike. A 'one stop shop' approach and ICT facilities will support efficient working procedures for the processing of applications and the issuing of permits.

Principle of water allocation

The new Water Act (2009) imposed a transfer in the management of **groundwater**, in terms of the license system for abstractions and infiltration. In the earlier regime, deputy of the State (provinces) were responsible for all groundwater abstractions. This responsibility has partly been transferred to the Regional Water Authorities, but in practice, provinces are still managing the most important abstractions: (i) industrial abstractions > 150,000 m³ per year, (ii) abstractions for public drinking water supply, (iii) underground storage of energy. Apart from large abstractions for drinking water supply, provinces are showing some reticence to permit groundwater abstractions. Smaller groundwater abstractions are regulated by the Regional Water Authorities¹³¹ (ordinance or *keur*)¹³². This regulation can imply either a permit obligation or general rules for smaller abstractions of groundwater. The River Basin management plan (RBMP) of the Scheldt Basin¹³³ notes that groundwater abstractions in the Netherlands above 240 m³ per day need a permit (Law on groundwater), while it is of note that regional differences occur. All known and permitted abstractions have been registered in a database. The (general) regulations for the major part of the Scheldt Basin are however more strict. The ordinances (*keur*)¹³⁴ of the former 2 Regional Water Authorities in Zeeland covering the largest part of the Scheldt Basin (now combined in 1 Board *Scheldestromen*) laid down specific rules for groundwater abstractions. **Notification** and **metering** is obliged for groundwater abstractions above 5 m³/hour or annual abstractions above 12,000m³. An **abstraction permit** is obliged for all groundwater abstractions except exemptions described in article 21 of the ordinances. With regard to agriculture, no permit is required if (i) abstraction occurs in non vulnerable freshwater areas¹³⁵ and below 10m³/hour and 1,000m³ per month and 8,000m³ per year (for irrigation, less stringent thresholds are defined at 60m³/hour, 3,000 m³/month or 8,000m³ annually); (ii) abstraction occurs in non vulnerable and non freshwater area below 10m³ per hour or 30,000m³ per year.

Under normal conditions, abstractions from **surface water** in the Netherlands don't generate significant effects on the water condition. Responsible authorities for abstractions from surface water are the State and the Regional Water Authorities. When surface water is sufficiently available, smaller abstractions (usually <

¹³¹ Regional Water Authorities are known as Water Boards. Both descriptions are used in this text.

¹³² Article 1 of the Law on Water Boards defines water system management / protection (including groundwater) as a key task for Water Boards.

In order to take up this responsibility, the ordinances (*keur*) and rules and regulations of Water Boards have been modified accordingly.

¹³³ RBMP 2009-2015, p 30

¹³⁴ Keur Waterschap Zeeuws-Vlaanderen (2009) and Keur Waterschap Zeeuwse eilanden (2009). The ordinance of the new Water board *Scheldestromen* will apply from October 2011 and relies on the stipulations in existing ordinances.

¹³⁵ Areas are mapped as annex to the ordinance (*Keur*).

10 m³ per hour) are possible without notification for e.g. irrigation purposes. Abstractions between 10 and 50 m³ per hour (middle range) need notification.¹³⁶ Large capacity abstractions (over 50 m³ per hour) always need a permit. Rules for the major part of the Scheldt Basin are however more strict¹³⁴: Permits for surface water abstractions are required for pumping capacities above 15m³ per day.

Source: RBMP 2009-2015

The Water Act contains provisions on **levies** such as charges, legal fees, subsidies, compensation and the recovery of costs. It provides the basis for the *pollution charge* and *groundwater charge*. The pollution charge has to be paid for direct discharges into surface waters, subject to the 'polluter pays principle'. The charge applies to all sewage discharges, water sanitation works and / or discharges in surface water. The pollution charge affects mainly households and industry, as agricultural activities are rarely connected to public sanitation services. Even though provinces are no longer issuing permits for all groundwater abstractions, they remain entitled to claim charges for groundwater extraction. Regional Water Authorities will be able to pay for expenses incurred with their groundwater-related responsibilities from the revenues of the *water system levy* as laid down in the Water Boards Act. Municipalities pay for their water-related responsibilities from the municipal water charge, which is laid down in the Municipalities Act.

Principles of charging

Van der Veeren et al. (2011) notes that the principle of charging for water management in the Netherlands is based upon the *Interest-payment-say principle* which results in solidarity and fairness: if your interest is larger, you pay more. For example, with respect to water quantity management ('dry feet'), payment is according to the value that is protected. In former days members of regional water boards were mainly farmers. Their protected value was the value of agricultural land so farmers pay a water system levy per ha of agricultural (unbuilt) land for water quantity management (*omslagheffing* or *watersysteemheffing*). Nowadays also citizens want to have a say. They pay according to the value of their property (houses). A similar principle is installed for water quality management (wastewater treatment): payment for water quality occurs according to emissions (measured in population equivalents). The Netherlands as such have a long history of payment according to *polluter pays* and *user pays* principles. However, where it is not appropriate to finance water-related work out of local taxation, for example because the interests of a larger area of the country are at stake, funding is provided by a higher tier of government out of general public resources. This is the case, for example, with flood protection for the state-managed waters (RBMP 2009-2015).

The Netherlands installed a groundwater tax (national level) as an incentive for sustainable use of groundwater resources. The tax is also considered as a price markup reflecting the discrepancy between the high value of groundwater (reliable quality and availability for those who have access) and the relative small production costs for users (industry, drinking water companies, some farmers with access to groundwater sources). These production costs appear to be rather modest compared to the production costs of surface water while the overall resource availability is limited. The groundwater tax has been imposed to reflect this

¹³⁶ Middle range capacity abstractions however need a permit in certain zones where sensitive nature or buildings are protected.

high value of groundwater and to promote rational use of the available resources (tariff of 0.1883 € per m³¹³⁷ and payable by industry, drinking water companies and agriculture (but excluding irrigation)¹³⁸). The unit tariff is lower when abstraction is combined with infiltration. Next to this (national) groundwater tax, provinces also impose a groundwater levy to finance their groundwater management activities (ranging from 0.0081 to 0.0254 € per m³ depending on the province)¹³⁷. It is clearly stipulated in the Groundwater Law what services or activities can be charged to groundwater users: research, costs of measures to mitigate impact of groundwater abstraction, costs for groundwater register and some compensation or penalty fees (RBMP 2009-2015).

Source: van der Veeren et al. (2011) and RBMP 2009-2015

5.1.2.2 Actors: role in water allocation and water pricing¹³⁹

The Water Act acknowledges only two water authorities, the State as authority for the main waterways and the Regional Water Authorities as the authorities for the regional waterways and wastewater treatment. Provinces and municipalities do not act as water management authorities, though they do have certain tasks in water management.

The state is responsible for infrastructure, flood defence and the water quality of state managed waters. These include the major rivers which are part of international river basin districts as well as the Dutch part of the North Sea.

On the regional level, there are 25 regional water authorities.¹⁴⁰ These Water Boards are responsible for regional water quantity management ("dry feet"), water quality management (e.g. sewage treatment), and land reclamation.¹⁴¹ The Water Boards are democratically chosen and can finance their water management activities using own levies (e.g. surface water levies and water quality charges). These levies should not be more than required to cover the costs since Water Boards are not allowed to make profits. At the same time, revenues should be enough to cover the costs, since no funds are available to cover losses. The form and contents of Regional Water Authority charges are determined by a number of tax principles, such as the interest-payment-say principle (dating back to the origins of the Water Boards), the polluter pays principle, the cost recovery principle and the solidarity principle (see text box principles of charging in paragraph 5.1.2.1).

Besides Water Boards, the Netherlands counts 12 democratically chosen provinces. The provinces are responsible for groundwater management, which they can finance by charging a groundwater levy.

¹³⁷ Figures are for 2007

¹³⁸ Irrigation is exempted as of January 2006, see paragraph 5.2.2.1.

¹³⁹ Paragraph has been derived from van der Veeren et al. (2011) and Arnold et al. (2011).

¹⁴⁰ <http://www.uvw.nl/vereniging.html>

¹⁴¹ Two third of the Netherlands would regularly be flooded if there were no dikes. The Netherlands has a long history in taking land from the sea through (large) dikes and drainage. It is costly to maintain dikes and sluices for these large land reclamation activities. Farmers were responsible for maintenance of infrastructure and this has been transferred to community groups, the predecessors of the later water boards. In a community, every farmer was responsible for a certain part of the dike. In a later period the Water Boards started to maintain the dikes themselves to ensure a certain quality, and the farmers just paid water taxes. See e.g. <http://www.waterland.net/index.cfm/site/Water%20in%20the%20Netherlands/pageid/CDA0E5A3-D1F5-1767-58EECA08BC8288ED/index.cfm>

Furthermore, each province draws up regional water management plans (increasingly as part of integrated environmental/spatial plans) and they supervise water management by the municipal authorities and Regional water Authorities. Provinces are the competent authority to grant permits for large groundwater abstractions and infiltration (see text box principles for water abstractions in paragraph 5.1.2.1).

The municipalities have the task to provide for the collection and drainage of rainwater and groundwater. Municipalities can charge citizens a sewerage levy, to pay for costs related to sewerage, but they can also use money from the public budget for this purpose.¹⁴² Finally, drinking water supply is in the hands of 10 drinking water supply companies, ownership of which is shared between various public authorities (provinces and municipalities).

Water management In the Netherlands includes many different parties (authorities at different levels, Regional Water Authorities, drinking water supply companies, NGO's, knowledge institutions and private parties). This is organised as a broad consultative structure aimed at reaching consensus between all stakeholders through a bottom-up approach and decision-making on all levels. Consultations take place at all levels of government (national, provincial and local), at all stages (policy preparation, formulation and implementation) and with both strategic and operational objectives (i.e. the *Dutch 'polder model'*). (van der Veeren et al., 2011)

Relevant government bodies for the Scheldt Basin are:

- Central government
- 3 Water Boards: Waterschap Scheldestromen, Waterschap Hollandse Delta, Waterschap Brabantse Delta
- 3 provinces: Zeeland, Brabant, Zuid-Holland
- 20 municipal councils

5.1.2.3 Priorities: allocation of scarce supplies¹⁴³

The 'drought' season annually begins at the first of April. The State (*Rijkswaterstaat*) regularly spreads drought messages, and early in the year this message gives a forecast of the potential shortage or temperature problems for the summer period. These messages are sent every two weeks or more frequently if need be, usually until mid September.¹⁴⁴ The Netherlands experiences water shortages once in a while. The problem is usually more specifically freshwater shortage. The very dry summer of 2003 and dry springs of 2005 and 2011 (extremely dry) are the most recent examples. In periods of water shortages it is no longer possible to serve every designated use. The National Coordination Commission for water allocation (lcw) assembles in periods of multi-regional water shortages, or if water levels of the Rijn or the Meuse at the border (inflow from neighboring countries) are below a minimum value (RBMP 2009-2015). This commission (lcw) allocates State water resources to the different demands according to the national priority ranking. The 'sequence of priorities' were drawn up in response to the exceptional drought of 1976, and updated after the

¹⁴² Considering decreases in budgets allocated from the national budget to local authorities, municipalities have the tendency to rely on the sewerage charge (Jantzen, 2008).

¹⁴³ Arnold et al. (2011)

¹⁴⁴ <http://www.helpdeskwater.nl/onderwerpen/gebruiksfuncties/waterverdeling/>

summer of 2003 when drought was almost as intense. In the event of water shortages the Water Act enables taking one function precedence over the other ('priority of rights' of *verdringingsreeks*). This priority ranking is usually further translated to a regional ranking.

Agricultural water use, shipping and other sectors in category 4 have the lowest priority when water is short in supply. Farmers and horticulturalists cultivating capital-intensive crops and factories using process water rank higher (category 3). All categories are shown in Diagram39 below:

Diagram39 : Priorities in water allocation in times of water shortages



The National Coordination Commission for water allocation (lcw) considers water quantities per sector and takes into consideration the water quality depending on the demand. Each sector requires water from a certain quality (e.g. chloride content for farmers, temperature for cooling water or irrigation purposes e.g. in horticulture, ...).¹⁴⁵

5.1.3 Water resources and aquatic ecosystems

The yearly precipitation rate in the Scheldt River Basin is fairly limited with 775 mm per m² on average. Evaporation is relatively high resulting in a modest precipitation surplus of 175 mm per year. This surplus is the lowest close to the sea (150 mm) and reaches 220 mm at the border between the provinces of Zeeland and Brabant.¹⁴⁶ At present there is no water shortage except in very dry years (1/10).¹⁴⁷ At present no water imbalances are caused by irrigation, but climatic change and the increasing scarcity of fresh surface water

¹⁴⁵ <http://www.rws.nl/water/veiligheid/watermanagement/landelijkecoördinatiecommissies/lcw/>

¹⁴⁶ Commissie Regionaal Waterbeheer (RBO Schelde) (2004). Karakterisering stroomgebied Schelde. Art 5 reporting.

¹⁴⁷ P.c. Victor Witter, Water Board *Brabantse Delta*

might bring about an imbalance of resources. The quantitative status of all groundwater bodies is good. This means that there is no depletion of the available groundwater. Abstracted groundwater is sufficiently replenished with precipitation surpluses or infiltrations. Groundwater has however high chloride concentrations.

It is expected that climate change will bring higher temperature and precipitation rate. Local abundances of rainwater will occur as it is assumed that rain will come in short but massive rainfalls. Summers will become warmer and drier. Rising sea level will result in an increased intrusion of salt water in coastal areas with possible consequences for drinking water supply, agriculture and nature. The problem of coastal erosion is assumed to extend and drainage of water from polder areas (in wet periods) and sea branches will become more difficult.

The Scheldt Basin is dominated by its large area of polders. Over time, the installation of dams and pumps facilitated a more refined management of the surface water levels especially for agricultural purposes. The hydrological regime in the river basin (and the Netherlands) is therefore highly artificial. In summer, water levels are relatively high to ensure sufficient water for the crops. In winter, water levels are kept relatively low to create sufficient storage capacity in the event of heavy rainfall. In many low-lying polders (and low water levels), there is a continuous (salty) groundwater flow and salty groundwater rises up as seepage water. This often makes the water of many polder waters brackish.

Another typically Dutch phenomenon is the large-scale damming up of tidal outlets to protect the country from flooding (IJsselmeer dam, Delta Project in the southwestern Netherlands and in the Lauwersmeer). Practically all sea branches were isolated from the North Sea and tidal system is only present in parts of the Westerschelde and the Oosterschelde. The construction of dams impacted the state of water resources by creating “freshwater” lakes. These former sea branches are further separated in “variable” basins with (temporary) freshwater, brackish or saltwater characteristics. Water levels and chloride content are regulated per individual basin through means of inlets, dams and sluices. The Delta project was not solely installed for flood protection but also served to the objectives of freshwater availability, of former islands and potential for inland navigation, fisheries, recreation and nature.

5.1.4 Water use for agricultural demand/supply

5.1.4.1 Agriculture at a glance¹⁴⁸

The Scheldt Basin contributes only 3% of the total GDP of the Netherlands (25 billion €). The contribution of different sectors in Scheldt Basin differs from the global picture for the Netherlands. Industry is the most important sector (more than 60% of regional GDP) while the tertiary (services) sector is less important in the Scheldt Basin (Zeeland). Recreation and tourism are important within the latter. Agricultural land takes 75% of the total land area in the Basin but contributes only 3% to regional GDP. This is however slightly higher

¹⁴⁸ Commissie Regionaal Waterbeheer (RBO Schelde) (2004). Karakterisering stroomgebied Schelde. Art 5 reporting.

than the average at national level. In 1998, the Agricultural sector employed 8,000 FTE's in the Basin. Agriculture also plays an indirect but important role for the typical landscape of the province and the attractiveness for other sectors like tourism and recreation.

The regional GDP amounts up to 0.6 billion €. Arable farming (large cultures) are the most important contributor with more than half of the production value. Horticulture and glasshouse farming are important with more than 15%, together with mixed farming. Cattle breeding and bulbs are less when comparing to average figures for the entire country. The share of cattle (milk cows) is nevertheless growing as farmers moved from Noord-Brabant and the *Randstad* to Zeeland. Coastal and transitional water are important for aquaculture and fisheries. The Oosterschelde (together with *Wadden* area) plays a major role in mussel farming.

It is expected that agricultural land use will decrease by 3.5% over the coming years, in particular the share of arable land (RBMP 2009-2015). Production value of arable farming is however likely to increase as exploitations are shifting to more intensive crops. The area of horticulture (mainly glass) is assumed to double in the period 2010-2015. The province of Zeeland plans to concentrate these large new exploitations in Zuid-Beveland (3 zones) and Zeeuws-Vlaanderen (1 zone). The area for orchards and grassland is also expected to grow. These activities generate higher added value than the traditional cultures dominating today. The importance of intensive water-consuming crops is growing. The regional plan of the province of Zeeland aims at more large exploitations to prevent further fragmentation of the area.

5.1.4.2 Water and agriculture

5.1.4.2.1 Irrigated area and main crops

A 2007 study on the benefits from the WFD for agriculture and horticulture¹⁴⁹ notes that irrigable surface in the province of Zeeland is rather modest while most of the irrigable surface in the Netherlands are situated in the provinces of Brabant and Limburg. Van Bommel et al (2007) indicates that irrigated surface in a dry year can be several times the area in a normal year. Irrigation in the province of Zeeland is important in Zuid-Beveland, where +/- 1 out of 5 farmers are irrigators (half of them drip irrigation for fruit farming) (Alterra, 2006).

Gravity fed (canal) distribution system for surface water started with the creation of the Lake *Volkerak-Zoom* (1987) as a freshwater basin used for water supply. The water resource is important for some specific areas in Zeeland (Reigerbergsche polder, Tholen/St. Philipsland with crops like vegetables) and the (north-)western part of Brabant. For the Brabant area that is part of the Scheldt RB, about 5.000 ha of agricultural land can import surface water by means of canals.¹⁵⁰ Sprinkler irrigation by using groundwater is possible, though use of groundwater for irrigation faces heavy restrictions. The availability of groundwater with low

¹⁴⁹ van Bommel, K., Bondt, N., Dolman, M., Reijnders, C. (2007). De baten van de KRW; Een eerste inventarisatie naar de potentiële baten van schoner water voor de land- en tuinbouw. Den Haag, LEI

¹⁵⁰ P.c. Victor Witter

chloride contents is limited to some specific locations in the Scheldt Basin. Irrigated area in the Brabant part of the Scheldt Basin has been rather stable over the past 25 years.

De Vries et al (2009) states that arable farming (traditional cultures with limited irrigation water demands in the Netherlands) still predominates in many areas of the southwestern Delta (this is broader than the Scheldt Basin). Other agricultural exploitations are however more dependent on the availability of (high quality) freshwater, i.e. horticulture (bulbfarming, chicory), fruit farming or glass house farming. Irrigation plays a role in following (rather small) areas of the Scheldt Basin (or within the broader southwestern Delta region):

- Tholen/St.Philipsland: Agricultural area 9,469 ha (4,600 horticulture, 2,200 mixed farms and 30 ha glass) and 1,855 irrigable. The total area lies within the Scheldt RB.
- Zuid-Beveland within the Scheldt RB: important role for fruit growing and orchards. An important share of fruit farming depends on the supply of freshwater through an agricultural water pipeline operated by Evides (drip irrigation).¹⁵¹ To the east of the island, +/- 630 ha irrigable area in the Reigersbergsche polder (on a total agricultural area of 1,000 ha) can be supplied with freshwater from the lake Volkerak-Zoom.
- West Brabant: irrigable area is situated both in the northern part (depending on lake Volkerak-Zoom) and the south bordering the province of Zeeland. The southern part is situated in the Scheldt Basin and irrigable area is estimated at +/- 5,000 ha.

It is of note that glasshouse farming demands high quality water and van Bommel et al. (2007) indicates that neither groundwater nor surface water are suited (without treatment) for these purposes. Rainwater is the most commonly used source (preferred above drinking water) and the sector will most likely shift to closed systems where drainwater is captured and recirculated as much as possible.¹²⁹ Groundwater demand for these purposes will further decline as the WFD no longer allows to discharge the residue from the desalination process to the water bodies.

5.1.4.2.2 Water use in agriculture

There is little quantitative information on water abstractions or water use from agriculture in the Scheldt Basin. This is especially the case for irrigation water and the water that is used for flushing (i.e. to lower the chloride content of water bodies in order to keep the freshwater status¹⁵²). The 2004 description of the basin (art 5 report) indicates that groundwater abstractions for agriculture (irrigation) are estimated at 0.67 Mm³ compared to 29.46 Mm³ of total groundwater abstractions.¹⁵³ Surface water in the bodies of the Scheldt Basin have a high chloride content which make these abstractions unsuitable for certain applications. Van Bommel et al. (2007) lists 1.6 Mm³ water use for irrigation in 2005. In the dry year 2003, this figure amounted up to 5.5 Mm³ sourcing from both groundwater and surface water. Irrigation water demand varies thus significantly with climatic conditions. Rainwater reservoirs can also be used for irrigation but no clear figures have been identified on this component. Other water use in agriculture within the Scheldt Basin (excluding irrigation) in 2005 was +/- 2.6 Mm³. The bulk of this volume (2 Mm³) was delivered by a water supply company and

¹⁵¹ See e.g. http://www.zlto.nl/templates/dispatcher.asp?gensubsub=true&page_id=25223301

¹⁵² p.c. Jan Auke van Werkum. The main beneficiaries of these flushing activities are farmers that can use the water for irrigation purposes of chloride contents are acceptable. See e.g. de Vries et al (2009).

¹⁵³ Commissie Regionaal Waterbeheer (RBO Schelde) (2004). Karakterisering stroomgebied Schelde. Art 5 reporting: Drinking water supply takes the lion's share of these abstraction from groundwater with 24.42 Mm³.

served as drinking water for cattle breeding. Surface water is not often used for these purposes in order to prevent the spread of diseases. Pumps for groundwater or surface water abstractions are not very common compared to other regions in the Netherlands. Presence of pumps is only 5% compared to e.g. 34% in the Meuse Basin (sandy soils in the southeastern part). Horticulture has a stronger than average presence with 12% and 7% for cattle breeding exploitations (van Bommel et al, 2007).

Water use in agriculture is low in terms of abstracted volumes. The availability of freshwater (supply) in the Scheldt Basin (and southwestern Delta by extension) is however an ongoing concern. The water system in the polder area needs to be managed thoroughly in order to allow cultivation of farmland in this area, considering the brackish nature of the water bodies. It is sometimes argued that drought damage is worse than salt damage if water quantity managers need to decide (Alterra, 2006). Nevertheless, the water volume that is mobilised in order to make farming in certain areas or crop choices possible is high compared to the actual water use in e.g. irrigation. The threat of salinisation and the feasibility of flushing (mainly for agricultural purposes) is subject of an ongoing debate in Dutch Water management. This is for example reflected in the research that is undertaken on the the potential decision to allow salinisation of the lake Volkerak-Zoom.¹⁵⁴

5.1.5 Resources and supply

The chloride content in both groundwater and surface water bodies does not allow farmers to rely on important water abstractions for agricultural purposes. Van Bommel et al (2007) summarised that irrigation water in the Scheldt RB comes from both groundwater and surface water sources. Throughout the country, groundwater is source of +/- 2/3 of the irrigation water while it is only 25% in the southwestern delta (Alterra, 2006). Most farmers use a combination of surface water and groundwater in a normal year (1.2 out of 1.6 Mm³ water in 2005). In the dry year 2003, groundwater was more frequently used than surface water but a large part of farmers still relies in the combination of both.

Regional differences in (fresh)water resources prevail in the area and tailored solutions are sometimes installed in order to secure the availability of water:

- The polder zone situated in (southwest) Brabant sources from fresh seepage water (*Brabantse Wal*).
- Parts of Tholen / St-Philipsland can benefit from freshwater inflows from the lake Volkerak-Zoom. In Tholen, A pilot project is running to provide water for +/- 1,000 ha.
- The Schouwen area has always been relying on rainwater-fed ground water resources floating on existing salty groundwater layers (*regenwaterlenzen*, see e.g. Deltares, 2009). Farmers have adapted to uncertain availability of freshwater by crops that are more tolerant to salt (sugar beets, potatoes, grass).
- The eastern part of Zuid-Beveland (Reigersbergsche polder) depends on freshwater inflow from the lake Volkerak-Zoom. Part of this “flushing” water can be used for irrigation (via the Channel Bathse Spui). The State as owner of the channel has the obligation to keep chloride content below 450 mg Cl. Irrigation water of an important share of the fruit farmers (several hundreds) on Zuid-Beveland are supplied by the freshwater pipeline operated by Evides. Moreover, *regenwaterlenzen* (i.e. fresh groundwater floating on salty groundwater layers) can also contribute to the continued availability of freshwater in Zuid-

¹⁵⁴ See e.g. de Vries et al (2009) or Rijk (2010).

Beveland.¹⁵⁵ There could be options to further optimise this through e.g. deep drainage, where lower lying salt water is drained to further increase the size of the “floating” freshwater layer.¹⁵⁶

Evides freshwater pipeline

A number of fruit farmers in Zuid-Beveland benefit from water supply through an agricultural water supply pipeline operated by the water company Evides. The pipeline has been set up in 1980s to control drought damage (public funding). The farmer’s association ZLTO indicates that fruit farmers with sufficient volumes of freshwater for irrigation have much higher yields than non-irrigators. This is mainly due to higher quality products (weight and optimal – better marketable- size). Source of water in the first period of the operation was the lake *Volkerak-Zoom*, but the blue algae problem has forced Evides to switch to water from the Biesbosch. A major disadvantage of this source is that during periods of water shortage, the capacity of the pipeline appears to be insufficient to cover the demand of the fruit farmers in Zuid-Beveland, as Evides also needs to guarantee supply to industry and recreational purposes. ZLTO asks for a further optimisation of the pipeline and evaluates alternatives for freshwater availability (winter storage) in the area. One important initiative is a project (sustainable water supply for fruit farming) where the current and future demand of freshwater for several individual fruit farmers is identified, together with potential (both existing or tailored) solutions. This initiative “Water Optimisation Plan” provide insights on demand (and solutions) at farm level (fruit farmers) and the region of Zeeland in the mid-long term, but should therefore be broadened to the entire agricultural sector.

Source: ZLTO, Nieuwe Oogst (November 2010)

5.1.5.1 Irrigation techniques

When freshwater is distributed for agriculture by public providers, this is done through canal systems managed by the Water Boards. Farmers primarily use spray or sprinkler systems to apply water on the field. Fruit farmers in the province of Zeeland (mainly Zuid-Beveland) predominantly rely on drip irrigation systems. They are permanently striving to further developments for optimised water use. These innovations are also motivated by specific prescriptions and quality requirements for their products and by the restrictions in the use of chemicals. Furthermore, several fruit farmers on Zuid-Beveland have created own reservoirs – rainwater-fed or supplied from the Evides pipeline -, mainly for frost protection. These reservoirs are (partly) financed through subsidies.¹⁵⁷

¹⁵⁵ P.c. Victor Witter, Water Board Brabantse Delta.

¹⁵⁶ <http://www.schouwenduiveland.climateproofareas.com/mei2011/>

¹⁵⁷ P.c. Jan Auke van Werkum, Water Board Scheldestromen

5.2 Current water policies and practices influencing water use in Agriculture

5.2.1 Water allocation policy in the agricultural sector

Water allocation policy for irrigation water or agricultural water is based on the general principles as detailed in paragraph 5.1.2.1. Regulation provides rules for the activity of water abstractions, there are no specific allocation rules for irrigation. It is of note that rules for water abstractions differ between regions, due to the availability of water and water quantity management in general.¹⁵⁸

With the new Water Law (2009), nearly all groundwater water abstractions for agriculture require notification to or a license from the Regional Water Authority. Before 22 December 2009, the province was the competent authority.¹⁵⁹ The province is still responsible for the strategic vision on groundwater management while Water Boards translate this vision to the operational context. Regional Water Authorities are using the same rules that have been followed by the provinces for a (undefined) transitional period. Abstractions for certain activities (including irrigation) only require a permit above a minimum threshold value for the pumping capacity.¹⁶⁰ These values vary per Water Board. Due to the lack of freshwater resources, the province of Zeeland applied strict rules for groundwater abstractions (location, pump capacity) which has now been continued in the policy of the Regional Water Authority Scheldestromen (see section 5.1.2.1). The Water Boards are responsible for new groundwater abstractions, their registration and the control and enforcement of existing permits.

The Regional Water Authorities are also responsible for surface water abstractions. Rules are also different by region and depend on water quantity and quality targets. In practice, there are little restrictions with the exception of "protected regions" with a nature function. Surface water abstractions for agriculture in the Scheldt Basin are fairly limited because of high chloride content. The Water Board Scheldestromen (area of the province of Zeeland) makes permits obligatory for abstractions with capacity larger than 15m³ per day. When water levels in water courses are too low, Regional Water Authorities can install irrigation bans (from surface water) and publish this decision on the agency's webpage.

The provincial ranking of water supply for several uses applies in times of shortage, and water withdrawals can be restricted (see paragraph 5.1.2.3). Bans on water abstractions, in particular from groundwater, are sometimes installed in times of water shortage (quantity or quality).¹⁶¹ During the dry spring period (2011), there have been a number of days where water abstraction was prohibited in the polder area close to *Brabantse Wal*.

¹⁵⁸ Stoof, C.R. en C.J. Ritsema (2006). Waterwinning voor beregening in de landbouw en op sportvelden: een overzicht van de regelgeving in Nederland. Alterra-rapport 1364. www.alterra.wur.nl.

¹⁵⁹ http://provincie.zeeland.nl/milieu_natuur/grondwaterbeleid/index

¹⁶⁰ www.helppdeskwater.nl

¹⁶¹ Pc Victor Witter (Water Board Brabantse Delta) and Jan Auke van Werkum (Water Board Scheldestromen).

5.2.2 Water pricing policy in the agricultural sector

5.2.2.1 Current Framework

Paragraph 5.1.2.1 introduced the principles of charging for water in agriculture. The water price differs for surface water, groundwater or water from a service provider (can also be drinking water). As the presence of freshwater is limited in the Scheldt Basin, tailored solutions for water supply (and related pricing) do exist.

All farmers pay a price for **surface water** (water levels and maintenance of watercourses and dams) to the regional Water Boards based upon the land area (water system levy or “*watersysteemheffing ongebouwd*”). Farmers pay as such a per ha charge for surface water but not solely for surface water supply or availability. The levy is covering water management activities like supply and drainage of water as a service for agriculture.¹⁶² In Zeeland, farmers pay 59.71 €/ha annually to the Water Board *Scheldestromen* (79.73 € WB *Hollandse Delta* and 31.19 € to WB *Brabantse Delta*). High chloride contents of surface water resources limit the availability of water suited for irrigation or agricultural purposes. Flushing to keep these contents below certain limits only happens in some small parts at the east of the Basin by inlets of water from the freshwater resources of the lake Volkerak-Zoom (Tholen, Reigerbergsche polder on Zuid-Beveland).

Groundwater abstractions can be subject to groundwater tax from the State and groundwater levy from the province (volumetric charges). Since January 2006, irrigation is exempted from the national groundwater tax if more than 90% of the abstracted volumes is destined for irrigation of plants (Stoof et al, 2006). Irrigation (and agriculture more general) is indirectly exempted from the (provincial) groundwater levy by installing threshold values (Mattheiß et al., 2009). In the province of Zeeland¹⁶³, groundwater abstractions below 20,000 m³ per year are exempted from the (provincial) groundwater levy. This levy has been called provincial levy as it is payable to the province and earmarked for its activities in groundwater management and drought-related research. Alterra (2006) notes that some provinces stopped charging this levy due to the high administrative costs related to the high number of small agricultural abstractions (Overijssel, Limburg). Regional Water Authorities are now responsible for “smaller” groundwater abstractions but the levy is still payable to the province. A large number of these smaller abstractions will be exempted from the levy, including most of the agricultural groundwater users.

Alternative systems are **external water delivery**, e.g. transported by trucks on a case by case decision or e.g. through the water pipeline operated by Evides. These solutions have specific (volumetric) charging systems.

Competent authorities (besides the State) can rely upon the Law of the provinces (art 223) and the Law of the Water Boards (art 115) to charge a fee (*leges*) for services like the granting of permits. The level of these

¹⁶² Owners of nature areas and buildings also need to pay a similar levy based on area or property value. The levy can as such not be considered as a real price for (access to irrigation) water.

¹⁶³ http://provincie.zeeland.nl/milieu_natuur/grondwaterbeleid/index

fees differs strongly between water quantity management authorities.¹⁶⁴ Publication costs can also be charged but some provinces (e.g. Zeeland) have included these costs in the *leges*.

The pricing policy is inspired on the cost recovery principle. Dutch provinces (can) charge for smaller groundwater abstractions in order to cover costs for groundwater management. On a national level, there is an environmental tax for groundwater abstractions but this does no longer apply for irrigation as of January 2006. The water system levy (Regional Water Authorities) also serves to cover costs for (surface) water quantity management. Charging has historically grown according to the interest-payment-say principle (see paragraph 5.1.2.1).

The current principles of water pricing have been in place for some time now. It might be expected that refinements in pricing will take place in the coming years to preserve water as much as possible and to discriminate according to the service level (e.g. flushing).¹⁶⁵ In current charging systems, there appears to be little relation between service level and the level of the water price (de Vries et al., 2009). This is largely due to the local conditions and whether freshwater availability for agriculture is one of the objectives of the Regional Water Authority¹⁶⁶:

- Farmers in the region Zeeuwse-Eilanden (northern part of Zeeland) have practically no access to surface water with acceptable (for agricultural purposes) chloride levels (salty seepage water, no possibility for inlets from State water). Nevertheless, these farmers are paying a higher water system levy than farmers in the polder close to the Brabantse Wal (in the eastern part of the Scheldt Basin) that can benefit from a secured availability of surface water suitable for agricultural purposes (seepage water from the Wal).
- Farmers in the Reigerbergsche Polder on Zuid-Beveland can abstract water from the canal Bathse Spui¹⁶⁷ between first of April and end of September. They pay an additional fixed charge of 30 € per ha or approximately 0.15 € per m³ (de Vries et al., 2009).¹⁶⁸ For more water intensive crops (e.g. irrigation water demand of 5,000 m³/ha), this additional charge corresponds to an additional charge of 0.06 €/m³ while the per m³ price for less water demanding crops (1000 m³/ha) would amount up to 0.3 €/m³. If inlet of freshwater is insufficient to stay below the defined chloride level, farmers get a reduction or exemption of this additional charge which has occurred in 2008.
- The region of Tholen also benefits from water inlet from lake Volkerak-Zoom (and Eendracht). This pilot project has been initiated 8 years ago¹⁶⁹: a small area can benefit from surface water for irrigation from the *Eendracht* (1,000 ha within the pilot and another 1,000 outside the project). The (pilot) project continues to run today and farmers are still not paying for this supply of freshwater.
- Freshwater pipeline operated by Evides: the installation of the pipeline to transfer freshwater from the Biesbosch (Bathse Spui before blue algae problems) to Zuid-Beveland has been subsidised but is now privately operated by Evides. Farmers (mainly fruit farmers) connected to the line pay 0.50 €/m³.

¹⁶⁴ Approximately 75 € for surface water (Water Boards in Zeeland) and +/- 500 € for groundwater (province of Zeeland).

¹⁶⁵ P.c. Victor Witter Brabantse Delta

¹⁶⁶ It is important to bear in mind the historical evolution of Water Boards described in the text box "principles of charging" in paragraph 5.1.2.1. Water Boards base pricing decisions on the cost recovery principle and the *interest-payment-say* principle. Farmers located in the proximity of cities for example can pay a lower price for a similar water quantity management policy (and associated costs), explained by the fact that costs of the Water Board are spread over more "beneficiaries". P.c. Rob van der Veeren.

¹⁶⁷ The State as owner of the canal has the obligation to keep chloride content below 450 mg Cl. Inlets from Hollands Diep are necessary if concentrations are above that level but this can't be maintained in dry periods (and additional blue algae problem).

¹⁶⁸ Assuming a common practice irrigation application of 200 mm and 10% irrigated area.

¹⁶⁹ As research project to study options for allowing siltation of Volkerak-Zoommeer.

5.2.2.2 Factors influencing the impact/effectiveness of water pricing policies

Irrigation water abstractions from surface water are rarely metered. Only a small number of the inlets feeding the canal systems are metered. At the individual farm level, no metering takes place. The water balance of the total irrigated area is estimated based upon expert knowledge and extrapolation of the metered inlets.¹⁷⁰ Water metering for groundwater abstractions is imposed in the *Waterbesluit* (art 6.11)¹⁷¹. This regulation concerns both licensed and unlicensed abstractions, for both the abstractions under provinces' or Water Boards' authority. Abstracted volumes need to be registered every 4 months or as stipulated in the license conditions (e.g. for seasonal abstractions which take place in short time periods). The metered volumes need to be declared to the competent authority on an annual basis.

The control of permits and abstractions occurs both through the definition of conditions that allow simple monitoring (for example no irrigation of certain crops during certain periods or whole day) and by on-site inspections of pump capacity and meters.¹⁷⁰ "Water quantity" authorities have the right to impose (high) fines in case of illegal abstraction and the abstraction source is closed.

Van Dijk et al (2009) notes that the cost of water is no significant part of the total production costs for most farmers. Certain specific high value and capital intensive crops require timely irrigation for crop yields and quality (bulbs, specific vegetables or orchard products). Water of sufficient quality (low chloride contents) is crucial for some high value crops in the region but can be scarce. Farm advice for irrigation and awareness programmes for the promotion of water saving technologies are a continuous challenge and well-developed in the study area and the Netherlands in general. These are often set up in combination with the farmer organisations (ZLTO or *Zuidelijke Land- en Tuinbouw Organisatie*) in the region of the Scheldt Basin). Some examples of running initiatives are Hightech "custom" irrigation for grass and maize (HTBOM, *Hightech Beregenen op maat*) and groundwater management in agriculture:

- Hightech "custom" irrigation for grass and maize¹⁷²: Advice module developed for ZLTO and integrated in the webapplication *mijnakker.nl*. The tool bases on Remote Sensing (RS) images to monitor crop growth and evaporation. The module (i.e. irrigation advice based on dehydration and water needs of plants) balances irrigation costs and short term weather forecasts to support farmer's decisions. The prototype of the module has been tested by 14 farmers with promising results for broader application. Application of the tool is currently expanded to a larger group of +/- 40 farmers.
- Groundwater management in agriculture, the project (AGB or agrarisch grondwaterbeheer) started off in the year 2000. The aim of the initiative is to increase the efficiency of groundwater use by the agricultural sector in Noord-Brabant. AGB proposes measures for a more economical use of groundwater and strives to (i) motivate farmers with efficient water use to continue their work and (ii) convince others to increase the efficiency by providing information and concrete measures based on latest research results. The province of Noord-Brabant compensates the provincial groundwater levy. Participants from cattle breeding sector finance the further development of the Hightech "custom" irrigation project (irrigation planner or advice) that should become available for all cattle farmers by 2012. Crop growers can either

¹⁷⁰ P.c. Victor Witter, Water Board Brabantse Delta.

¹⁷¹ http://wetten.overheid.nl/BWBR0026872/geldigheidsdatum_28-09-2011. Can be consulted through the pages on legislation at <http://www.helppdeskwater.nl>

¹⁷² <http://www.zlto.nl/nl/25222713-Thema%27s.html?path=11000193/11000198/10377286>

opt for the irrigation planner, online weather forecasts and reference values for evaporation, hygrometers (glass house horticulture) or information sessions on soil conditions, plant protection and irrigation.

5.3 Analysis of water pricing and water allocation policy

5.3.1 Drivers and Barriers

The perception can exist that freshwater “supply” for agriculture from surface water in the Netherlands is not charged. Regional Water Authorities organise this supply through water quantity management activities but usually have no formal task in freshwater supply.¹⁷³ Surface water is however priced by the water system levy (for unbuilt surfaces), reflecting amongst other costs for maintenance of water courses and water level management activities of the different Water Boards. Groundwater is not broadly available in the Scheldt RB and abstractions (in the province of Zeeland) for irrigation are free for quantities below 20,000 m³ per year. Van Dijk et al (2009)¹⁷⁴ argues that the provincial groundwater levy is not set to influence water use but from a cost recovery perspective.

De Vries et al (2009) describe that service levels provided to farmers by the respective Water Boards can differ significantly without being reflected in the price level. Farmers in Southwestern part of Brabant can benefit from fresh seepage water from the Brabantse Wal and only pay a limited water system levy to the WB Brabantse Delta while farmers on the Zeeuwse Eilanden pay a higher charge to the WB and have no access to freshwater of sufficient quality for irrigation (i.e. with low chloride contents). The current pricing system illustrates that there is no level playing field and pricing does not reflect the benefits for or service to farmers.¹⁶⁶

The Delta Commission advised to start a study to the determination of the real price for freshwater supply in the area (RBMP 2009-2015). The project should be finished before 2015 (cost recovery under WFD). The true cost of water supply to agriculture, in particular in light of the threat of salinisation and current “abatement” measures (for example flushing of surface water bodies with water from other water resources), is subject to strong debate (see text box below).¹⁷⁵ Water pricing could be further installed as an instrument to reflect differences in local conditions. It can therefore be argued that varying local conditions do not hinder pricing of water but are instead a necessary condition or driver for pricing. Price signals could help to steer decisions on land use and crop choices while today’s choices sometimes suggest an inverse situation, i.e. delivering (irrigation) water for crop choices that are not in line with the available water resources. Velstra et al. (2009) notes that from a cost-benefit perspective (society), it may be a preferred option to arrange private water supply in the Southwestern Delta area. This could still be arranged through Regional Water Authorities or by water supply companies. It is of note that “steered” water inlets would still be needed for water level management (protection of dikes and water quality objectives).

¹⁷³ P.c. Jan Auke van Werkum, Water Board ScheldeStromen.

¹⁷⁴ van Dijk, C.W., Ruijs, A. (2009). Economische sturingsinstrumenten voor de watervraag. Effectiviteit en Efficiency

¹⁷⁵ See for example newsletter on the salinisation discussion from the Dutch Ministry of Environment and Infrastructure (Rijkswaterstaat): Rijkswaterstaat, Zoet-zout. Nieuwsbrief over zoet-zout vraagstukken. Nummer 1, 2009.

Preventing salinisation of the lake Volkerak-Zoom: discussion of hidden costs

The lake Volkerak-Zoom has two main functions, being freshwater supply to agriculture and navigation. Shipping is not hindered by saltwater so the main beneficiary of the State's service to keep the freshwater status of the lake is agriculture. When annual costs for the sluices (salt barrier) would be charged to farmers based upon their consumed volume from the lake Volkerak-Zoom, one m³ would be priced at 1.50 € and costs would as such be higher than average costs for supplying drinking water. Moreover, the volumes that are effectively used for agriculture are marginal compared to the total water balance of the lake (less than 5%), so there's no optimal use of the lake as a freshwater resource. In the current setting, researchers even come to the quite controversial statement that it is not useful for farmers to save water as "activities of flushing" are then even less efficient as the quantity of water used in agriculture (objective of flushing) is even relatively lower than the total inlet of water...

Source: De Vries et al. (2009) and newsletter Rijkswaterstaat: Zoet-zout. Nieuwsbrief over zoet-zout vraagstukken. Nummer 1, 2009

Water prices can vary significantly between farmers. Many farmers benefit from indirect exemptions from groundwater charging (minimum threshold values) and only pay the area-based charge for surface water. Prices for water in the agricultural sector (where self-supply predominates) are therefore still a lot lower than water supply in other sectors. Currently, the average price for drinking water in the Netherlands varies between 1 and 2 €/m³, excluding the costs for piping, which are mostly billed as a fixed fee in addition to the m³ price for the water used (Jantzen, 2008). The range is explained by large differences between costs for drinking water. In some parts, very old pumping stations are used to pump groundwater – where capital investment costs have been recovered in the past, contrasting to for example with Rotterdam, where water from the Meuse is taken and purified using expensive purification processes (Matthei et al, 2009). Companies (including farmers for drinking water supply e.g. for watering the cattle) pay prices for water supply ranging from 0.8 to 1,64 € per m³.¹⁷⁶

The RBMP (2009-2015) illustrates a nearly 100% (financial) cost recovery for water services in the Netherlands. The allocation to sectors and cost recovery in sectors requires assumptions, though van der Veeren et al. (2005) states that there are no significant cross subsidies between sectors. The RBMP does however not provide information on the total costs that should be allocated to agriculture nor prices paid by the sector. The RBMP underlines the importance of self-supply in the agricultural sector (both user and supplier of the water service) and mentions own costs directly paid by the sector for various defined water services¹⁷⁷:

- Production and distribution of water: 35 million € (irrigation)
- Waste water treatment: 6 million € (agriculture) Environmental and resource costs are not separately covered by the plan.

¹⁷⁶ Figures are based on calculations for different reference companies with different annual water use. See study Arcadis (2008). Vergelijking van de kostprijs van waterlevering en afvalwaterzuivering voor de gebruikers in verschillende Europese landen. Study executed for the Flemish Environment Agency.

¹⁷⁷ Figures are presented for the national situation. Further allocation to river basins would necessitate multiple assumptions and are illustrated in annex to the Dutch report on cost recovery (van der Veeren et al., 2005)

- Regional watersystem management: costs made by Regional Water Authorities for quantitative regional water system management is paid for by users of the water service by means of levies. Households pay a fixed levy depending on the value of the houses, industry pays a levy depending on the value of the real estate, agriculture pays a levy depending on the value of the agricultural land, and also nature organisations pay a levy depending on the value of the natural land. Costs and revenues for regional water system management by Regional Water Boards were approximately €512 million in the year 2000. On top of that, agriculture also incurs costs for self-services in terms of drainage (€25 mln.) and water storage (€12 mln.). Total (financial) cost recovery is approximately 100%.

RBMP 2009-2015 does not further discuss environmental and resource costs but these are considered in the water price.¹⁷⁸ Due to the private operation of the agricultural pipeline supplying water to fruit farmers in Zuid-Beveland (by Evides, see section 5.1.5) cost recovery should be near 100%. The investment costs have been supported by the government. As Evides needs to shift to the water resources of the Biesbosch instead of the lake Volkerak-Zoom (blue algae problem), de Vries et al. (2009) note that the charged price of 0.50 € per m³ is apparently not sufficient to cover operating and maintenance costs. Evides tends to claim compensation when chloride concentrations in the lake Volkerak-Zoom reach high levels.

Water management activities and the current water pricing and allocation have been long installed. There is a rather stable system (both in terms of physical layout as well as management). The combination of surface water transport by canals and sprinklers for field appliance gives rather good flexibility for farmers. Velstra et al. (2009) identifies an implicit weakness of the current allocation system where the State or Regional Water Authorities have the obligation (i) to (artificially) provide freshwater (chloride content below norms) in certain locations and (ii) for (too) long periods.

5.3.2 Effects of the water pricing policy

5.3.2.1 Direct Effects

In general, there is a lack of information about the quantities used for irrigation or evolution of water demand in agriculture and irrigation.¹⁷⁹ Water pricing and allocation is currently not designed to promote sustainable water use or steer farmer's decisions (e.g. crop choices) (see for example van Dijk et al. (2009)). Farmers rather (will) have to adapt to the (gradually) lowering availability of freshwater in the area, which is (only partly) reflected in water policy: more stringent rules on water abstractions (e.g. in the province of Zeeland),

The Netherlands have historically not been confronted with lack of water resources but primarily fought against abundance of water. Certain areas are confronted with lack of water of sufficient quality which is usually dealt with by flushing surface water bodies with (large) water volumes from external sources. When there's sufficient availability of freshwater in external systems, no problems arise, but there's a trend where the activity is more difficult in dry periods. This system of flushing does not stimulate water savings at the

¹⁷⁸ These costs are estimated and recovered based on measures currently installed to prevent and mitigate negative environmental effects. P.c. Rob van der Veeren. For further reading, see van der Veeren et al. (2005)

¹⁷⁹ P.c. Jan Auke van Werkum, Water Board Scheldestromen

individual farm level as sufficient water is available and the real price is difficult to charge to individual users (and thus farmers in particular as they are the main beneficiaries of this activity).

For surface water, it has been indicated that farmers pay a flat rate (water system levy) for access to water and water quantity management. This charge does not include incentives for water savings at the farm level. Future developments (climate change) are expected to result in higher costs for Water Boards (flood protection, water availability) and thus a potential increase in the water system levy. One option currently considered in the Netherlands¹⁸⁰ is to increase the levy and earmark a part of the revenues to compensate farmers investing in water savings and innovations (through capital support or green and blue services).

More than policy decisions on water pricing, the process of salinisation *an sich* has an effect on farmer's (irrigation) decisions. Arnold et al. (2011) notes that damage caused by salinisation only accounts for one percent of the overall drought-related damage. This is due to heavy flushing and to the fact that farmers and horticulturalists opt for drought-related damage rather than salt damage. A substantial part of the losses caused by water shortages are the indirect result of choosing to prevent moisture damage. By opting for deep drainage, farmers and horticulturalists implicitly accept that they will sometimes lose crops due to water shortages.

The Scheldt RB (and the west of the Netherlands by extension) is the object of several research initiatives and (pilot) tests for adaptation of agricultural practices to increased salinisation. Numerous initiatives are launched and the knowledge base on future (fresh-)water demand and availability and possible strategies are expanded. Potential strategies focus on short term abatement (flushing of water bodies, salt barriers, ...) and long(er) term adaptation (farm level and sector: crop choices, moving production, self-sufficiency, water savings, ...) and combinations thereof.

5.3.2.2 Indirect Effects – demand responses of users to water prices

Van Dijk et al (2009) notes that the cost of water is no significant part of the total production costs for farmers. Limited price changes will not result in significant changes in behaviour nor income. Lack of water resources and shortages will lead to lower production. The agricultural sector risks drought related every year. Crop yields can be down by 10 percent in an average dry year. However, this does not necessarily equate to economic damage as prices can be higher depending on climatic conditions (Arnold et al, 2011).

For capital intensive (often water intensive and dependent) crops (bulb farming, fruit farming, orchards), individual farmers tend to opt for – expensive - tailored solutions (water supply with trucks, individual rainwater reservoirs, water conservation at the farm level) as drought related damage can have more significant impacts on their income. Other farmers move away to more salt tolerant crops or even move production to other regions in the Netherlands.

¹⁸⁰ P.c. Rob van der Veeren

The policy decision to keep the freshwater status of the Lake Volkerak-Zoom has direct benefits for farmers. Rijk (2010) calculates that a saline lake Volkerak-Zoom would lead to a decrease in gross revenue of +/- 13% for the region of Tholen if no alternative freshwater supply is considered, because of the loss of potential for irrigation and water level management (moisture in root zone of plants). When considering alternative options for freshwater supply for these areas (for example the inflow from another freshwater resource through the Roode Vaart), multiple options for agriculture prevail and this could controversially even lead to a more water intensive agriculture in the region.

The simplest solution for farmers facing insufficient availability of freshwater is to choose for crops that are not depending on irrigation, though these crops often give lower return for farmers. Velstra et al. (2009) describe that farmers need to balance costs and benefits related to drought versus salt. One option that is considered and starts to become implemented is the shift away from crops that are not tolerant for salt. Some traditional crops allow brackish water with chloride contents between 200 and 1000 mg/l, meaning that damage caused by salt is then lower than damage due to water shortage. Irrigation with water with higher chloride concentrations however needs additional measures, e.g. more water needs to be applied per ha in order to flush the salt that is piling in the plant's root zone as a consequence of the evaporation process. Irrigation with salt water also requires more frequent and precise on-field application like drip irrigation or low sprinkler systems. Drip irrigation can provide additional benefits for farmers in terms of higher yields and a more uniform product (e.g. more optimal size of potatoes). It might also be needed to apply more nutrients and soil approval techniques. This alternative of irrigation with brackish water leads to high costs making it only possible for crops with higher returns (for example potatoes).

The blue algae problem during summer period in the lake Volkerak-Zoom illustrates the pressure from agriculture and water management policy on water bodies. It is anticipated that the only solution to tackle this environmental problem might be to move away from the freshwater status of the lake (return to natural status). The current policy of "guaranteeing" freshwater in several (smaller) regions in the Scheldt RB (Southwestern delta area by extension) can no longer be maintained from the lake Volkerak-Zoom. Many parties need to be involved in this (State) decision. The National water plan announced a study to real pricing of water (true cost) which most likely should also cover the main causes and responsibilities for the blue algae problem.¹⁸¹ Many research initiatives are initiated to evaluate policy options for alternative water supply in the region and adaptation for agriculture. De Vries et al. (2009) argues that differentiated (geographically and in time) measures will be required considering the diverse landscape of today's agriculture.

¹⁸¹ See for example newsletter on the salinisation discussion from the Dutch Ministry of Environment and Infrastructure (Rijkswaterstaat): Rijkswaterstaat, Zoet-zout. Nieuwsbrief over zoet-zout vraagstukken. Nummer 1, 2009.

5.4 Conclusions

The Netherlands have always been confronted with abundance of water resources. Moreover, large (and small-scale) damming projects created opportunities for agriculture and other human activities in areas like Zeeland and other regions in the West of the country.¹⁸² Natural hydrological processes however impose limits on uses as several areas are facing the threat of salinisation. This is particularly relevant for the Scheldt RB where (riverine) freshwater inflow is also non existing.

The agricultural landscape in the Scheldt RB does not fully reflect this situation of absence of freshwater resources. Water shortages have not been considered as a serious threat in the Netherlands, and to some extent, water availability is guaranteed by water authorities. One weakness of the current allocation system could as such be described as the obligation of the State or Regional Water Authorities (i) to (artificially) provide freshwater (chloride content below norms) in certain locations and (ii) for (too) long periods.

This has created an artificial situation where irrigated agriculture (horticulture, fruit farming or bulbs) is possible in certain areas where freshwater is not sufficiently available. The debate on the freshwater status of the lake Volkerak-Zoom clearly demonstrates that certain (crop and location) choices allowed under current policy are not sustainable in the long term. It is of note that these crop choices are of course also inspired by climatological characteristics (close to the sea) and soil conditions. These capital intensive crops (high production value) can apparently justify customised - more expensive - options for water supply, e.g. private supply, tank transport, on-farm storage,

Due to local conditions (proximity of cities, primary activities of Regional Water Authorities), prices for water (water systems levy) in agriculture appear to be independent of the service levels provided to farmers by the respective Regional Water Authorities. Current policy discussions on water supply / availability also include the fundamental decision whether water supply should remain a public responsibility, e.g. when considering the social cost-benefit perspective. This discussion is particularly relevant in the said areas where irrigated agriculture depends on access to freshwater guaranteed by regional water authorities. Many research initiatives are broadening the knowledge on the way forward, but it can be assumed that future strategies will include measures for both resistance (flushing of water bodies, possibly more differentiated in space and time) and adaption (self-sufficiency and storage, water savings, private supply and related pricing, ...).

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¹⁸² This equally applies to regions in the North of the country like Friesland or Groningen. These regions are however not situated in the Scheldt River Basin.

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6 ROMANIA - Buzau Ialomita

The key questions for this case study have been addressed by analysing different official and non-official information sources as well as input from key country experts. Literature sources include the Romanian National Rural Development Programme, selected articles regarding irrigation systems and water management (World Bank, ICPDR, University of Agricultural Sciences, Bucharest, CELICIA FP6 documents). Additionally, information was gathered from an expert at the Bucharest Water Administration through a questionnaire and through interviews.

6.1 Characteristics of the case study area

6.1.1 Broad introduction on the area and characteristics of agriculture

6.1.1.1 National level

Romania is located in the south-eastern part of Central Europe and its land mass is almost entirely (97.4%) within the Danube River Basin. In Romania the Danube River covers 237,391 km² and nearly 22 million inhabitants. Romania covers almost a third of the Danube river basin surface area and over a third of the river's length flows within Romanian territory. The RB is subdivided into 11 sub-districts managed by the National Administration of Romanian Waters.

The territory is divided into three main regions: hills/plateaus (36%), plains (33%) and mountains (31%) (ICPDR, 2006). The climate is mild, temperate-continental, with most precipitation falling in the summer. Mean annual temperatures are 8-11° in the agricultural areas and -2° on the mountain summits. The mean annual precipitation is between 400-800 mm in the main agriculture area, but up to over 1200 mm in the mountain areas. Precipitation is unevenly distributed across the territory, with the eastern part of the country receiving less than 400 mm annually compared to 700mm in the west (ibid). Droughts are not uncommon, with a severe drought occurrence every 15-25 years. Precipitation also varies according to season: in the winter due to the cold and at the end of the summer and the autumn periods due to lack of precipitation. During dry periods in the warm season, precipitation might be absent for 50-100 days, and due to this persistence of the drought the some rivers become completely dry. In the rainy years precipitation can exceed 1000 mm in some regions of plain and hilly areas, while in the mountain areas values of more than 2400 mm per year might be found. On the other hand, in the dry years the annual quantities of precipitation may reduce up to 200 mm in the southern and eastern zones of Romania and 400-600 mm in the southeastern areas of Romania, where the case study is located.

Romania is considered both a poor and rich in water resources; there is a significant different between theoretical and usable water resources. The long-term annual average of available freshwater amounts to a theoretical potential of 6380 m³/person, which is much higher than the European average. On the other hand, the actual usable resources is around 1770 to 2660 m³/person, Specific mean flow is under 1

l/s.sq.km on the Romanian, Dobrogea, Timis and Arad Plains and 40 l/s.sq.km in the high zones of the Fagaras and Retezat mountains (ibid). Nevertheless, Romania does not have any water scarcity problems, as supply is principally secured by large reservoirs maintaining considerable volumes of water for supply.

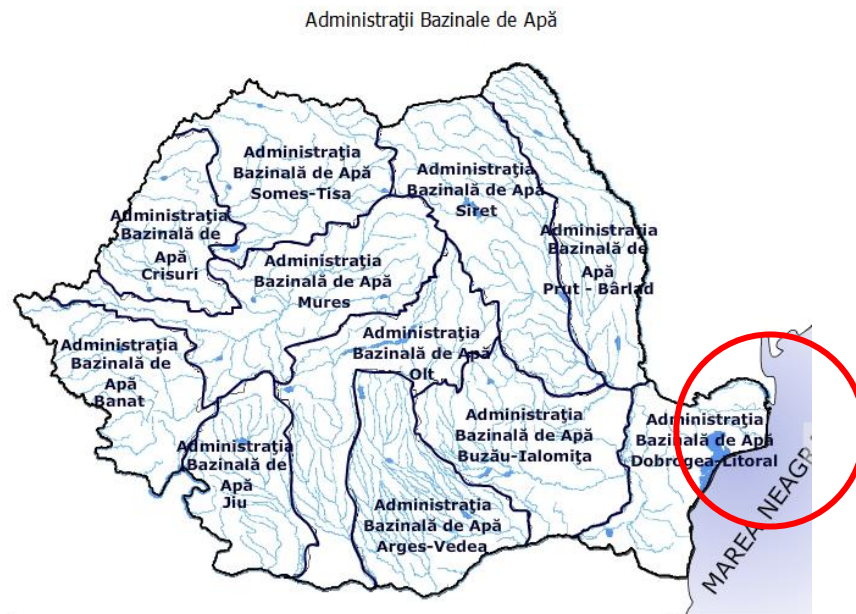
Land use is predominantly agriculture: 72% (14,857,800 ha) is agricultural, 27% forest, 3.7% waters and 6.9% other uses (2000 data, ICPDR). Over 80% of agriculture is located in the plains. Arable land accounts for 63.2% of agriculture lands, followed by 23.3% pastures, 10.14% hayfields and 3.5% vineyards/orchards. The main crops grown on arable land are cereals (69%), such as wheat and maize, and oilseeds (14.4%). The contribution of agriculture towards the national GDP is high compared to the EU average accounting for 12.1% GDP and 13.6% GVA (NRDP, 2007, p.10). Around 32% of the population is employed in agriculture and forestry (2005 data, ibid, p.14). Based on historical data, these numbers point to a decline in the agriculture sector's contribution to the national economy. Before 1991, agriculture's contribution to total GVA was around 20%. Significant fluctuations can be attributed to spring floods and summer droughts: In 2007, harvested wheat reached only 55% of the 2006 production, while corn and sunflower barely reached one third (GAIN Report RO7006, 2007 in ibid, p.21).

Almost all agricultural land has been privatised since the restitution and redistribution of land that took place after 1991. Farm size is very small; the average Romanian farm is 3.37 ha with an average of 1 ha per parcel (Ibid, p.17). 80% of all holdings comprise farm with sizes below 5 ha. As such, agricultural output/performance is poor due to low yields, low growth and global competition (ibid). The average yield for wheat for the period from 2000-2005 was only 2,508 kg/ha and for maize it was 3,150 kg/ha. These yields are far below average and only reflect around 40% of their agronomic potential (ibid). Similarly, vineyards only see about 30 hl wine/ha, compared to the EU average of 50 hl win/ha. From 1991-2000, the productivity of the main crops show strong fluctuation due to the high frequency of droughts, lack of modern agricultural equipment, high fragmentation of land property, prevalence of small farms, irrigation projects failing, land degradation increase and dramatic drop in fertiliser use (ICPA, 2000).

6.1.1.2 Buzău-Ialomita River basin Administration

The Buzău – Ialomita Water District is located in the south-eastern corner of Romania.

Diagram40 River Basin Districts in Romania



It covers a surface of 23 874 km² and includes the Buzău and Ialomița hydrographical river basins and the inter-rivers areas Ialomița - Buzău and Danube – Argeș – Ialomița. The Buzău river is 308 km in length and Ialomița river is 400 km. Total surface water resources amount to 731.53 million m³ and groundwater resources amount to 1.025 million m³. The population from Buzău river basin is around 363,947 inhabitants and in Ialomița river basin around 1,423,304 inhabitants (2005). In Buzău and Ialomița, 65.5% and 59.8% of the population is connected to the centralised water supply, respectively.

The River Basin Administration is characterised by a temperate-continental climate with three distinct climate zones: mountain, hill and plain. The average annual temperature is 11.8°C and the average multi-annual precipitations are between 1000 and 1400 mm in the mountainous part, 600 – 800 mm in the hill area and 300 – 550 in the plain area (CELICIA, 2008).

Most of the territory is occupied by arable land (73 %), followed by forests and shrub (20%), urban and industrial areas (6%) and water (1%) (TWINbasin, 2005). The main economic activities are industry and agriculture. The agriculture sector in the District mainly focuses on arable production with over 1,600,000 ha arable land producing cereal, technical plants, grape-vine, and fruit trees (ibid).

6.1.2 Water resources and aquatic ecosystems

6.1.2.1 National level

Romania's water resources are relatively poor and unequally distributed throughout the territory and comprise of the Danube river (44%), other inland rivers (46%) and groundwater (10%). Total water resources

of inland rivers and lakes are estimated at about 40 billion m³/year with an average multi-annual flow of 1,300 m³/s (UNEP, 1999, p.17). Only 12% of potential water resources can be used in the natural flow regime, so many reservoirs have been developed for water volume redistribution.

Most of the reservoirs serving water use today were built in the 1960s. Romania has a considerable history with the construction of dams and reservoirs to supply water. The oldest reservoirs dates back to as early as 1780, but it wasn't until 1960 that construction increased significantly; between 1980 and 1990 78 reservoirs were built. However, between 1991 and 2000 only 17 dams were constructed (Rădoane and Rădoane, 2002). The great numbers of reservoirs in Romania help to protect its water supply due drought events, and the country subsequently experiences little or no water scarcity problems.

Around 7.8 billion m³ is abstracted for human use (2005 data, ICPDR, 2006), of which the main users are industry (56.4%), agriculture (26.3%) and domestic supply (17.3%). The drinking water supply mainly comes from surface waters. The agriculture water use includes aquaculture, which represents about 40% of water used in the sector.

Table 22 Water demand evolution in Romania (billion cubic meters)

	1980	1990	1995	2000	2001	2002	2003	2004	2005
Industry	9.81	9.06	8.02	6.64	6.04	6.17	5.64	4.62	4.4
Agriculture	6.79	9.1	5.98	3.03	1.74	1.75	1.86	1.98	2.05
Domestic	2.2	2.25	2.0	2.07	2.0	1.86	1.69	1.42	1.35
Total	18.8	20.4	16	11.74	9.78	9.78	9.19	8.02	7.8

Source: Romanian Ministry of Environment and Sustainable Development (n.d.) Water Management. The Basis of the Romanian sustainable Development. Present Stage and Perspectives.

From the 7.8 billion m³ abstracted each year for all uses in Romania, irrigation, therefore, represents a very small amount: about 11%.

Table 23 Water abstracted for irrigation (million m³)

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Irrigation Abstraction	686	892	903	407	114	440	896	581	731

6.1.2.2 Buzău-Ialomita River Basin Administration

The river water resources are estimated at 2,272 km³/year with seasonal variations. Hydrological resources vary from year to year depending on the occurrence of droughts in the area. For example, the Ialomita River the multi-annual average flow is 1.388 km³/year (44 m³/s) but during a serious drought in 1990, the flow was reduced to 0.704 km³/year (22.3m³/s). This situation is similar to Buzău River (CELICIA, 2008).

In terms of water availability in the Buzău River catchment, there are 482 inhabitants for 1 million m³ water (CELICIA, 2008). The main water vulnerability issue in this catchment is water resources management as opposed to any particular water scarcity problems. However, in the Ialomita catchment area, there are 1273 inhabitants for 1 million m³ water. As such, the Ialomita catchment is categorised as an area characterised by slight water scarcity (ibid). The specific demand for drinking water per total inhabitants during 2002-2006 was around 28.2 m³/year/inhabitant. This low demand of drinking water is explained by the fact that only 1 584 596 inhabitants (of which 451 600 in the rural region) are connected to the water supply central systems. For this sector, the specific demand of water was 44.66 m³/year/inhabitant.

There are 16 groundwater bodies in the District, of which 3 are at risk of failing to achieve good status in accordance to the Water Framework Directive, but this is mainly due to quality issues as opposed to quantity issues (Apele Romania, 2005).

The main water users in the Water District are industry and irrigation. As the following Table depicts, agriculture water use is dominant in the Buzău catchment, whereas industry is the main user in the Ialomița catchment.

Table 24 The Evolution of water requirements (mil m³/year)

	2001	2002	2003	2004	2005
Buzău River Basin					
Domestic	0	0	0	0	0
Industry	.011	.011	.015	.004	-
Irrigation	.10	.10	.10	.10	.10
Aquaculture	1.65	1.65	1.2	.4	-
Total	1.76	1.76	.131	.5	.10
Ialomița River Basin					
	2001	2002	2003	2004	2005
Domestic	54.31	47.88	45.64	35.51	28.83
Industry	110.28	97.25	93.47	64.75	54.01
Irrigation	2.46	2.46	10.85	4.42	1.79
Aquaculture	32.15	32.15	24.72	30.97	-
Total	199.2	179.74	174.68	134.65	84.63

Source: Celia, 2009

Forecasts¹⁸³ of water requirements in the Water District point to an increasing trend in water use across all sectors but especially in the agriculture sector due to climate change. Modelling of water use in the face of decreasing precipitation and increasing droughts due to climate change are based on the following trends:

- Evolution of gross domestic product and gross added value obtained as a result of water use in industry;
- Objectives of the Operational Programme "Environment" the Romanian Government which provides the objectives to be achieved in water supply to the population in the regional system;
- Data from the National Administration for Land Arrangements which provides for aquaculture, the evolution of water requirements having as a water source the Buzău and Ialomița rivers has been drawn from the study mentioned above.

¹⁸³ The CECILIA FP6 project (2006-2009) assessed the impact of climate change at the regional to local scale for the territory of central and eastern Europe, with emphasis on using very high climate resolution

Table 25 The forecast of the water requirements evolution (mil m³/year)

	2010	2015	2020
Buzău River Basin			
Domestic	0	0	0
Industry	.020	.020	.025
Irrigation-8628 ha	1.5	16.40	32.80
Aquaculture	2.0	9.0	14.0
Total	18.41	25.42	46.83
Ialomita River Basin			
	2010	2015	2020
Domestic	51.0	59.0	68.0
Industry	92.0	115.0	146.0
Irrigation-25344 ha	6.0	12.0	65.0
Aquaculture	32.0	34.0	34.0
Total	181.0	220	313

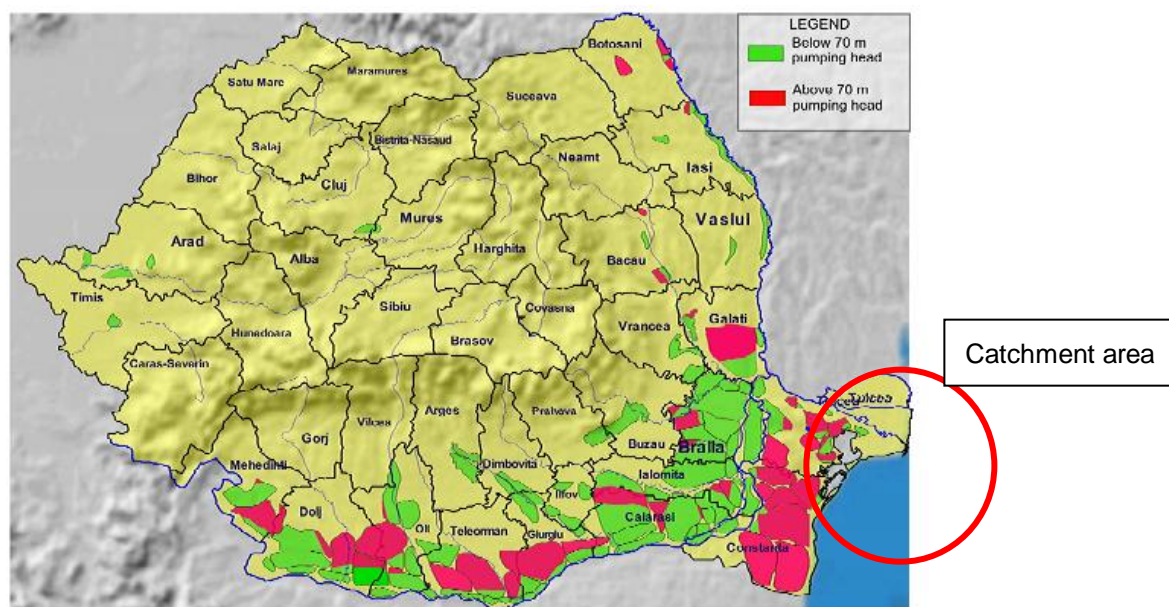
Source: CELICIA, 2009b, p.7

6.1.3 Water use for agricultural demand/supply

6.1.3.1 Role of water use in agriculture

The agriculture sector has traditionally played a significant role in the Romanian national economy. The total agricultural area in Romania is 14.8 Mha, of which 9.8 Mha are arable. Prior to transition, the agriculture sector was organised into large, collective farms. These large farms (8000-1200 ha) allowed for the construction of large-scale irrigation systems. The irrigation systems in Romania were mainly built between 1970 and 1989 to combat the dry areas in the Romanian Plain, Dobrudja and the Moldavian Plateau, located mainly in the southern and south-eastern part of the country.

Diagram41 Area equipped for irrigation. Source : World Bank, 2007



By 1989 3.1 million ha were equipped for irrigation. After the restitution, most of the farm land was returned to private owners, resulting in a highly fragmented agriculture sector characterised by very small farms (average around 3.5 ha) and low productivity. The large scale irrigation works built in the 1970's and 1980's are for the most part not suitable for the around 80% subsistence farmers. Moreover, investments in irrigation have been largely absent since 1990 with state budgets for land reclamation decreasing over time. As a result, much of the former irrigation infrastructure has fallen into disrepair; only around 1.5 million ha have a function irrigation system in place (NALR). However, most of the remaining irrigation systems are not in use.

Table 26 Evolution of Agriculture irrigation area

	1992	1996	2003	2005	2006	2007	2008	2009	2010
Area equipped for irrigation	3.2 million	3.2 million	3.2 million	3.2 million	3.2 million	3.2 million	3.2 million	3.2 million	3.2 million
Actually irrigated area	450,000	249,000	569,067	45,718	96,223	323,844	208,218	294,138	74,503

Source: Öko Inc, 2001, p.8-9; Apele Romane Bucharest

The irrigated area has fluctuated significantly in recent years due to meteorological, hydrological, social and economic factors. The significant decrease in irrigation land in 2005 and 2006 compared to 2003 levels was due to major flood events. In 2008 the decrease from the previous year can be attributed to technical and economic constraints. The most recent dramatic decrease in irrigation area is the result of the abolishment of the subsidy for electricity costs to pump water to agriculture plots; Water Users Association (AUAI) estimate that electricity makes up 80% of water use costs for irrigation (Banila, The Diplomat, vol 7 (3) April 2011).

6.1.3.2 Irrigation systems

10 to 15 % of irrigation systems are surface irrigation, with the remainder using sprinkler systems; a small amount is also irrigation through flooding (rice plantations). Water abstracted for irrigation comes from reservoirs fed by the Danube River and inland rivers also from the Danube itself; no ground water is permitted to be used for irrigation purposes. Similar systems are found in the Buza-lalomita river basin. The main irrigated crops are: grain maize, winter wheat, soybean, sunflower, successive fodder crops, sugar beet, potatoes, bean, grapes and fruit-trees. Yields obtained in experimental fields from irrigated row crops and fodder crops indicate that irrigated wheat yields are 50-60 percent higher as compared with those of the rain-fed wheat. In absolute values, yields of grain maize are 5-6 tons/ha non-irrigated, against 10-12 tons/ha irrigated, of soybean 1.3 tons/ha against 3.3 tons/ha, and of alfalfa (green mass) 20-25 tons/ha against 50-60 tons/ha (ICPA, 2001). Agricultural water demand per irrigated area amounts to 540 m³/ha for field crops; 14,022 m³/ha for vegetables and 22,900 m³/ha for rice.

Currently, 75 percent of the total irrigated area in Romania and the largest part of such area is located on terraces along the Danube River course. In some cases, irrigation schemes are located over an elevation of 150 m above the water level in source. Thus, electric power consumption for water lifting is high, making irrigation very costly. In the Buzău-lalomita River Basin, irrigated agriculture lands are largely below 70m, as shown in Diagram 2 above; however, there are also considerable areas where the fields are located above 70m.

As with the rest of Romania, in the Buzău-lalomita, the irrigation systems are characterised by three terraces. Water is delivered to the first terrace through a gravity supply canal after a primary pump station lifts water from the Danube (or a tributary) and a main pump station again lifts the water to the terrace. Pressure pump stations (SPPs) and buried pipelines supply water for overhead field sprinkler systems that deliver the irrigation water to crops. Higher terraces are supplied by successive second and third lift pump stations on the main supply canals. The overall static lift to the highest terraces can reach over 200 m. The World Bank supported study on Irrigation and Drainage (1992-94) suggests that irrigation is not economical in the higher terraces even if agriculture is re-developed and that it should be discontinued so as to avoid further wastage of resources.” (World Bank, 2007)

The main characteristics of irrigation schemes in Romania are as follows (Ibid, p.42):

- Average density of underground pipes network: 18.5 m/ha;
- Water pumping efficiency: 50-70 %
- Elevation of areas reclaimed for irrigation above the water source: frequently within 20 to 100 m and exceptionally over 150 m;
- Flow metres on the supply network: very few;
- Type of watering equipment used: mostly hand moved, and in fewer cases self-moved mechanised equipment that operates at average and high pressure (in the range of 2.5-4.5 atmospheres) and watering intensity in the range of 6 - 9 mm/hour.

Water is managed and supplied by either the National Administration for Land Improvement (NALI) or Water User Organisations (WUOs); there is no self-abstraction. Most of the irrigated land is under the control of the NALI (2.9 million), while some of the irrigation area has been transferred to WUOs. The main problems related to the NALI controlled irrigation infrastructure include (Maracine, et al, 2009, p.558-559:

- Old and decaying facilities
- Facilities are located on land with over 70m height from pumping wells (non-economic)
- Channels are leaky leading to considerable losses
- Pumping stations significant high electricity
- Lack of investment in rehabilitation of facilities.

The major problem surrounding the WUOs is a lack of interest in irrigated water (given the largely subsistence nature of farming), a lack of irrigation equipment, limited access to funds to modernise irrigation infrastructure as well as problems surrounding the administration of assets taken over by the WUOs from the government (Ibid). While there are some projects to modernise irrigation systems (e.g. 2004 World Bank Siret-Bărăgan facility covering 500.000 ha of Northern Bărăgan), others are hampered by project requirements. Measure 125 of the Romanian Rural Development Programme provides payments to modernise irrigation systems. However, none of the 29 projects submitted by the WUOs were approved as they were unable to fulfil eligibility criteria: WUOs had to already have a modernised upstream irrigation structure, a high index of dryness in the designated area, as well as show at least a 10% water savings (Banila, The Diplomat, vol 7 (3) April 2011).

6.1.3.3 Pressures from irrigation agriculture

As only an average of 11% of total surface water resources are abstracted for irrigation, there are no significant pressures from irrigation in Romania. As mentioned above, no groundwater is used for irrigation purposes, and neither are any groundwater bodies in Romania at risk of failing to meet good status due to quantitative issues. There are no water imbalances (i.e. reduced river flow below minimum levels). Irrigation water use does not affect other economic sectors. There is no water deficit from the supply point of view; the available water resources exceed the demand as the 2020 trend water demand study shows. The great majority of water resources for irrigation are concentrated in reservoirs with multiple purposes, for which the minimum ecological flow is assured.

6.2 Current water policies and practices influencing water use in Agriculture

6.2.1 Water allocation policy in the agricultural sector

Water allocation is managed by the National Administration ‘Apele Romane’ and its regional branches. The National Administration “Apele Romane” (RWNA), initially formed in 1991, applies the national strategy and policy regarding qualitative and quantitative water management of water resources. RWNA controls the compliance of water management regulations and acts for protection of water resources against deterioration, for a sustainable use of water resources, and for administration and exploitation of the National Water Management infrastructure. It is the sole entity in charge of allocating water sources to water users based on standing order contracts. Surface and groundwater policy are part of the same economic and financial mechanism. As groundwater is not permitted for irrigation, there is no system of groundwater rights for this use.

The Apele Romane is governed by the 1996 Romanian Water Law (Act 107), which established the need for public permits for water abstraction. As such, water allocation is controlled through water management permits, which set quantitative limits to water use. Under the Water Law, water management permits and water management licenses are mandatory for all water users, for work on or related to water, except for small household level works.

Under the National Strategy for drought mitigation, prevention and combating land degradation and desertification, each river basin district is required to have a Restriction Plan developed for how to administrate water use during drought periods. During such periods, a water hierarchy prioritises water uses among the sectors: the first priority is supplying the domestic sector, following by industry and agriculture. Additionally, the National Strategy describes a list of short, medium and long term measures for managing emergency hydrological drought situations. Restrictions plans are in place in each of the Water Districts; however, to date there have been no periods where irrigation was restricted. Currently, Romania is only using 40-50% of its water capacities in their reservoirs.

Surface water abstraction permits for irrigation are based on a total water balance calculated at river basin level. The water balance takes into account: precipitation rates, runoff, “minimum flow to ensure the life of aquatic ecosystems”¹⁸⁴ and evapotranspiration against the potential water demand. As all water use requires a permit, permit applications from all water-using sectors are calculated together to estimate the basin’s water demand. This is then balanced against the hydrological and climatic elements.

To apply for water abstraction, farmers are required to fill out a form stating the quantity and location of water abstraction. In the approval letter from the Apele Romane, farmers are informed of potential restrictions on water abstraction in times of drought; to date no restrictions have taken place as no drought events thus far

¹⁸⁴ The methodology to calculate minimum flow is currently under revision.

have significantly affected water supplies. A system of penalties is applied for deviation from the utilisation/exploitation norms in the following cases:

- for exceeding the authorised abstraction volume;
- for exceeding in the restriction period of abstracted volumes mentioned in restriction plan; and
- for exceeding the authorised maximum concentrations of the pollutants.

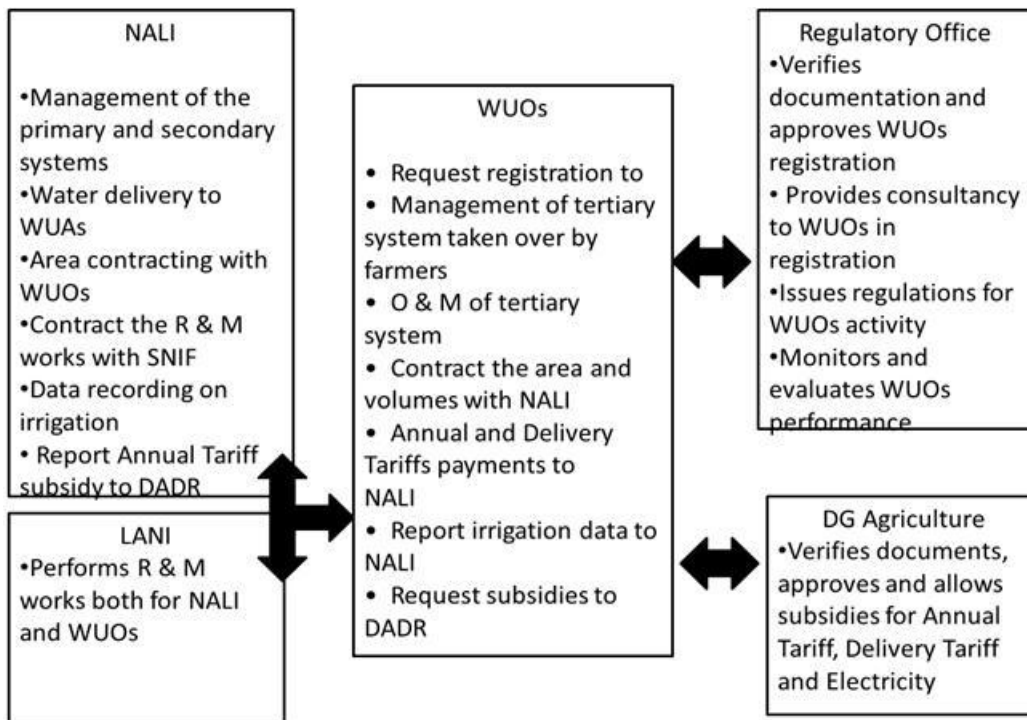
Penalties are also applied for unpaid bills.

The Water Law is complemented by the 1996 Land Reclamation Law (Act 84), which manages all specific agricultural activities, including irrigation. In addition, in 2008 the Land Improvement Act was amended (Law 167/2008) to include the following main provisions (Maracine, et al, 2009, p. 559):

- Irrigation is a commercial activity based on supply and demand
- Handling over the terminal irrigation infrastructure to WUOs
- Rehabilitation of irrigation infrastructure under NALI ownership is based on state-allocated resources
- WUOs are required to draw annual and multi-annual contracts for irrigation water delivery and pay a minimum 20% of the annual rate as contribute per hectare in advance for the delivery of the irrigation water
- State-budget subsidies of one part of the annual rate for the delivery of the irrigation water provided per unit area until 01.01.2010.

Both the NALI and the WUOs are responsible for operating and maintaining irrigation infrastructure. The legal framework for the transfer of state owned irrigation works to WUOs is set in 2001 Law 573. This law was amended in 2004 to address weak and unclear provisions on the establishment of WUOs and the handing over of the management of irrigation infrastructure from the NALI. The Diagram below describes the roles of different institutions within water allocation and maintenance of irrigation works.

Diagram42 The Institutional Framework for Irrigation



Source: Adapted from: World Bank, 2007, p.47

In 2007, 248 WUOs covering an area of 634,000 ha have been established in the country, with most of them in eastern part of the Romanian plain. Due to the high costs of pumping water, most of the WUOs are established on lower terraces (with 80 percent of WUOs' territories located below 70 m pumping head) where operations are relatively cost effective. According to the 2010 Final Report "Irrigation costs Payment capacity of Water Users Association" (OUAI) of the Ministry of Agriculture and Rural Development, from a total of 293 OUAI, which irrigated in 2009, only 129 OUAI will continue to irrigate, 114 needs to implement solutions for counteract the elimination of the subsidies, and 50 will cease to exist due to a lack of interest.

6.2.2 Water pricing policy in the agricultural sector

6.2.2.1 Current Framework

As mentioned above, water prices in Romania are set by the government. Previous to 2009, water pricing was based on the state budget for water management. The old system of tariffs for irrigation (at the level of 1994) used to transfer most of the costs and all risks to the state budget and provided no incentives for developing an economically viable irrigation sector.

Since the implementation of Article 9 in 2009, the water pricing policy in Romania is now based on the polluter pays principle and the user pays principle. While there are no specific provisions to incentivise users to use water resources efficiently, water abstraction allowances (or the amount of water allocated to each sector) are determined by assessing the overall water balance of national water resources. Specifically, this

means that each year the total water resources are evaluated against the amount of water to be abstracted. As Romania uses far less water than available, the water balance is maintained.

Water prices differ according to use, even within the agriculture sector itself, as shown in the table below. Water prices do not differ across river basins, although some basins have much higher costs than others due to water management infrastructure of the basin. As such, the uniform pricing involves redistribution of financial funds between basins.

Table 27 Water prices in the agriculture sector

Agriculture sub-sector	Surface water	Groundwater
Livestock	11.9 €/1000m ³	13.69€/1000m ³
aquaculture	0.12 €/1000m ³	2.62 €/1000m ³
Irrigation	0.71€/1000m ³	Not allowed

The economic instrument for irrigation is the "Water supply tariff for irrigation" (charged by NALR) and involves:

- "the contribution for using the water resource"¹⁸⁵ (NALR to Apele Romane), which includes water use and water discharge; and
- all necessary costs for abstraction, pumping, transport.

Diagram43 Total cost of Irrigation

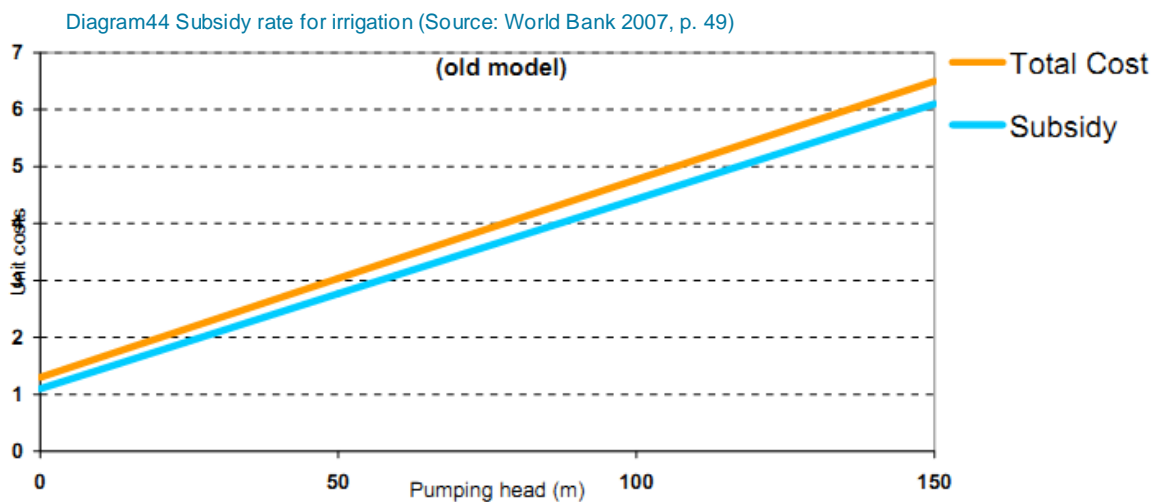
Contribution for water resource 0.71E/1000 cm ³	Irrigation tariff applied by NALR which includes operational and maintenance costs of irrigation infrastructure, energy costs for pumping
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With respect to the polluter pays principle, users pay or "contribute" for discharging waste water. The price/contribution is based on a set of parameters: General (chemical indicators; specific chemical indicators; toxically and very toxic chemical indicators; bacteriological indicators physical indicators) discharged into water resource (Kg). These parameters are monitored by the Apele Romane and applied for all users including agriculture (for example, for phosphorus the contribution is 44.3Euro/1000 kg). The money collected from the pollution tax is used to cover the budget for monitoring and enforcement.

¹⁸⁵ According to the Apele Romane, in Romania water pricing or the amount abstractors pays for using water is called "the contribution for using the water resource."

With respect to the user pays principle, agriculture water users are charged .71€/1000m³, i.e. their “contribution for using the water resource” for irrigation. Water is largely abstracted from reservoirs collecting water from the Danube and inland rivers. The water tariff is volumetric and metering is in place to monitor water use. An important component of the irrigation tariff is the electricity cost of pumping and transporting water from the reservoirs. Many of the farms using irrigation are located on terraces high above the water source. Depending on the height distance from the water source, the total cost of irrigation can fluctuate significantly. Taking into account the cost of electricity – the further one is from the source, the greater the electricity need - the total cost of irrigation can range from a minimum value of 2 €/1000 m³ (of which the water price is 35% of total cost) up to 247 €/m³ (of which water price is 0.28% of total cost). Therefore, the greater the height distance, the lesser the water price plays a role in the overall cost of irrigation.

Previous to 2010, the costs of pumping for irrigation was heavily subsidised. In the past, electricity was subsidised at a high rate and even increased in the last years to encourage irrigation. As you can see in the Diagram below, almost the entire cost of pumping water was covered by the subsidy.



From 2006-2008, electricity was subsidised at a rate of 26.7€/1000m³/water pumped. In 2009, this was increased to 105€/1000m³ water pumped. However, as the previous Table shows, the irrigated area only increased by 30% or around 86,000ha. As the irrigated area never surpassed 300,000 ha since 2004, it was decided to eliminate the electricity subsidy. As described in section 3.3.2, this has resulted in a significant decrease in the number of hectares irrigated in Romania of around 75%.

According to Apele Romane, cost recovery of the water management system is considered to be at 100% as the “contributions for using the water resource” (paid by the water resource users) cover the operational and maintenance costs of the water management infrastructure system (Dykes, dams, water intakes, river regulations), which belong to Apele Romane, as well as capital costs and environmental and resource costs. Here, operation and maintenance costs refer only to the general water supply infrastructure and do not cover individual irrigation systems – such costs are covered by the NALR or WUOs (see below). Moreover, capital

costs of irrigation infrastructure are not covered as a) there are no plans to expand the irrigation system and b) such costs would be the responsibility of the NALR or WUOs. Environmental costs are covered by the pollution tax, whereas Romania considers itself to have no resource costs – that is, there are no opportunity costs because all water users theoretically have no restricts as water scarcity is not an issue. However, at the moment only internal environmental costs are taken into account and not externalities; the water authority plans to develop a methodology to include externalities into account in the 2nd river basin cycle. Due to change in how water prices are set following the implementation of Article 9, water prices for irrigation in Romania actually decreased by about .20€/1000m³.

As mentioned in section 6.1.3.2, irrigation systems are managed by either the NALR or WUOs. The irrigation tariff is applied and collected by either the NALR or the water user organisation. Operation and maintenance costs of irrigation systems themselves set and management by either the NALR or WUOs. WUOs are able to set their own charges to cover operation and maintenance costs. To this end, WUOs can levy on-farm irrigation water supply charges, annual membership fee on the basis of the size of land owned or used and operation and maintenance charges. WUOs are required to sign long term service contracts so that NALR can properly plan its operations, in particular with sections of schemes to maintain operational functions. In exchange for an annual charge paid by the WUO, which covers the maintenance costs, the NALR maintains the main system under repair. Under the long term contract, the WUOs agree to pay two types of service charge: (i) the annual fixed charge based on the command area of the specified pressure pumping stations to cover the maintenance cost, and (ii) volumetric charges for the water consumed to cover NALR variable costs, principally electricity.

6.2.2.2 Water Pricing ratio of total production costs

According to estimation by Apele Romane¹⁸⁶, the total costs of irrigation in Romania, as well as Buza-lalomita River Basin, could amount to around 32% of crop production costs taking the following aspects into account:

- In 2009 the arable area was around 9,423,000 ha with a value of crop production of 35,735,477,000 lei (8,508,446,904 Euro),
- Irrigated area in 2009 was 294,138 ha (approx 3% from the total arable area)
- A rough estimation of crop production related to irrigated area is approx 263,000,000€

This calculation based on 2009 data shows that the total costs with irrigation was around 85,000,000€ or approximately 32% from the crop production costs.

¹⁸⁶ Please note that this figures are indicative and there is no official indicator related to it.

6.2.2.3 Factors influencing the impact/effectiveness of water pricing policies

The main factors influencing the impact or effectiveness of water pricing are as follows:

- **Abundant surface water resources.** While low precipitation and drought events require the additional of irrigated water, there are enough water resources in the Buzău-Ialomita River Basin due to the extensive reservoir system. This means that there is no water scarcity, even in time of droughts. As such, water resources are not limited and there is no competition between users within and between sectors.
- **The price of water compared to the total cost of irrigation is low.** As mentioned in section 4.2.1, the percentage of total irrigation costs range from less than 1% to around 30%. The price of water decreased by .20€/1000m³ since the implementation of Article 9 without any increase in water use. Therefore, water use in the irrigation sector is determined by other factors, such as the cost of electricity. Some literature points electricity costs accounting for 90% of the total irrigation costs (Banila, The Diplomat, vol 7 (3) April 2011).

At the moment, it appears that other EU policies linked to the environment do not significantly influence water allocation or pricing in Romania. Cohesion funds have not been used to secure irrigation infrastructure, nor has any rural development funding been used to modernise irrigation equipment or systems thus far.

6.3 Analysis of water pricing and water allocation policy

6.3.1 Drivers and Barriers

Water allocation and water pricing in Romania and the case study region follows the principle of maintaining a water balance. Romania's water situation, even with periods of droughts, is very good. This can be attributed the high number of large reservoirs that were constructed through the country in the 1970s. The total water use for all sectors does not come close to reaching the maximum water use possible. In Romania, 2010 water use figures amount to around 6.5 billion cubic meters; reservoir capacity is around 11 billion cubic meters. In the Buzău-Ialomita River basin, water resources are also abundant compared to use. While the Ialomita catchment does have slight water scarcity issues, they are not significant enough to required water use restrictions. Water allocation, therefore, does not need to follow a prioritisation among sectors. Water for irrigation purposes does not negatively impact water use for any of sector.

With respect to water use for irrigation, a main barrier in the current system is the lack of irrigation systems viable for use. Almost ½ of actual system is in disrepair and unusable. Moreover, the irrigation system is outdated and needs to be adapted to the new agriculture sector structure, i.e. smaller units for smaller farms. At the moment, water pricing is not negatively affecting the system per se, as there are major structural problems with supplying water for irrigation purposes. The cost of water is high, not because of the water price itself but rather the high electricity costs of pumping water.

6.3.2 Effects of the water pricing policy

6.3.2.1 Direct Effects

There direct effects of the water pricing policy in Romania, including the Buzău-Ialomita River Basin, are low. Due to the low percentage of water prices in the overall cost of irrigation, water pricing has had little effect on water use in Romania. Instead, other factors influence the decisions farmers take regarding irrigation such as electricity prices. Since the elimination of the electricity subsidy in 2010, irrigated areas have decreased by 75%. There are no specific number as to how much water has been saved as a result of the decrease in irrigated area; however, it can be assumed that significant water savings have resulted. One proxy to estimated water savings is to look at how much water was used per hectare per crop before and after the subsidy.

Table 28 Estimated of water use per crop with and without electricity subsidy

Crop	Irrigation norm with subsidies (m ³ /ha)	Irrigation norm without subsidies (m ³ /ha)	Percentage change
Wheat	1,000	250	-75%
Corn	2,000	1,500	-25%
Sunflower	1000	250	-75%
Rape	1,000	250	-75%
Wheat seed	1,000	1,000	0%
Corn seed	2,000	2,000	0%
Rice	12,000	12,000	0%
Soybeans	2,000	2,000	0%
Vegetables	3,000	2,500	-25%
Alfalfa (Lucerne)	2,000	2,000	0%

Source:

Personal

correspondence with Apele Romane

The table shows that for some crops there has been a significant drop in the amount of water used, especially for wheat. On the other hand, crops such as rice or culture seeds have had no changes; this is because the income resulting from rice and culture seeds still cover the cost of irrigation.

There have been no studies to date looking at the price elasticity of demand. The estimations of the share of irrigation water costs in the total irrigation or even total production costs mentioned above are very rough and should not be aggregated for the country. However, the estimations point to a very low price elasticity of demand, especially in areas where electricity use is high. Areas in Romania where the agriculture fields are located about 150 meters, the share of water price for total irrigation is less than 1%. However, in areas

below 70 meters, the share is around 30%. Here, the price elasticity is moderate although not significant enough to change farmer behavior. This result is also confirmed by the fact that although water prices decreased by .20€/1000m³ since 2009, there has been no increase in water use but rather a decrease.

In addition to a significant reduction in irrigation, another direct impact has been a shift in which crops are grown as well as complete abandonment of agriculture production in some areas. Since the subsidy has only recently been eliminated, concrete data regarding changes in crops or agriculture abandonment rates are unknown. However, based on the table above, farmers are more likely to move away from wheat, sunflower and rape production and more towards rice and culture seeds.

6.3.2.2 Indirect Effects

No studies exist regarding the indirect effects of water allocation and water pricing on farmer behaviour regarding water use. As such, it is not possible to make any statement regarding the effects of water pricing on water use or the effects of water pricing on farmer income.

Currently, irrigated agriculture does not represent a high percentage of overall agriculture production. However, farmer yields and their subsequent income levels are significantly lower compared to the rest of the EU. To recall, the average yield for wheat for the period from 2000-2005 was only 2,508 kg/ha and for maize it was 3,150 kg/ha. These yields are far below average and only reflect around 40% of their agronomic potential (NRDP, 2007). Similarly, vineyards only see about 30 hl wine/ha, compared to the EU average of 50 hl wine/ha. Lower yields compared to other EU farmers significantly impacts income. However, it is not possible to indicate whether the lower yields in Romania are just a result of a lack of irrigation; rather, it is a result of a combination of factors such as the lack of modern agricultural equipment, very small farm sizes and lack of fertiliser use.

6.4 Conclusions

Water resources in Romania are not hampered by significant water scarcity and droughts. Significant drought events have occurred in recent years and climate change projections point to more events in the future. However, water scarcity is not an issue in the country, even in the drier south-east where the Buzău-Ialomița River Basin is located. This is due to the significant amount of water stored in reservoirs throughout the country. As such, water allocation among sectors is not competitive and water use in one sector does not negatively impact water use in another sector. Total agriculture water use (including aquaculture and livestock) represents only 11% of total water use in Romania, indicating that this does not have a significant impact on water resources.

Water allocation is based on maintaining a water balance within the country's reservoirs. This means that abstraction permits for all sectors are analysed together to ensure sustainable water use. As only around 45% of the total water available is used on a yearly basis, it is clear that the water allocation policy in

Romania is achieving sustainable water use. Forecasts of water use towards 2020 show that even with a doubling of water use for irrigation, the Buzău river basin will continue to have excess water and the Ialomița river basin will only be marginally vulnerable (CELICIA, 2009, p. 6). As such, water savings does not play a significant role in irrigated agriculture.

The relatively recent elimination of the electricity subsidy has significantly impacted water use in the agriculture sector. Farmer behaviour is greatly affected by electricity prices and the lack of irrigation systems that are suitable for smaller farms. There have been no significant studies undertaken to determine whether farmers on smaller farms would be interested in irrigating if a more adequate/suitable irrigation system was in place. Only around ½ of the former irrigation system is usable due to a lack of maintenance and repairs in the past. However, it can be assumed that there is not a high unmet demand for irrigation, as highlighted by the only moderate increase in irrigation following the increase in electricity subsidies from 2006 to 2009. However, since the elimination of the electricity subsidy in 2010, irrigated agriculture dropped by 75%. It is unknown, however, what impact this elimination in subsidies and subsequent reduction in water use has had on yields and on farmer income.

From the case study, it is clear that there are two major barriers to water use for irrigation in Romania:

- Lack of proper infrastructure
- High irrigation tariff due to electricity

In order to give farmers the possibility to irrigate crops in the future, especially considering the forecasts for increased droughts in the future, it is necessary to repair much of the existing irrigation system and to consider new designs given the change in farm structure since the beginning of the 1990s. Modernisation of the irrigation infrastructure would on the one hand allow for more irrigation and potentially higher yields but it would also reduce water leakages in the conveyance systems, thus ensuring that the current sustainable use of water does not become unsustainable in the future.

Given that it is not likely that the electricity subsidy will be reintroduced, agriculture production will most likely shift away from the terraces in the south-eastern part of the country along the Danube towards more lowland areas. This can only be confirmed through future studies. To ensure the sustainability of the agriculture sector as a whole, uneconomical agriculture production, such as those taking place on terraces, should be eliminated. The potential to use former agriculture land that was abandoned in the past should be investigated to ensure that there is not a significant drop in agriculture production or in agriculture jobs, given its high importance with respect to national GDP and employment rates.

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7 SPAIN – Guadalquivir

The case study focuses on the Guadalquivir River Basin District (RBD) in Spain, with complementary data on the Fuente Palmera irrigation area. The basin has been selected after an analysis of different criteria (allocation, pricing systems, innovative trends, upcoming pressure on the basin, etc.) by literature and interviews.

The key questions for this case study have been addressed by analysing different official and non-official information sources. One of the main sources is the draft River Basin Management Plan (dRBMP) for the Guadalquivir basin (MARM, 2010), and this information has been complemented, research papers, and newspaper articles.

Many of the sources use proxy data that sometimes are made explicit, but often data uncertainty is not made explicit. When different sources have been consulted, this document uses data ranges that reflect this uncertainty range.

Specific information on the Fuente Palmera irrigation area has been provided by the Guadalquivir River Basin Authority (RBA). The Fuente Palmera Irrigation Community is located in the medium valley of the Guadalquivir RB, and shows some of the trends towards intensification and efficiency that are increasingly characteristic for the irrigation sector; and it was selected by the RBA as a showcase because it can be considered as a mixed system sharing characteristics of the Lower and the Upper Basins.

The document has been revised and contributed to by Francesc La-Roca, Julio Berbel, Joan Corominas, Víctor Cifuentes, Leandro del Moral, Eva Hernández, Manuel Lago, Gerardo Anzaldúa, Carlos Mario Gómez, Ricardo Segura, Juan Ramón López Pardo and Wolfgang Krinner.

7.1 Characteristics of the case study area

7.1.1 Overall water resources availability and usage

The average renewable resources in the Basin, amount to 5,754 – 7,043 hm³/year, as derived from multiannual measurements for short-term and long-term historical datasets, respectively (MARM, 2010:71¹⁸⁷).

Average water usage in the basin is estimated at 3,832.69 hm³ (MARM, 2010:110)¹⁸⁸

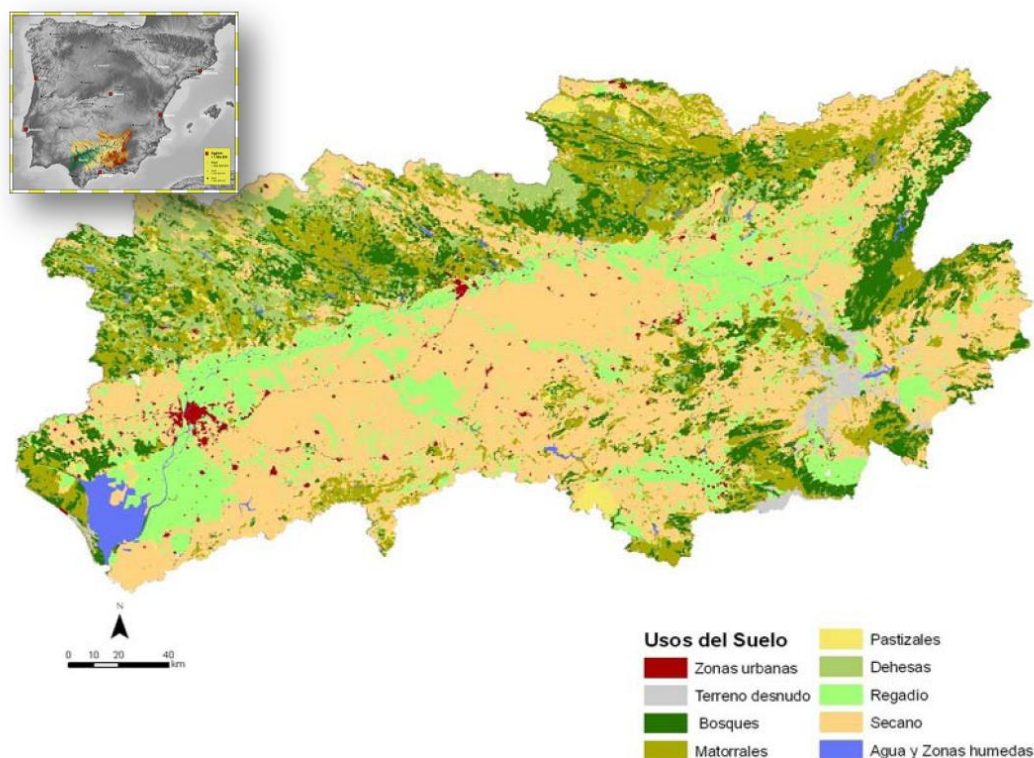
Based on the more conservative figures of the dRBMP, per capita water consumption in the RBD is 950 m³/y. Currently, the main water uses in the basin are agriculture (85%), domestic use (11%), industrial use

¹⁸⁷ Note that the Spanish Planning Guidance IPH establishes that both, the long term and the short term historic datasets (statistics of the serial of 1980/82 to 2005-06 and 1940-41 to 2005-06) shall be analysed in order to get a picture on the decline of water resources in Spain in the last decades and make a more realistic planning.

¹⁸⁸ Please note, that the water consumption data for agriculture are a proxy based on average consumption per hectare as established by the Planning Guidelines IPH, and as detailed in the dRBMP:96. Those figures, nonetheless, are a 26% below the ideal water consumption data for crops used by the Regional agricultural authorities (Junta de Andalucía, 2011b:12) and claimed by irrigators (Feragua, 2011), though the agricultural authorities also recognise that the ideal water consumption is usually not reached (due to lacking water or economic reasons. Some stakeholders claim for using a range of data for effective water consumption, in order to reflect the above-mentioned uncertainties (e.g. WWF, 2011).

(3%) and tourism (1%) (Berbel *et al.*, 2011). The below map (MARM, 2010:Memoria:27) provides a rough image of the main water users, according to land uses, with urban areas marked in red, and irrigation farming in light green.

Diagram 45: Land uses in the Guadalquivir basin (MERM, 2010)



(Legend: Red: urban areas; Grey: bare soil; Dark Green: forest; Medium Green: Bushes; Yellow: Grassland: Olive Green: Pastures; Light Green: Irrigated; Orange: Rainfed; Blue: Water and wetlands)

Thus, the Guadalquivir RBD allocates overall at least 54% of its interannual available water resources.

In order to adequately satisfy the water demands for urban water supply and agriculture based on the 10 years-focused guarantee¹⁸⁹ defined in Spain's water legislation, the water gap¹⁹⁰ in the basin is estimated currently at -562.32 hm³/year. This is reflected in basin global balance on the following table (MARM, 2010:Memoria:154, Tabla 82), and actions of the PoM will address at least part of this gap and reduce it (e.g. new dam construction, expected savings by irrigation efficiency, etc.) by 2015 down to -437 hm³/year.

¹⁸⁹ In a consecutive 10-years period, the deficit shall not be higher than 100% of one year (for agriculture water demand) and 8% for urban demand).

¹⁹⁰ Although the average allocation is less than the available resources, there is still a gap as in a consecutive 10-years period, deficit (see previous note) still take place in some years

Table 29: Water balance of the Guadalquivir basin (MERM, 2010)

Scenario	Simulated demand (hm ³ /year)	Annual		Bi-annual		Decennial deficit				
		Hm ³	% demand	Hm ³ accum.	% demand	Hm ³ accum.	% demand	Admissible hm ³	Gap	
									Hm ³ /year	% demand
Scenario 2007	2,571	1,918	74.6%	3,502	68.1%	7,726	30.1%	2,080	562	21.9%
Trend scenario 2015	2,716	1,960	72.2%	3,516	64.7%	6,457	23.8%	2,282	437	16.1%
Scenario 2015	2,439	1,652	67.8%	3,007	61.6%	4,677	19.2%	2,045	285	11.7%
Scenario 2027	2,454	1,696	69.1%	2,962	60.4%	4,695	19.1%	2,047	287	11.7%
Scenario 2027 (incl. climate change)	2,454	1,720	70.1%	3,081	62.8%	5,129	20.9%	2,047	330	13.4%

In these circumstances and according to the dRBMP, the Guadalquivir can be considered as a “**closed basin**”, this means that all its usable water resources (river flow) have been put to use for part or all of the year (e.g. Seckler, 1996 and Molle, 2003 in Smakhtin, 2008). As a river basin approaches ‘closure’, competition for water between different sectors increases, and allocation and pricing regulations become more relevant.

The pressure on the resource is expected to rise in the coming years; while water demand is expected to increase, climate change is also expected to result in lower water yields and further raise demand for irrigation. It bears mentioning that new users are being included, some with important demands (e.g. energy).

7.1.2 Overall water management rules in Spain

The Spanish 2001 Water Act (RDL 1/2001) which consolidates the 1985 Water Act and its subsequent reforms sets the legal framework for water management and planning in Spain, including or water allocation and pricing in agriculture.

In terms of water resources allocation, Spain is divided into river basin districts (RBDs). These RBDs can either encompass a single river basin (e.g. Guadalquivir) or merge several smaller river basins in one administrative unit. If the RBD includes more than one Region, it is managed by the National Government via a River Basin Agency, as it is the case of Guadalquivir.

7.1.2.1 Water allocation rules

Water allocation is a multi-level multi-agency process in Spain which operates within different institutional frameworks at different spatial and temporal scales, with differences on a temporal scale (according to Hernández-Mora *et al.*, 2010):

- Long term allocation: Throughout the 20th Century and given Spain's rather rigid water permitting system, the construction of large hydraulic infrastructures has determined the allocation of certain volumes of water to different uses. In this sense, some dams are used exclusively for hydroelectric purposes, some are assigned to specific irrigation development projects, some may be used for urban water supply in specific areas or cities, some combine uses (irrigation, urban supply) and some are intended for the "general water regulation system".
- Mid-term allocation (RBMP horizons): RBMPs allocate water to different exploitation systems and user groups within each system for the duration of the plan based on current uses and expectations of the future evolution of demand. The 1998 RBMPs used a 10 and 20 year time-frame for water use and allocation decisions, and current RBMPs use 6-year planning time-frames (2009-2015; 2015-2021; 2021-2027) according to the WFD¹⁹¹.
- Annual allocation: Within the parameters established in the RBMPs, RBA's User Management Councils and Dam Release Commissions decide annual allocation quotas (e.g. m³/ha for different crops) to individual users or groups of users (e.g. Irrigator Associations) depending on annual precipitation and existing reserves. Users have representation in these boards and therefore participate in allocation decisions.

On a spatial scale, the following different levels can be distinguished

Table 30: Spatial allocation levels (Hernández-Mora *et al.*, 2010):

Geographical/ spatial scale	Characterisation	Legal/ administrative instrument	Dominant allocation criteria
International	Shared RBDs with Portugal	Albufeira Convention	Guarantee for hydroelectric production, supply, minimum environmental flows, and flood protection.
Spain	Allocation of water resources among RBDs within Spain	Spanish National Hydrologic Plan: inter-basin transfers >5 hm ³	"National water balance" National economic and territorial strategies
RBD	Allocation of water resources between basins within the same RBD	RBMP	Regional Economic development/ Sector development
Exploitation	Territories within a RBD	RBMP:	Sector / Territorial (Sub-basin)

¹⁹¹ Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.

Geographical/ spatial scale	Characterisation	Legal/ administrative instrument	Dominant allocation criteria
System	supplied by a common distribution network (natural, as in a common aquifer, or artificial, in an irrigation system)	Water balance	
Demand Unit	Cluster of users grouped by activity/use (irrigation, urban supply, hydroelectric users)	RBMP: Existing uses & future demand expectations	
User	Holder of water use rights (a city, a hydroelectric company, a landowner or a group of them...)	Water use permit	Existing rights

The RBMPs build on existing water rights and try to increase availability for new users (new rights), as in Spain's large semi-arid climate areas and under the given low prices for water, "demand" is always growing. Thus, the Plan allocates water to current right holders and creates reserves for potential future "demands".

7.1.2.2 Water rights

Former 1866 and 1879 Water Acts allowed the existence of a double legal regime for the water rights: an administrative (public) treatment of surface waters and a private one for groundwaters. The ownership of abstracted water from ordinary wells (mainly for domestic use) belonged to the owner of the land where the well was located. On the contrary, rivers and other streams belonged to the public domain and, subject to a water use permitting system (*sistema concesional*), whereby individual water users, municipalities or irrigator associations request and are granted water permits (*concesiones*) by the RBA that give them a right to use a certain volume of water for a specific purpose, in a specific location, for a maximum renewable period (currently of 75 years). The currently valid 1985 Water Act declares all waters (surface and ground) to be public domain and maintains the water use permitting system that has been operational since the 19th century, extending it to groundwater uses. The requests are dealt with under application of the allocation priorities for water users. Existing owners of declared private waters are given a 50-years moratory period to keep the ownership, before it gets transformed into a *concesión*.

7.1.2.2.1 Irrigation communities

If the water is used for irrigation, the holder of the water right is often the Irrigators Community. Irrigators Communities are corporations of public right ascribed to the Basin's Agency; and they are a grouping of all the owners who own an irrigating area forced by law to join together, for the autonomous and common administration of the public waters, without intention of profit.

Nowadays in Spain there are around 6,200 Irrigators Communities in the census. The reason why irrigation water users gather in Irrigators Communities is conditioned by the existence of common properties and related equipment, such as: Water (generally with one or several common outlets), Transport and distribution hydraulic networks, and Right-of-ways caused by the works; and their management can be better approached by an association of all users (Del Campo, García, n.d.).

7.1.2.2.2 Precarious water rights

If the RBA cannot guarantee access to water as established by the quota with the average available resources, it can assign (provisionally) “precarious water rights”. In practice, this rights type has been widely assigned to those areas where (complementary) irrigation happens (e.g. olives), and where farmers are allowed to store and use winter flush flows (between September 15th and April 15th) (e.g. Camacho & Rodríguez, 2005:485). This practice, if applied in large areas and when plot-proper storage systems are getting relevant, can affect the overall stream flow level in the main (regulated) rivers of the RBD.

7.1.2.2.3 Private abstraction

The 1985 Water Act states that a permit is not necessary to drill a new well for abstracting less than 7000 m³/year. Thus, 20 years after the enactment of the 1985 Water Act the number of private groundwater abstraction rights remains uncertain as do, by extension, the pumped volumes. The number of water wells in Spain is estimated between one and two million. This means there are between 2 and 4 wells/km²; however, this ratio is three times higher if it is applied only to the surface of the 400 aquifer systems. The average groundwater withdrawal from each well is low (between 2500 and 5000 m³/year), indicating that most are meant for domestic use or small irrigation (Llamas and Garrido, 2007).

7.1.2.3 Water Pricing rules

The economical-financial regime for the use of the water public domain is established at the Water Act 1/2001 in which the cost recovery principle (including environmental and resource costs) shall be considered by Public Administration regarding the water related services, according to the long term projections of supply and demand, and implemented by:

- Encouraging efficient use of water, thus contributing to the pursued environmental objectives.
- Adequate contribution from the difference uses, according to the polluter-pays principle and transparency and considering, at least, drinking water supply services, agriculture and industry.

By law, cost recovery is considered as a main criterion for water pricing. The Administration responsible for water supply shall set the tariff structures based on consumption blocks, aiming to provide basic needs at an affordable price and to discourage excessive consumption. Appropriate mechanisms to avoid duplicity when recovering the cost of services shall be used.

However, certain considerations (social, environmental, economical, geographical and climatic) are to be considered when applying cost recovery, as long as environmental objectives are not compromised. Water Pricing takes place at three levels:

1. River Basin Authority: On one hand, beneficiaries of surface and groundwater regulation works developed with public finance must satisfy the CR (*Canon de Regulación*), a regulation levy to compensate investment costs borne by the Administration as well as operation and conservation of those works. On the other hand, beneficiaries of specific hydraulic infrastructure developed with public finance must satisfy the TUA (*Tarifa de Utilización del Agua*), a water use tariff for the availability or use of water, to compensate investment costs borne by the Administration as well as operation and conservation of those works.

Both CR and TUA are estimated as the sum of the envisaged functioning and conservation costs of the infrastructure, the administrative costs attributable and a 4% of the investment value¹⁹². The resulting amount will be distributed among beneficiaries attending water use rationalisation, equity on the distribution of obligations and auto-financing. Both CR and TUA are billed on a per-hectare basis. Estimations for the Fuente Palmera Irrigation Community indicate that 85,22% of the cost is recovered from CR and TUA.

2. Irrigation district. Each irrigation community charges to their members a contribution or apportionment (*derrama*) for the costs incurred on its activities (i.e. distribution, maintenance of tertiary infrastructures...), including CR and TUA charge by the RBA

In traditional Irrigation Communities, with surface waters, the most common tariff system is based in a single annual payment, on a per-hectare basis. This approach does not provide water-saving incentives (MARM, 2010). In Irrigation communities facing limitations on water availability, a binomial approach is however used (a payment per hectare and per-hour of effective irrigation at a theoretical flow). In this case, farmers have a more clear understanding of the water consumed and their limitations of use. This is also the approach on irrigation communities with conjunctive use of surface and groundwater and new irrigation schemes. For the Irrigation communities with groundwater as unique source, the payment is also set based on surface unit and duration of irrigation events, since the aim is to cover consumption of electrical energy. However, for automated drip irrigation, billing is made on a per-cubic meter basis. Volumetric tariffs are more linked to irrigation technology than to scarcity. Within the same community, different tariff systems may be possible, e.g. drip irrigation schemes having volumetric tariff and surface water irrigated areas having binomial tariffs. The dRBMP estimate revenues from apportionments on 55.65 M€ annually, corresponding to an average price of 0.0257 €/m³ at year 2005 (this figure does not include CR and TUA). The most common tariff in the basin is set based on the surface (76.1%), followed by volumetric tariff (11.0%) and fix-amount (1.3%) (Tragsatec, 2008). The Guadalquivir river basin district charges the highest average per-hectare tariff in Spain (262.90 €/ha), although the volumetric tariff is not one of the highest. There are

¹⁹² Krinner and Segura (2011) point out that the formulae applied to calculate investment value tend to estimate only a portion of the total cost.

however tariff for other concepts, e.g. payments depending on the number of olive-trees (3 -6 €/olive-tree in average) (Tragsatec, 2008).

3. On-farm, which covers costs related to infrastructure (owned by the farmer) management at farm level, and costs of self-abstraction (mainly groundwater). In both cases, costs are fully paid. Average costs for surface water is 0.11 €/m³ (including payments to the Irrigation Community and therefore to the RBA) and for groundwater sourced farms is 0.15 €/m³, which includes pumping costs¹⁹³ and depreciation of wells (Berbel and Kolberg, 2009).

In this framework, it should also be taken into account that since the 1980s, EU Common Agriculture Policy (CAP) subsidies, as implemented in Spain, have stimulated the intensification of Spain's agriculture, including water usage. A clear overlap has been identified in relating relatively low-decoupled CAP subsidies with areas where aquifers are overexploited or polluted by nitrates (Becarés *et al.*, 2010), as subsidies are linked to farming systems with intensive use of natural resources (soil and water), fertilisers and phytosanitary products, compromising their sustainability. Nevertheless, efficiency on water use seems to be reinforced by CAP reform influences farmers' choice towards water productive crops.

Overall, there is a strong controversy on the level of cost recovery for RBA services, with estimations ranging from 20-23% (Krinner and Segura, 2011; Corominas, 2010) to 85% (MARM, 2010), depending mainly on the costs and discount rates considered.

7.1.3 Broad introduction on the area and characteristics of agriculture

The Guadalquivir River Basin is the longest river in southern Spain, with a length of around 650 km. It covers an area of 57.527 km² with a population of 4.2 million people. The basin has a Mediterranean climate with an annual average temperature of 16.8°C, and an annual average precipitation of 570 mm which is heterogeneously distributed.

7.1.3.1 Main agricultural data

Agriculture covers 2,971,291 hectares (MARM, 2010) in the RBD, out of which 845,986 (28,5% of total) are irrigated. Irrigated agriculture in the basin is reflected by some key features of the following table: type of crops, surface in the RB, gross water endowment/ha and overall net water consumption (MARM, 2010, p.97).

¹⁹³ There has been a significant increase in energy costs in recent years and the average cost is now around 0,20 €/m³ for most groundwater users. Surface cost also has increased significantly (250%) after pressurised networks have been developed in irrigation communities.

The main crop type in the basin according to the area is olive (intensive and extensive), and despite its low water consumption per hectare, it is now the major water user in the basin. Other key crops (by order of overall water consumption) are cotton (though the crop surface is decreasing), rice, extensive winter cereals, horticulture and citric.

Table 31: Agricultural demand in the Guadalquivir basin (MARM, 2010)

Crop type	Irrigated Surface (ha, %)	Endowment (m ³ /ha)	Net demand (hm ³ ,%)
Cotton	127,030.69 (15.0%)	4,500	571.64 (23.0%)
Maize	9,299.94 (1.1%)	5,100	47.43 (1.9%)
Olive (extensive)	392,569.70 (46.4%)	1,500	588.85 (24.0%)
Others	13,386.61 (1.6%)	4,500	60.24 (2.5%)
Sugar beet	8,072.28 (1.0%)	4,500	36.33 (1.5%)
Olive (intensive)	69,568.23 (8.2%)	2,200	153.05 (6.2%)
Irrigation on limited production	2,351.28 (0.3%)	1,080	2.54 (0.1%)
Rice	35,530.21 (4.2%)	10,400	369.51 (15.0%)
Citrus fruits	27,677.23 (3.3%)	4,000	110.71 (4.5%)
Extensive crops (Winter)	79,598.20 (9.4%)	2,430	193.42 (7.9%)
Strawberry and Raspberry	3,807.94 (0.5%)	3,000	11.42 (0.5%)
Orchard	16,882.52 (2.0%)	4,000	67.53 (2.7%)
Sunflower	25,568.66 (3.0%)	3,510	89.75 (3.7%)
Horticultural crops	34,051.53 (4.0%)	4,500	153.23 (6.2%)
Greenhouse Crops	590.90 (0.1%)	4,500	2.66 (0.1%)
TOTAL	845,958.92 (100%)	2,906	2,458.31 (100%)

7.1.3.2

Gross Value Added

The data regarding the GVA (Gross Value Added) give an estimation of the value of goods and services produced in an area, industry or sector of an economy. In the particular case of the Guadalquivir RB, they also show (MARM, 2010:73) the high relevance of the tertiary sector and of construction sector in the 1995-2005 period (data have changed since then significantly)

Agriculture¹⁹⁴ is responsible for only 5.5% of gross added value (GAV), with a slight decrease of -0.05% in this 10-years period, and with the lowest productivity per worker. Nonetheless, the sector is also relevant for part of the associated industry and tertiary sector, in particular, agro-industry (e.g. olive oil bottling or packaging of agricultural products) generates 29% of the industrial GAV and 22% of employment in this sector (MARM, 2010 Annex 3:18).

Table 32: Socioeconomic data of the Guadalquivir basin (MALM, 2010)

	Interannual Growth Rate in real terms (1995-2005)			Productivity 2005	Share 2005
	GAV (%)	Employment (%)	Productivity (%)	€/worker	% over GAV
Agriculture & Livestock	-0.05	1.72	-1.77	25,013	5.5
Energy	5.52	2.61	2.91	183,559	3.7
Industry	2.54	2.98	-0.44	36,173	9.5
Construction	9.14	8.13	1.01	38,033	14
Services	3.97	3.58	0.39	38,549	67.2
TOTAL	4.18	3.86	0.32	38,221	100
NATIONAL TOTAL	4.09	2.69	1.40	45,285	

The employment trend scenario for 2015 (based on the trend data of 1995-2005; MARM, 2010:86) reveals agriculture as a minor, but significant sector. Most possibly its relative relevance will increase a bit more due to the economic crisis and changes in the industrial structure in Spain. The crisis however, has served as a stimulus to the increase of labour fraud in Andalusian agriculture, currently estimated at 28% (Donaire, 2011).

¹⁹⁴ This includes livestock, irrigated and rainfed agriculture. Estimations for irrigated agriculture are 3,5% of GDP.

Table 33: Employment trend scenario in the Guadalquivir basin (MARM, 2010)

Guadalquivir RB	2015
Agriculture & Livestock	181.59
Energy	18.26
Industry	245.72
Construction	576.62
Services	1,731.38
Number of employments (10 ³)	2,669.74

7.1.4 Water resources and aquatic ecosystems

According to the Guadalquivir dRBMP, the total consumptive water demand reaches 3,833 hm³/year (in 2007); up to 87% of this total demand (or 3,329 hm³/year) is dedicated to agricultural uses.

7.1.4.1 Scenarios for the water balance: Climate change

For the horizon 2030, simulations considering a temperature increase of 1°C and a rainfall reduction of 5% project a decrease of mean hydraulic yields of almost 12% in the RBD, which is above the national Spanish average of 8% (Iglesias et al., 2005 in Berbel et al., 2011). This figure is coherent with Spain's Planning Guidance that foresees provisionally an 8% decrease in the natural water availability of the Guadalquivir by 2027¹⁹⁵, and has been confirmed recently (CEDEX, 2011).

7.1.4.2 Quantitative status of the water resources

7.1.4.2.1 Groundwater bodies with not complying with the good quantitative status

In the RBD, there are 3 different types of aquifers (calcareous, alluvial and detrital) with a total groundwater resource of 1,962 hm³/year, and a total of 60 groundwater bodies (MARM, 2010:48), and a total surface of 35,627 km².

A total of 19 groundwater bodies (approx. 32% of total) do not comply with the good global status due to a bad quantitative status.

Regarding water requirements (and current ecological status) of aquatic ecosystems dependent on water (e.g. wetlands that have not been identified as water bodies), are not currently determined due to the complexity of the subject. However, specific studies on the issue are under development, and are expected

¹⁹⁵ IPH (ORDEN ARM/2656/2008, de 10 de septiembre, por la que se aprueba la instrucción de planificación hidrológica) Chapters 2.4.6. and 3.5.2.

to be finalised before January 2015. So, the environmental flow regime must be implemented by the same date (MARM, 2010:137)

As stated in the dRBMP (MARM, 2010:136), the environmental flows regime in water scarcity situations is characterised by a minimum monthly distribution and determined by simulating the suitability of habitat.

According to the dRBMP the quantitative gap (difference between the baseline and the good ecological status) can be estimated at 202.12 hm³/year (published by Berbel *et al.*, 2011:629).

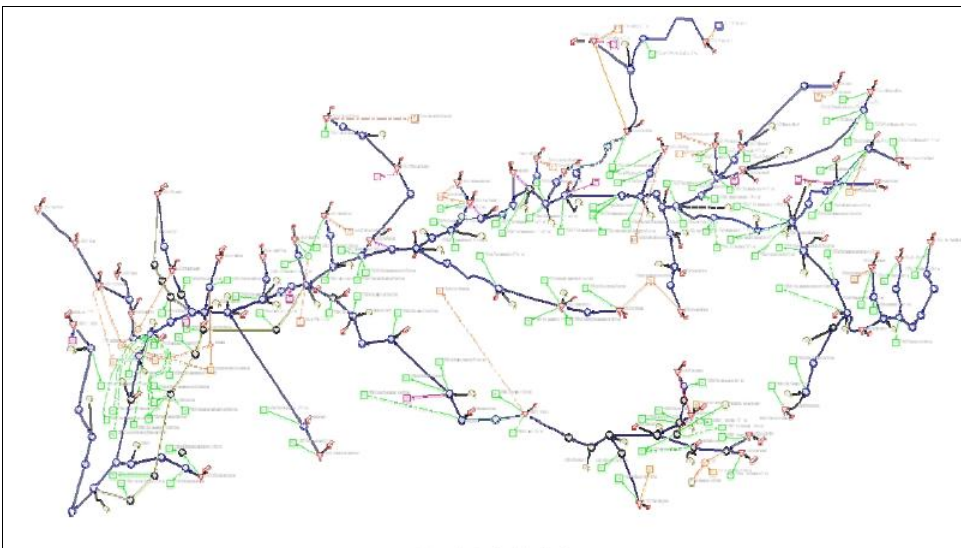
7.1.5 Water use for agricultural demand/supply

Irrigation is one of the key features of Spanish agriculture. Approximately 16,000 hm³/yr are used to irrigate mainly (47%) annual crops (cereals, leguminous plants and fodder), and permanent ones (fruit and olive trees and vineyards (35%)) (INE, 2011 for Spain).

7.1.5.1 Water sources

The water usage can be classified in “stored surface waters”, “unstored surface waters” and “ground waters” and the main supply elements are reflected in the following scheme (MARM, 2010:Memoria,153):

Diagram 46: Graph of the basin model (MARM, 2010)



Approximately 2/3 of irrigation areas in the Guadalquivir are supplied with surface water and 1/3 with groundwater. The groundwater share in this basin is much larger than the 80/20 distribution at the National level (INE, 2011). The following table reflects the key data (MARM, 2010: table 55):

Table 34: Agricultural demand units and irrigable areas according to water source (MARM, 2010)

Water source	Agricultural units	Surface (irrigable, ha)
Surface, non regulated	169	101,802.34
Surface, regulated	71	415,369.54
Groundwater	73	321,232.50
Re-used water	44	7,581.55
Total	357	845,985.92

The relatively higher relevance of groundwater sources can be explained with the following arguments: Irrigation is more relevant in the Guadalquivir, so all resources are used; large parts of the basin do not have available surface water resources; pumping costs are affordable for high-revenue crops; groundwater is administratively (and timely) easier to access, and there is a significant share of illegal groundwater usage in the RBD.

7.1.5.2 Irrigated agriculture and system(s) in the RB

The most recent data on the Guadalquivir RBD show an irrigated area of 845,985.92 hectares, though up to 883,083 hectares are officially transformed and allowed for irrigation, and the missing 37,097.08 hectares are only dependent on water supply/allocation.

7.1.5.2.1 Evolution of the total irrigated area with the most recent data

The historical evolution of the Guadalquivir RBD shows a continuous increase of irrigated agricultural area, even in recent times (Camacho and Rodríguez, 2005; MARM, 2010), when new irrigation has focused on permanent crops such as olives (between 1997 and 2008 the irrigated olive area in the RBD more than doubled; Pérez Blanco *et al.*, 2011).

Table 35: Evolution of the total irrigated area

Year	Source	Area (ha)
1904		142,900
1977		441,900
1992	RBMP 1995	487,395
1999	Inventario de Regadíos	640,493
2002	Inventario de Regadíos	696,493

Year	Source	Area (ha)
2004	Inventario de Regadíos	764,735 ¹⁹⁶
2010	dRBMP	845,985 ¹⁹⁷
2015	dRBMP (estimation)	880,556

In a similar way, the irrigated area in Fuente Palmera has increased in +6%, from 5,296 ha (2004) to 5,600 ha (2009).

The continuous increase is strongly supported by farmers unions that reflect the demand for increased irrigation (full or complementary), moderately supported by irrigator associations (Feragua, 2011) unless the overall water consumption puts under risk the existing irrigators and their water consumption, and opposed and criticised by NGOs and several scientists (FNCA, 2011).

According to the dRBMP, the increase of officially irrigated areas between 2009 and 2015 will be +34,571 hectares, with an overall water consumption of 73 hm³/year. This means an additional¹⁹⁸ water consumption of agriculture by +2.4%.

Though it is assumed by the River Basin Authority that no further irrigation increase will take place post-2015, surprisingly the dRBMP does not include further information on trend scenarios for water consumption in agriculture beyond 2015. This is particularly concerning because those projections have been made for all other water sectors, but not for the main water user in the basin, and because it is very difficult to assume that there will be a +/-0 trend, in particular under the given climate change scenarios.

7.1.5.2.2 Main irrigated crops with the most recent data on production

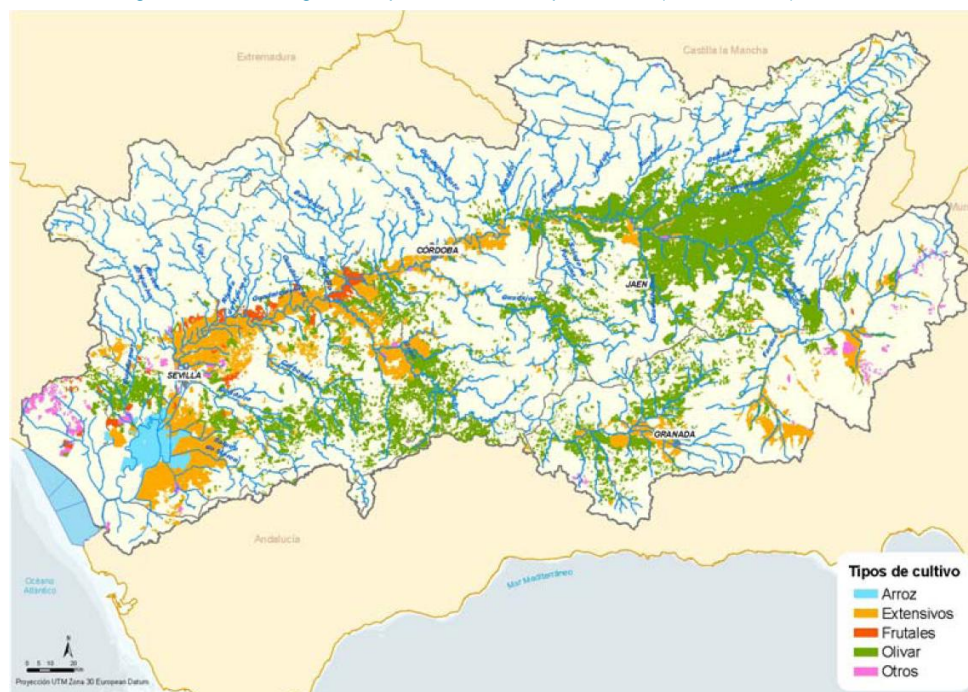
The main crops in the Guadalquivir area are olives, cotton, rice, winter cereals and citric. The following map (MARM, 2010) reflects the main crop areas: rice (blue), extensive crops (orange), fruit trees (red), olive trees (green) and others (pink).

¹⁹⁶ This figure includes the Guadalete-Barbate area, now administratively included in another RBD

¹⁹⁷ This figure has included significant field work to verify data.

¹⁹⁸ This is not a real increase, in the strict sense, as it was already planned in the current RBMP.

Diagram 47: Main irrigated crops in the Guadalquivir basin (MARM, 2010)



7.1.5.2.3 State of play of techniques used for irrigation

The following table summarises the global data for the Guadalquivir RBD regarding irrigation techniques

Table 36: Irrigation techniques in the Guadalquivir basin (MARM, 2010:98-99)

Irrigation system	Surface (ha)	% of use	Max. Efficiency ¹⁹⁹ (%)	Global
Gravity irrigation	184,829	22	0.67	
Sprinkling	104,511	12	0.75	
Drip irrigation	556,648	66	0.86	
TOTAL	845,986	100		

7.1.5.2.4 The importance of irrigation for agriculture

Irrigation is possibly the most significant element for agriculture in the Guadalquivir RBD, resulting in an increased variety of possible crops, increased production security under drought scenarios and for higher revenues.

The Fuente Palmera Irrigation area has an overall income of 17,919,449 €, this is 3,199.8 €/ha, with a net benefit of 1,021.2 €/ha. In terms of labour days, the study area needs 26.2WD/ha (Inventario de Regadío; CHG, 2011b). In terms of productivity per water units, Fuente Palmera ranks very high in the Guadalquivir

¹⁹⁹ Maximum Global Efficiency is defined by the sum of partial efficiency of each irrigation systems, the efficiency in the transport infrastructure associated and the efficiency in the supply infrastructure.

basin with $1.2\text{€}/\text{m}^3$ (Camacho & Rodríguez, 2005:487), due to its new infrastructures (from the 1980s), the modernisation process and water efficiency and the adaptation of crops.

7.1.5.3 Pressure from irrigated agriculture

According to the dRBMP, agricultural demand in 1998 lay at $2,847\text{ hm}^3/\text{year}$, are now at $3,329\text{ hm}^3/\text{year}$ and for the 2015 trend scenario they are estimated in $3,402.66\text{ hm}^3/\text{year}$. This equals a 16% increase for the decade between 1998 and 2007 and a 5% increase for the 2007 to 2015 forecast.

Agricultural demand considering the measures of the RBMP is estimated in $3,101.40\text{ hm}^3/\text{year}$ or a reduction of approx. 9% of the total demand estimated (for 2015 trend scenario). Nonetheless, it is foreseeable that this estimation based on the recovery of water rights (due to modernisation processes) will not happen by 2015 (as the 2010 Andalusian Water Law fixes that the water rights review process will be established only from 2015 onwards; and according to the past implementation process of modernisation between 2006 and 2011) (Gómez, 2010), and most possibly the trend scenario (above) prevails until 2015.

The gross demand for irrigation (in accordance with the dRBMP this means total water derived, considering the efficiency of transport, distribution and system of application) is currently estimated in $3,329\text{ hm}^3$. Regarding the origin of resources to supply such demand the dRBMP informs that 74.77% is satisfied by superficial water, responding to the needs of 517,172 ha of crops. The rest of the demand is satisfied by groundwater resources (representing 24.73% of the total consumption) and reclamation/reuse of waste water (representing only a 0.49%).

7.1.5.3.1 Illegal Abstraction

Non-authorised water usage reflects different legal situations (according to WWF, 2006 and Dworak *et al.*, 2010:9-10):

- Wells and surface water intakes that are exploited without previously applying for authorisation from the competent authority. This situation is typical in areas where water resources, especially aquifers, are overused (the Water Authority not being able to grant new concessions due to the lack of resources) and/or in cases of unauthorised land use (e.g. non-authorised transformation to irrigated farming of public land or protected areas).
- Abstractions with pending licences. In many cases Water Authorities are behind schedule with the procedures of granting new concessions. Many applicants start abstracting water without any permit before the Authority replies to their application.
- Users abstracting greater volumes of water than what they are entitled to. Licence holders usually can only abstract the volume assigned by their Water Authority. However, many users extract amounts exceeding this limit, or not according to the time period established by the permit.
- Transfer of water rights among water users or to new potential users when it is not foreseen in the country water law. Non-authorised trades are not subject to any assessment of damages to third parties or the environment.

- Un-authorised changes in the characteristics of the water intake, e.g. though the deepening or widening of the registered well.

According to the water law, the permit implies a respect to both water consumed and area irrigated, but some users may enlarge the irrigated area by decreasing intensity even using the same amount of water. This is not strictly legal in Spanish Law even if it does not increase water consumption, but current practice, and is an important factor for explaining the 'non fully documented irrigated land' with a reduced influence in water demand.

The number of overall illegal water abstractions in Spain is unknown, but significant. It is accepted that more than 510,000 major boreholes are non-authorized and they abstract at least 3,600 hm³ of groundwater ($\approx 45\%$ of all water pumped from aquifers). These figures imply that one sixth of the total irrigated land in Spain is using a non-authorized water source (WWF, 2006:1).

Current figures of non-authorized water usage in agriculture for the Guadalquivir basin range between a 3% (80.38 hm³/year, based on Berbel *et al.*, 2011) and 15% (Giansante, 2003 and the national estimate from WWF, 2006), and pro-irrigation trends have continued over the last decade even when no legal water sources have been available (WWF, 2010) with a low level of closure of illegal takings (AEVAL, 2010). Illegal abstractions are considered as a minor infringement and would be fined by a maximum ticket of 6,010.11 € (CHG, 2011b).

Non-authorized water usage in agriculture has mainly happened in those areas where the RBA did not provide water supply by official means (dams, irrigation channels) and has been based on individual wells (up to 1,200 meters deep) to groundwater sources. Though the information is scarce, it can be assumed that olive (since the 1990s boom) and berry plantations are partly irrigated with this non-authorized water, in Eastern Andalusia and close to the Huelva coastline, respectively.

A Cost-Effectiveness Analysis of the Guadalquivir's Programme of Measures (PoM) reveals "strict groundwater abstraction control" with eliminating all illegal abstractions as the most effective (80.38 hm³/year out of a total of 137.09 hm³/year) and efficient (0.07 €/m³ compared to an average of 1.68 €/m³) out of 7 measures²⁰⁰ in order to reduce water consumption in the RBD (Berbel *et al.*, 2011).

²⁰⁰ Improvement of urban distribution networks, modernisation of irrigation systems, service cost recovery in urban sector, service cost recovery in irrigation, volumetric billing for irrigation, extension services for irrigators)

7.2 Current water policies and practices influencing water use in Agriculture

7.2.1 Water allocation policy in the agricultural sector

7.2.1.1 Water allocation hierarchy

According to the Spanish water law, the overall priority for water allocation is the urban water usage, followed by environmental flows restrictions and agriculture. Though currently not applicable to the Guadalquivir basin, the 2010 Andalusian Water Law²⁰¹ has enshrined a new approach that eliminates the different ranking between economic water users, making new water users (e.g. recreational, energetic, industrial) more competitive (e.g. Pérez Blanco *et al.*, 2010) with the traditional large water holders or irrigation areas with a low added value per water unit. The priority is established in terms of sustainability, contribution to territorial cohesion and employment and income generation criteria, ranking first Domestic water uses, second Non-domestic urban water uses (low consumption activities) and third Agricultural, industrial, tourism, other non-urban economic uses; and urban high consumption economic uses.

Nonetheless, according to Art.18 dRBMP Guadalquivir, irrigation and other agricultural water uses are third ranked after the water supply to urban areas (incl. minor industries) and environmental flows restrictions. This applies for the whole RBD with some exceptions regarding some dams for cooling water supply. With a similar aim as Art.23 of the Andalusian Water Act in order to stimulate economic growth, Art.18 dRBMP prioritises also water usage changes from agriculture to the production of renewable energy up to a limit of 50 hm³ in the basin, as well as other similar shifts to industrial usage and water usages included in Land Use Management Plans, summing up a total of 150 hm³/year.

7.2.1.2 Allocation under drought situations

In 2007 Spain approved Drought Management Plans (DMP, *Planes Especiales de Sequía*) for all river basins in compliance with the 2001 NHP Law. The Plans established for first time a standard for adaptation of water allocation to the irregular water availability. The plans operate by objectively determining different threshold levels (normal, pre-alert, alert and emergency) depending on the resources available in each exploitation system in the basin at each point in time.

Each level triggers different actions (from public awareness campaigns, to efficiency measures, to sale of water permits, to restrictions). The goal of the actions is to avoid reaching the next level and, ultimately, avoid imposing severe use restrictions.

DMPs have been very successful over the last drought period (2004-2009) in ensuring water supply, and are the basis for an EU Guidance Document on DMPs. Nonetheless there are number of weak aspects (e.g. lack

²⁰¹ Article 23 of LEY 9/2010, de 30 de julio, de Aguas para Andalucía

of environmental thresholds for WFD objectives, use of different management systems: river basin vs. water management area, definition of the economic compensations insufficient support for high-revenue crops, etc. (e.g. Pérez Blanco *et al.*, 2011), that require an updating process of the 2007 DMPs.

The Spanish Hydrological Planning Guidance (IPH) document defines a supply guarantee for each user group, in order to calculate possible deficits in different exploitation systems and for the basin as a whole, agrarian water supply would be satisfied when:

- Water deficit for any given year did not exceed 50% of existing demand.
- In two consecutive years, added deficit did not exceed 75% of annual demand.
- In 10 consecutive years, added deficit did not exceed 100% of annual demand.

7.2.1.3 Allocation procedures

Allocation is decided by RBA Governance bodies.

The Water Release Commission discusses and makes proposals for water releases from dams to the President of the RBA on the appropriate system for filling and emptying of reservoirs and aquifers in the basin, and paying attention to the concession rights for different users. It is made up by 67 representatives of administrations and water users across the RBD.

6 Water Exploitation Boards²⁰² for the main river stretches ensure the coordinated operation (respecting water rights), and exploitation of hydraulic infrastructure and water resources (river, related aquifers, etc.). They are built up by water users.

7.2.1.4 Efficiency and allocation

Water use efficiency in agriculture is one of the main action lines of the Spanish water administration over the last years and is also included in the dRBMP and in regional agendas. Efficiency aspects have several links with water allocation:

- Efficiency can free-up water for other water uses at the overall basin level (e.g. irrigation intensification or enlargement, reallocation to other water users or environmental stream flows) though it often also reduces return flows
- Efficiency standards and estimates are used for annual allocation purposes (average water use per hectare per year for different crop types)

In order to fix this new increase of water requests with the available resources, the Guadalquivir dRBMP highlights increased water use efficiency in agriculture as one of its key aspects, reducing the trend scenario of agricultural water consumption by 9.73% (301 hm³)²⁰³.

²⁰² <http://www.chguadalquivir.es/opencms/porta/chg/servicios/juntasExplotacion/composicionJuntasExplotacion/>

²⁰³ dRBMP Memoria Anejo 3 Usos y demandas del agua:85

7.2.1.4.1 Irrigation techniques and their efficiency levels

In the Guadalquivir RBD, 66% of the irrigation area (556,648 hectares) has a localised irrigation system at the plot level (MARM, 2010:72), with a significant increase over the last years.

In the Fuente Palmera irrigation area case study, drip (60%) and sprinkler (40%) irrigation make up the total of irrigation systems. This can be explained due to the recent modernisation process, and the pumping effort and costs, as the area is located between +60 and +110 m over the Guadalquivir river level (CHG, 2011b).

7.2.1.4.2 Efficiency and modernisation investments

Over the last decade (e.g. National Irrigation Plan 2003-2008; Irrigation Modernisation Action Plan 2006-2008), and integrated in Rural Development Programmes (RDPs) and the upcoming Strategy for Sustainable Modernisation of Irrigated Agriculture in Spain – horizon 2015²⁰⁴), Spain's water allocation policy focuses much on improving irrigation efficiency, and grants aids to irrigator communities for new efficiency technologies and infrastructures.

The Andalusian Irrigation Plan 2011-2015 defines that investments are still required in different aspects for 396,456 hectares (35.83% of the overall irrigated area²⁰⁵), with a different focus (plots, networks, supply infrastructure, automatisisation, control elements, drainage, etc.) and depth, and an average cost of 3,265 €/ha (Junta de Andalucía, 2011b).

The aids²⁰⁶ under RDPs) cover up to 90% of the project investments at the irrigation district level, and 40-60% at the plot level (Feragua, 2011)

In the case of the studied Fuente Palmera area there has been a 13.5% water abstraction decrease per hectare²⁰⁷ between 2004 (2,773 m³/ha) and 2009 (2,398.9 m³/ha) though this dataset is limited (the area abstracts since 1984), no explanation nor intermediate data have been provided for this trend (CHG, 2011b), and a general cut of e.g. -8.0% for olives irrigation should also be taken into account at the National level between 2008 and 2009 (INE, 2011).

7.2.1.4.3 Efficiency standards

Articles 20-21 dRBMP establish a set of efficiency values, maximum water consumption per hectare/year for the main crops and a 2015 forecast of water savings.

The maximum water consumption/hectare establishment has been subject of significant conflicts with irrigators, and the dRBMP standards are currently a 26% below the standards set by the Regional Department for Agriculture (Junta de Andalucía, 2011b:12; Feragua, 2011), but has recently been streamlined, recognising that farmers usually don't consume the optimal water supply required for their crops.

²⁰⁴ Currently under public consultation: www.mma.es/portal/secciones/participacion_publica/eval_amb/2009_p_019.htm

²⁰⁵ Please note that these data refer to Andalusia as a region.

²⁰⁶ Measures concerned are 111 to 115, 121 to 125, 131 to 133, 211, 212, 214 to 216, 221 to 223, 225 to 227, 311 to 313, 321 to 323, 331, 341, 411 to 413, 421 and 431 (Junta de Andalucía, 2009)

²⁰⁷ Note that taking into account the increase of the irrigated area in Fuente Palmera (data provided by CHG, 2011b), the cut is only of 8.5%

7.2.1.4.4 Allocation review due to efficiency increase

So far, the different modernisation programmes have not been accompanied by a revision of existing water permits to accommodate them to the new (lower) water requirements and some research advice that this overall target compliance will possibly not happened at all (Gómez, 2010; Fuentes, 2011:12; WWF, 2011a). Rather, farmers have intensified production, either increasing crop rotations (up to 2 or 3 harvests per season), or expanding total irrigated area (often inside the irrigable area). As a result, agricultural water demand has become less flexible and return flows have decreased (WWF, 2006) e.g. return flows are expected to decrease from 117 hm³/year to 66 hm³/year in the Guadalquivir RBD by 2015. (WWF, 2011a)

These increased efficiency and the crop shifts can make Spain's agriculture more vulnerable to potential water shortages and increased energy dependency and pumping costs, and reduce water availability during drought crisis when agriculture could lose water shifted to priority water users (urban supply).

In any case, the review process regulation is slowly up taking into the Spanish legislation: The Andalusian Water Law²⁰⁸ foresees that from 2015 onwards those irrigators that receive public financial support for their water-efficiency improvement loose a part of their water rights towards the Public Water Bank²⁰⁹. Nonetheless, Article 22 of the Guadalquivir dRBMP still establishes that up to a 19% of the water savings (44,4 hm³) can be re-invested in new irrigation areas in the RBD²¹⁰; and it is foreseeable (due to past experience) that the dRBMP's overall -9.73% water consumption trend estimation based on the recovery of water rights (due to modernisation processes) will not happen by 2015.

7.2.1.4.5 Restrictions to irrigation

In the last 30 years, in a 1/3 of all years, less than 65% of the water demands of irrigation have been satisfied. In 5 years, almost no irrigation has taken place (Junta de Andalucía, 2011b:43).

Over the last 3 years, no restrictions have been applied to the surface water irrigation in the Guadalquivir RBD, and in the main Guadalquivir river area 1,200 hm³/year were available, though in 2009 and 2010 only 805 and 1,010 hm³ were consumed in the irrigation period from July 1st to September 15th. This figure includes the 50 hm³/year transferred to the Almanzora area outside the RBD. Additional 50 hm³ were allowed to increase the supply/ha for 10,000 hectares of precariously irrigated fruit trees and horticulture.

7.2.1.5 Inter-basin water transfers

Despite its overallocation of resources, the Guadalquivir basin delivers water up to the Almanzora basin (part of the Mediterranean Andalusian RBD). This legal inter-basin transfer happens via a regular water transfer, plus a complementary (seasonal) water market between irrigators established e.g. in 2006-2008, based on the 2001 Water Act.

²⁰⁸ Disposición adicional octava

²⁰⁹ Art 46, Andalusian Water Law

²¹⁰ This volume is enforced by the current RBMP and has been agreed with the European Commission

The Negratín (Guadalquivir RBD) to Almanzora (Mediterranean Andalusian RBD) transfer in the Andalusian autonomous region was approved in 1998 (Royal Decree 9/1998) in order to strengthen supply guarantee for overall water demands in the province of Almería, both for irrigation and for municipal water supply. It transfers a maximum of 50 hm³ from the Negratín dam, in the Guadalquivir headwaters to the Cuevas de Almanzora dam, 120 kms away. A budget law the following year (Law 55/1999) appropriates the necessary funds for the infrastructures. The law explicitly recognises that the Guadalquivir River basin has no “excess water” but, rather, that the water transfer will contribute to a situation of water deficit in the basin. The 1999 law therefore establishes strict conditions for transfers to take place:

- Transfers will only be allowed when reserves in the Negratín dam exceed 210 hm³.
- Transfers will only be allowed when overall reserves in all the dams in the Guadalquivir river exceed 30% of total capacity
- A maximum of 50 hm³ can be transferred annually.
- The final users were responsible for the costs of the potential new infrastructures that may be necessary to build in the Guadalquivir river basin to compensate for the added deficit that may be caused by the water transfer, which eventually amounted to the building of a new dam (Breña II).

In 2005, a new piece of legislation (Royal Legislative Decree 15/2005) allowed the use of the infrastructure in order to transfer water resources between both basins that resulted from seasonal water permit purchase agreements (a type of water market) between users in the Negratín and the Cuevas de Almanzora basins. Garrido and Calatrava (2009) report purchase prices of 2 – 2.4 €/m³ for public water concessions, to be transferred; whilst farmers with concessions from Negratín reservoir leased water at 0.15 – 0.18 €/m³.

The Negratín-Almanzora water transfer is managed by a Technical Management Commission (*Comisión de Gestión Técnica*) which determines the transferable amounts on an annual basis. It is made up of representatives of the Andalusian Water Agency, the Guadalquivir RBA, and users of both the donor and recipient basins, but does not include other water stakeholders.

Users pay the administrative price of 0.12 €/m³ (0.06 €/m³ for the water and 0.06 €/m³ for the financial and management cost of the infrastructure) (Berbel *et al.*, 2010), except in water scarcity situations.

7.2.1.6 Water markets

In Spain, two options for water markets have been established (Hernández-Mora *et al.*, 2010):

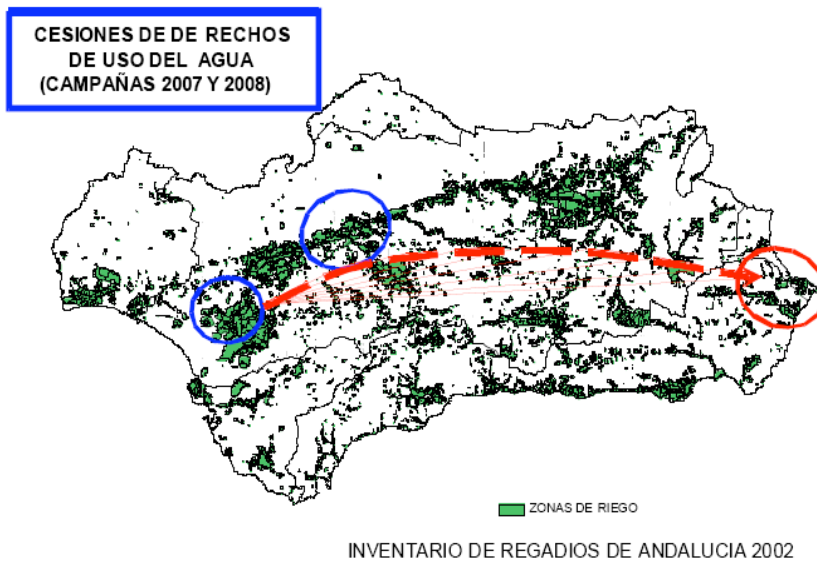
- Public water permit exchange center (*Centro de intercambio de derechos de uso*) – according to the 2010 Andalusian Water Law named Public Water Banks (*Bancos Públicos de Agua*) - set up and managed by a RBA. It uses public funds to buy water rights from legal users for a limited time-period; or permanently. Until now, the Centers have been active in the Guadiana and Júcar RBDs, mainly oriented towards minimising the effects of (illegal) groundwater overexploitation (e.g. Requena, 2011).
- Water permit seasonal sales (*Contratos de cesión*) allow for voluntary agreements for sale of water use rights on a seasonal basis among users in the same or different river basin districts. The sales must be approved by the competent RBA and respect the order of priority allocation established in the RMBPs.

Sales have taken place between irrigators in the Tajo and Segura river basins, in the Guadalquivir river basin, or between urban water users and irrigators in the Tajo river basin.

7.2.1.6.1 Formal water markets in the Guadalquivir basin

In the Guadalquivir RBD, seasonal sales have occurred between (a) irrigators communities in the Middle and Lower Guadalquivir basin (Margen Izquierda del Bembézar, Pago de la Vega del Serón) and the Aguas de Almazora S.A. Water Company and (b) the proper water company after having acquired 1,600 hectares of rice paddies in the Lower Guadalquivir, as shown in the following map

Diagram 48: Seasonal water sales in the Guadalquivir basin (Corominas, 2011b):



15 hm³ water selling were provided from the Guadalquivir middle stretch where extensive summer crops and citric are cultivated with an average productivity of 2,300 €/ha or 0.3 €/m³ and an associated employment of 22 WD/ha. In this area, the water price is 0.012 €/m³ and constitutes 4% of the production costs. 1,200 m³/ha were sold at a price of 0.18 €/m³ (approximately 2/3 of the productivity).

10 hm³ water was provided from the Lower Guadalquivir rice paddies, with a productivity of 2,200 €/ha or 20.2 €/m³ and an associated employment of 8 WD/ha. In this area, the water price is 0.024 €/m³ and constitutes 11% of the production costs. 5,000 m³/ha were sold at a price of 0.18 €/m³ (approximately 90% of the productivity). The selling of water in Lower Guadalquivir rice area is a 'permanent sale' as the landowner is the Almazora irrigation community that bought the land with the linked water rights. The RBA authorises the transfer of 50% of nominal water concession (i.e. instead of 12.000 m³/ha, the transfer is limited to 6000 m³/ha) but every year the transfer should be specifically approved according the specific conditions of each hydrological year.

The water was acquired in the Almazora area, for citric and horticulture with an average productivity of 8,500 €/ha or 1.6 €/m³ and an associated employment of 60 WD/ha. In this area, the water price is 0.015

€/m³ and constitutes 14% of the production costs. The acquisition covered 25 hm³, with an average of 1,500 m³/ha.

7.2.1.6.2 Evaluation of water markets

Though an *ad hoc* expert group was set up ex-post by the Spanish MoE (Arrojo *et al.*, 2008), no significant public evaluation of the water markets was carried out (neither qualitative nor quantitative, nor regarding the environmental, social and/or economic aspects)²¹¹. Only the direct compensation of lost profits has been supervised with an added difficulty of these concepts within the water market inside the Aguas de Almazora S.A. Water Company.

The main concerns regarding the water seasonal sales allocation process in the Guadalquivir RBD have been the following (based on Arrojo *et al.*, 2008 and Corominas, 2011b):

- Lack of ex-ante and ex-post evaluation of the water-management effects (e.g. e-flows, non-consumptive water usage, water quality) of transferring water consumption from the lower basin to an external basin directly from a dam located in the upper basin.
- As the seller and buyer is the same entity in the case of the rice paddies market, the lost benefits are 0 €, and an analysis of external costs is missing (apart from the establishment of 0.04 €/m³ for the non-irrigation of rice paddies).
- Complexity of the water rights system, in particular if the sales affect the proportional part of overall irrigator communities' rights on water. In this case (rice paddies), the sales process is lacking its legal basis as the water seller is not holding the water rights as required, but in practice the Irrigators Community has given its OK to the selling.

It is expected that water markets will increase in the Guadalquivir RBD both inter-basin and intra-basin, in order to “adjust” the problems of the over allocation of water rights. Thus, and according to the dRBMP, new water users such as producers of renewable thermo-solar energy can be enabled to acquire water from agriculture (Del Moral, personal communication 27 June 2011, refers to a current negotiation process in the Castril area).

In fact, the Guadalquivir dRBMP²¹² foresees Public Water Banks though it explains also the uncertainties regarding the overall water savings and the water-management impact of the measure.

7.2.2 Water pricing policy in the agricultural sector

Water pricing has been traditionally established as a mean to (partially) recover costs of the investment, operation and management of the infrastructure on a per-hectare basis, discouraging water use efficiency and the adoption of water saving techniques. As a result of WFD transposition to the Spanish law, cost recovery and polluter-pays principle was introduced.

²¹¹ Please note that a FP7 research project Cap & Trade analyses the Guadalquivir water markets. URL: <http://www.capandtrade.acteon-environment.eu/>.

²¹² See MARM (2010): PoM Annex 10, page 111

However, no significant advances towards (financial, environmental and resource) cost recovery have been made. The current position from users that “costs are already been recovered” has acquired official status and their *status quo* has been maintained, especially hydropower and farmers. The lack of transparency in the cost evaluation of public water services prevents society to be aware of shadow subsidies and the scarce promotion of social participation avoids public debate on this topic (except a 2007 working group including public water debates), as a motivated exemption from cost recovery (Corominas, 2011a).

Environmental and resource (opportunity) costs are not being considered yet the dRBMP proposes two possibilities to approach these²¹³.

7.2.2.1 Current Framework

7.2.2.1.1 Water prices (for sectors)

At country-level, average tariffs paid for irrigation water in areas where water is supplied by RBAs is 0.02 €/m³ except for the agricultural uses served by the Tagus-Segura Transfer, who pay about 0.09 €/m³ whereas that use groundwater pay an average of 0.04 to 0.07 €/m³ (Garrido and Calatrava, 2009). According to the Guadalquivir dRBMP, the average tariff for water considering all uses is 0.0145 €/m³, and is split in the following way:

Table 37: Average water tariffs

Average water tariffs	Agriculture	Households	Industry
Guadalquivir ²¹⁴ basin (MARM, 2010)	0,0262 €/m ³	1,47 €/m ³	1,75 €/m ³
Fuente Palmera (CHG, 2011b)	0,18 €/m ³	0,705 €/m ³	0,875 €/m ³

There is a big difference between prices from groundwater and surface water provided by RBA through Irrigation Communities. In Fuente Palmera, normally price of groundwater is twice the surface water. In case of self-abstraction (usually groundwater), this is “not priced” as the farmers pay their own costs, estimated at 0.15 €/m³ (Berbel and Kolberg, 2009; Fuentes, 2011:14).

7.2.2.1.2 Aims of the water policy

The Water Act 1/2001 establishes that the cost recovery principle (including environmental and resource costs) shall be considered by Public Administration regarding the water related services, according to the long term projections of supply and demand, and implemented by encouraging efficient use of water and an

²¹³ The dRBMP includes a measure on cost recovery of raw supply for the 10% of the annual equivalent cost of the whole PoM.

²¹⁴ The agricultural tariff has been estimated as the ratio of total revenues received from RBA irrigation services (CR and TUA) and irrigation communities (*derrama*), divided by the estimated irrigation demand at basin level. See MARM (2010): Annex 9:43 and Annex 10: 111). Please note that it does account for on-farm costs, thus cannot be directly benchmarked against households or industry tariffs,

adequate contribution from the difference uses, according to the polluter-pays principle and transparency and considering, at least, drinking water supply services, agriculture and industry.

The Administration responsible for water supply shall set the tariff structures based on consumption blocks, aiming to provide basic needs at an affordable price and to discourage excessive consumption. Appropriate mechanisms to avoid duplicity when recovering the cost of services shall be used.

However, certain considerations (social, environmental, economical, geographical and climatic) are to be considered when applying cost recovery, as long as environmental objectives are not compromised.

7.2.2.1.3 Water tariff structure

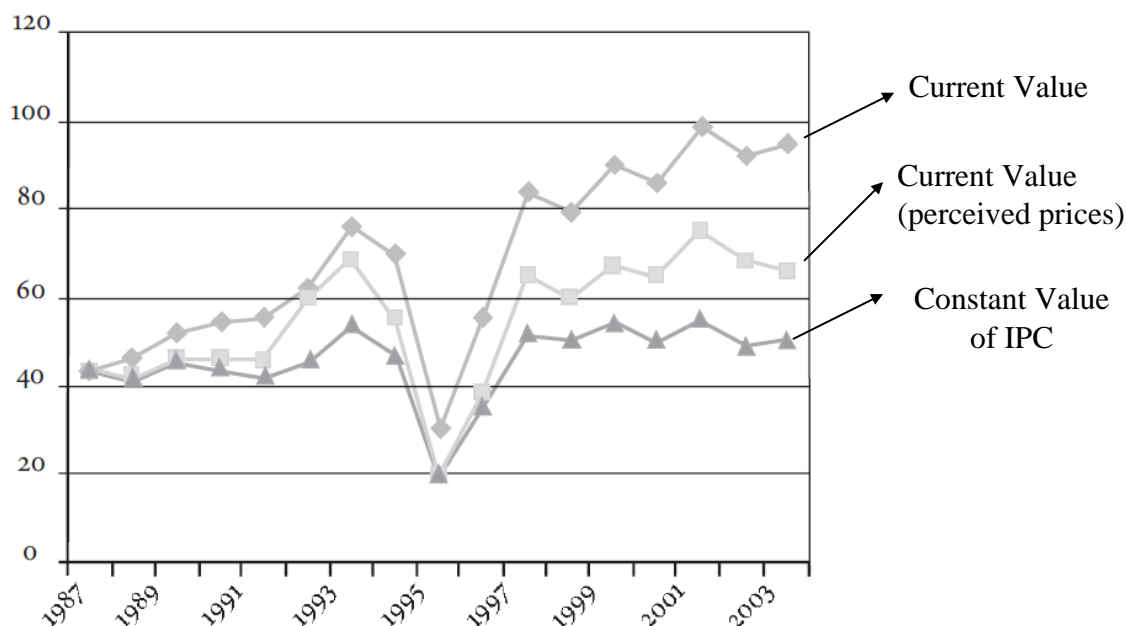
According to a Survey on Irrigator Communities (Tragsatec, 2008), area-based water tariffs are by far the most common (76.07% of the 234 assessed communities) in the Guadalquivir RBD. This can explain by large the strong irrigator's requests for larger water allocations to their crops. Water-consumption based tariffs are being applied in 10.68%, and fix tariffs in a 1.28%. 11.97% pay based on a mixed schemes or according to other criteria (e.g. irrigation hours). Furthermore, another water-related quota paid commonly in the basin is a 3-6€ per irrigated olive tree.

Regarding the energy costs for water pumping, irrigators in Spain pay different costs in the Spanish RBD. The Guadalquivir lies in the lower range of costs with an average of 0.02 €/m³ (the extremes are the Tagus basin with 0.001€/m³ and the Júcar RBDs with 0.116 €/m³) (Tragsatec, 2008).

7.2.2.1.4 Evolution of the pricing policy

The pricing policy historically remained flat-rate on a per-hectare basis before the promotion of latter modernisation plans, which involved adoption of metering devices in order to implement volumetric tariffs progressively. The next Diagram (Del Moral and Silva, 2006) depicts the evolution of irrigation water tariffs (CR + TUA) in the low Guadalquivir. The deflated plot shows that prices have not varied significantly from 1987 to 2003, when modernisation works began.

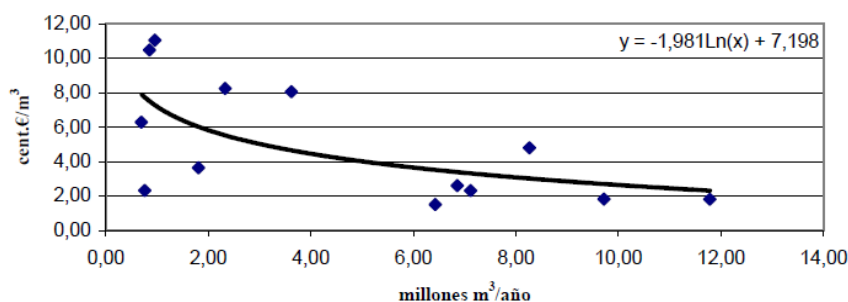
Diagram49. Evolution of irrigation tariffs (€/hectare) in Lower Guadalquivir



Charges for distribution of irrigation water to farms by the Irrigation Communities are traditionally set as flat-tariffs as well for surface water and volumetric for groundwater. From the development of modernisation projects onwards, metering is becoming a usual practice and volumetric tariff expands on the basin, though it is still a fixed part on the tariff to collect CR and TUA. The average cost is estimated between 0.02 – 0.08 €/m³ and decreases with the amount of water supplied (CHG, 2007)

Diagram50 : Apportionment costs in Irrigation Communities

coste vs tamaño



7.2.2.1.5 Subsidies provided

The Irrigation National Plan provide subsidies²¹⁵ in developing/modernising irrigation schemes, linked with a theoretical reduction in the permits which represents a 20% decrease in water consumption for most cases. This reduces abstractions and return flows as well, and improves water quality. Modernisation investments, operation and maintenance result however in a cost increase of 0,12 €/m³, 30% of which is currently being subsidised, thus users bear an actual increase of 0,06-0,09 €/m³. Subsidies are justified with the water savings from permit revisions by the RBA (MARM, 2010, Annex 9:27). Regarding the operation and maintenance costs, the irrigators have to pay from the very beginning (private funds). The investment costs are partly assumed by the authorities (SEIASA) due to the following setting: During a first 25-years grace period, the cost is fully assumed by the authorities, whereas from year 26 to 50, users payback the investment, though prices are not updated and this procedure can be considered as a hidden subsidy (MARM, 2010, Annex 9, p.45). This government capital is however paid back without interest rates and the part corresponding to EU funds are not recovered (Krinner and Segura, 2011).

7.2.2.1.6 Exemptions from the system

At basin-scale, certain services are excluded from cost-recovery, since their beneficiaries are not easily identifiable or are the society in general. For instance, flood protection derived from regulation works (accounted for a 20% of the cost), riparian or river-bed works in rural or urban areas, environmental regeneration in riparian areas, etc. are recovered by general taxes instead of user charges.

In drinking water supply systems on mountain or disfavoured areas, cost recovery is also overlooked, as user might not be able to bear the costs, or as a policy of population settlement and rural development. Irrigated areas in north of Jaen and Granada support an important generation of agricultural employment.

Cost recovery is not complete wherever irrigation (and sanitation) infrastructure has been financed by EU funds. The trend is to recover costs via CR and TUA.

Current irrigation water tariffs do not reflect the recent increase on investments in infrastructure as a result of modernisation projects, and the cost recovery is estimated to be 76,31% for irrigation (MARM, 2010, Annex 9, p.44). Nevertheless, modernisation projects also require important investments by the farmers themselves, thus making counterproductive to recover modernisation subsidies, and contradicting the Irrigation National Plan. In addition, subsidies to modernisation are linked to reduction of permits, thus farmers receive subsidy and reduce their water rights simultaneously.

²¹⁵ Investments, are financed to a 50% by the Ministry. However, some irrigation projects were considered as rural development measures, thus receiveing co-financing from the European Agricultural Guidance and Guarantee Fund (EAGGF)

7.2.2.1.7 Changes in the water pricing policy since the introduction of the WFD (2000)

A significant number of studies have been developed in order to analyse water pricing aspects in Spain, and despite the strong criticism on the validity of the data and the range of the cost recovery percentages, as well as on lacking debates on water pricing policies, information has improved significantly.

Today, water pricing policy is focused on polluter pays and incentive cost recovery (CHG, 2011b). In the Guadalquivir RBD, water prices for irrigators have decreased or not increased since the WFD (Feragua, 2011; CHG, 2011b), though farmers have to assume increased energy costs due to the efficiency modernisation process.

Levies are likely to double, and perhaps triple, if resource and environmental costs are also included in the definition of service costs (Garrido and Calatrava, 2009).

7.2.2.1.8 Water pricing in the dRBMP (2011-2015)

The major change foreseen in the dRBMP is an increase of 0.01 €/m³ for agrarian uses (and of 0.033 €/m³ for urban and industrial uses). Nonetheless, this change does not cover the costs of the PoM which implies an average cost of 0.141 €/m³ (apart from administrative and financing costs²¹⁶) (Corominas, 2010).

The PoM plans an increase of 57% in regulation and supply costs for all uses and it is expected to be completely transferred to the users (both investment and operation, deducting non-recoverable costs e.g. flood prevention). The level of cost recovery is expected to rise from 80,9% to 88.7% and is treated for all uses in general. Distributional issues of this cost recovery are not described in the dRBMP but are to be dependent on equity and territorial policy criteria.

The envisaged cost increase for water distribution at scheme level is 212%. Subsidised modernisation measures are justified by the improvement in irrigation efficiencies and water savings, which represent compensation from the users for the public spending. Increases in operation costs are fully paid by the farmers through the Irrigation Communities, but investment costs are partially (60-90%) subsidised. The level of cost recovery is expected to decrease from 76.3% to 75.3% in regulated waters.

The dRBMP envisages that on-farm groundwater usage, currently not priced, will be charged to redistribute the overhead costs of the RBA, currently afforded only by users of regulated (surface) waters. This will be done through a new *water planning and control levy* and the expected effect of all water pricing measures is full cost recovery (MARM, 2010).

²¹⁶ Note that this figure refers to all Andalusian RBMPs and their PoMs and not only to the Guadalquivir.

7.2.2.2 Factors influencing the impact/effectiveness of water pricing policies

7.2.2.2.1 Water prices, water resource types and crop selection

The different costs and other aspects such as availability and quality can also affect on the usage of different water resources for different crop types. In this sense, it is relevant to note that groundwater usage (0.1614 €/m³ according to Art.5 report; 0.15 €/m³ according to 2005 data) is in average significantly more expensive than surface water usage (0.0683 €/m³ according to Art. 5 report; 0.034 €/m³ according to 2005 data) (Argüelles, 2011).

Therefore, groundwater resources are mainly used for those crops that provide higher revenues and are more efficiently irrigated (e.g. drip irrigation), and require continued water supply (permanent vs. annual crops), thus also allowing farmers to earn a more certain return on investments from water savings (Fuentes, 2011:14).

7.2.2.2.2 Implementation of water metering

Increased water metering is one of the aims of the water policy in the Guadalquivir RBD, since May 2009 a ministerial order (ARM/1312/2009) introduced the obligation (to be implemented gradually) to meter all water consumption, regardless of the type of consumptive use (Fuentes, 2011:19).

However, neither clear information on this has been found on the dRBMP; nor information has been found on historical evolution of metering. In the Fuente Palmera irrigation area, all plots are metered though it is also recognised that minor illegal abstractions are being realised (CHG, 2011b).

7.2.2.2.3 Information about the price and allocation policy to farmers

Farmers are usually informed by a set of bodies, e.g. the Andalusian Water Council, National Federation of Irrigators Communities (FENACORE) and the corresponding Andalusian Federation of Irrigators Communities (FERAGUA), RBAs websites, etc.

FERAGUA has a strong communications and advocacy component (e.g. website, newsletter, etc.) and via the Irrigators Communities they communicate with the farmers. At the same time, many farmers are also associated to syndicates, in particular those that are not associated to an Irrigators Community, and the syndicates develop also lobby and communications activities on water, in particular during the irrigation seasons and droughts.

A 2008 opinion poll on Irrigators Communities (at Spain level; Tragsatec, 2008) shows that 50% are satisfied with the support and information received from the RBAs; but 50% require better maintenance of water infrastructures, more information, technical support and subsidies, a more effective control of illegal abstractions in their neighbourhoods, and a major effort to reduce water quality-related and flood risks.

7.2.2.2.4 Control system

The Guadalquivir RB authority has personnel in charge (*guardería fluvial*) of visiting, metering and controlling the water abstraction and correct compliance with what it stated in the water use license.

Nonetheless, monitoring of abstractions – in particular of groundwater – are weak (López-Gunn, 2009), due to the under-budgeted programmes ARICA and ALBERCA and the incompleteness of the official Register for water users (De Stefano, 2005). Registration of groundwater abstraction rights is still incomplete, undermining the enforcement of measures to prevent overexploitation. While progress has been made in improving control of excessive groundwater abstractions, this framework has still not been sufficiently effective to avoid overexploitation (Fuentes, 2011:24). According to OSE (2006) the number of infringement procedures for illegal abstractions in the basin reached 3.207 during the past 10 years. The following table (CHG, 2004) presents statistics on activity of this surveillance system (including not only abstractions, but also discharges, spills, sampling, sealing of meters, etc.).

Table 38. Complaints and reports filed by the *Guardería fluvial* in the Guadalquivir

	2000	2001	2002	2003
Complaints	817	867	999	1.230
Reports	9.875	9.780	10.745	12.057

7.2.2.2.5 Tackling illegal abstraction

Though there are most possibly tens of thousands of illegal water abstractions across the RBD, the administrative process for fines and/or closure is very complex and has been developed successfully for only some hundreds of illegal abstractions over the last years; possibly with a lower ratio than the increase of new illegal abstractions and often blocked due to political sensitivity and irrigator's lobby, e.g. AEVAL (2010), Dworak *et al.* (2010), Caro (2010) and WWF (2010).

Usually, RBA rangers or the Civil Guard's SEPRONA rangers identify illegal abstractions, often if somebody pressed charges against the water abtractor. Their access to farms is often impeded, when rangers try to access for inspection without a court's authorisation; and in a very limited number of cases (e.g. Bionest (Almonte), 2009), farmers demonstrate massively and impede the closure of illegal abstractions. Illegal abstraction are considered as a minor infringement and it would be fined by a maximum ticket of 6,010.11 € (CHG, 2011b), which can be considered of low impact. In consequence, Corominas (2011a) judges that the predominant water rights system in Spain is approaching a "private appropriation's system" instead of a "public water rights allocation system".

7.2.2.2.6 Share of water in total production costs

The share of water in the production costs of the Fuente Palmera irrigation community is of 7% (CHG, 2011b).

7.2.2.2.7 EU Common Agricultural Policy

More decoupled measures of support may make pricing policies more effective and less negative for farmers' benefits (Garrido, 2006). In Spain, CAP payments are mainly addressed to irrigated agriculture, rather than rainfed, especially for the category of Pillar 1 "Other payments", while Pillar 2 payments are linked to investments on the modernisation of irrigation schemes modernisation. Pillar 1 direct payments and Pillar 2 payments are reported to be higher on areas vulnerable to nitrate pollution, e.g. rice and protected crops in the lower Guadalquivir. Coupled payments represent 15% of total Pillar 1 in 2009 (Becarés *et al.*, 2010).

Furthermore, Pillar 1 "other payments" receiving areas coincide to a great extent with irrigation zones located on nitrate-vulnerable zones or schemes abstracting water from overexploited aquifers. In this sense, Becarés *et al.* (2010) alleged that some important wetlands, e.g. Doñana National Park (RAMSAR and Natura-2000 site), are threatened by pollution and overabstraction. Large share of the funds was absorbed by a small number of areas or large or intensive enterprises, benefiting farming practices with a negative environmental impact and less support was directed at enterprises of higher environmental value.

In the Guadalquivir valley, decoupling has different effects depending on the crop type. For crops with high water productivity (e.g. cotton, beet, garlic, olive) consumption of water and agrochemicals decreases due to the reduced income, while for low water-productive crops such winter cereals and sunflower, these reductions did not take place. Lorite and Arriaza (2009) report changes in farmer behavior with regard to water management, leading to increases in irrigation water productivity for cotton and beet using deficit irrigation practices, with less environmental impact and more guarantee of sustainability.

In a survey involving EU-15 and non-MS farms, Giannocaro and Berbel (2011) however reported significant differences in farmer's decision under different CAP scenarios regarding use of water, with an intention of slight reduction in water use on the farm in case of removal of CAP payments and instruments (CAP scenario by 2020), as well as a long-term invariant pattern to maintain current use of water, with intention of slight increase. CAP role however appeared to be non univocal and strongly case-specific (e.g. depending on subsidies, farm size, farmer's age or farm location). A common pattern of impact thus cannot be established as regional differences matter both on site-specific structural and institutional conditions (Blanco Fonseca, 2009)

In the *Campiña Baja* of Guadalquivir, partial decoupling under the current water pricing setup (marginal cost of water approaching zero) does not necessarily induces significant changes in the total irrigated area for competitive crops, i.e. olive (so far, constrained with production quotas and availability of irrigation facilities), cereals and industrial crops (sunflower, beet and cotton), with land reallocation from cereals to industrial crops (MMA, 2007). This latter phenomenon however reverts if full decoupling is considered. On the other hand, legumes are replaced by horticultural crops. However, these results cannot be generalised as are

dependent on local conditions, including soil characteristics and agronomical suitability, production patterns and farmer behavior towards risk and management complexities.

The impact of CAP reform on water demand was reported similar as for extension of irrigated area. No significant differences can thus be derived from the Agenda 2000, partial and full decoupling scenarios. Constraints on farmers' choices are related to water availability, rather than to its price, and allocation is made according to benefits, risks and management of crops. Variations on water demand were report to be less than 6% between scenarios.

Comparing simulated scenarios for Agenda 2000, CAP 2003 Reform and Total Decoupling, in the Guadalquivir, Gutiérrez and Gómez (2009) found that as decoupling is higher, the extension of irrigated land is reduced and, therefore, decoupling subsidies decreases irrigation agriculture. Nevertheless, this reduction on irrigated land does not have a similar effect on level of water consumption, which is however maintained. Higher dependence on market prices would then have as consequence an agrarian model less land-intensive and more water-intensive.

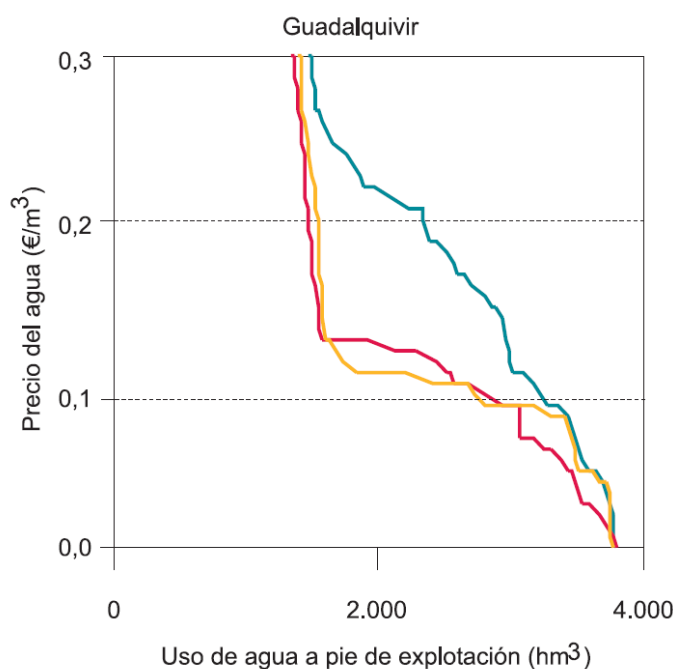
Table 39. Socioeconomic indicators under different CAP scenarios in the Guadalquivir (Gutiérrez and Gómez, 2009)

	Agenda 2000	2003 Reform	Full Decoupling
Irrigated surface (hectares)	736.328	726.708	672.079
Water use – Total requirements (hm³)	2.930	2.944	3.185
Water use – On-farm (hm³)	4.180	4.203	4.173
Water use – On-farm (m³/ha)	5.676	5.783	6.208
Irrigation application efficiency (%)	70	70	70
Gross value added (€/ha irrigated)	1.393	1.543	1.716
Net Margin + Single Payment (€/ha irrigated)	1.307	1.449	1.496
Wage employment (AWU)	46.101	37.012	36.576
Family employment (AWU)	22.334	18.010	17.442

At basin level, decoupling has a positive effect on the GVA of the agricultural sector in the Guadalquivir district (although not the case in other basin districts, e.g. Ebro) and the Net Margin. The effect on employment is however negative on labor, especially in the Upper Guadalquivir, where olive crops (>80% of total area) are very labour-intensive.

Despite not having significant effects on the demand of water, effects of decoupling are relevant regarding farmers' response to changes in water prices, as this would have more effectiveness as a saving measure. Decoupling itself does not save water, but enhances economic incentives to save water (and other inputs).

Diagram51. On-farm water demand curve for the Guadalquivir (Gutiérrez and Gómez, 2009)



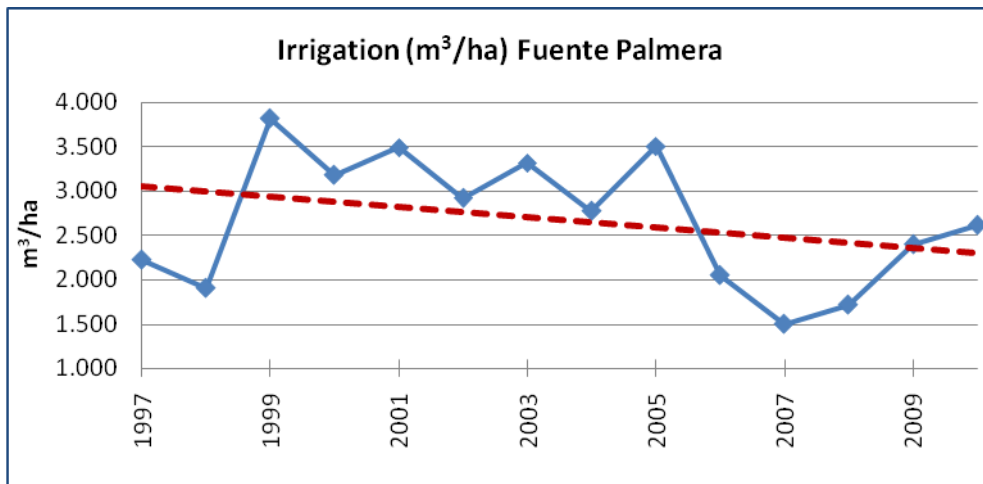
Blue plot: Agenda 2000, Yellow plot: 2003 reform, Red plot: Full decoupling

MMA (2007) also reports a neutral effect of the CAP 2003 reform in Campiña Baja on water use, and a higher farmers' sensitivity to economic incentives, like input (e.g. water) prices, but conditioned to maintaining levels of income. Water demand varies with water price if this latter is greater than water productivity.

For the Fuente Palmera Irrigators' Community, expansion of irrigated area correspond mainly fruit, citrus and olive crops (drip irrigation) and winter cereals (sprinkle) after CAP reform. Reductions are observed in cotton and maize. Water demand and use are higher under Agenda 2000. Main differences between 2004 and 2009 scenarios, besides changes in crop pattern and water use, are changes in crop profitability (income and cost), changes in CAP subsidies policy, increase in water cost (mainly due to energy), increase in high value crops. The consequences of the above mentioned responses to water cost increase has positive effects in water use and water productivity.

Increases in water cost experienced at Fuente Palmera are compensated by reducing water use by 11%. Shifting towards higher value crops and adopting techniques of partial irrigation whenever possible made water use more efficient by reducing losses in the system. Another strategy was deficit irrigation practice as long as fruit quality and price were not affected.

Diagram52. Evolution of water consumption in Fuente Palmera (CHG, 2011a)



Observed reduction in water use results from the combined impact of four drivers: (1) scheme modernisation (2) CAP reform, (3) irrigation management practices, and (4) increase in water cost. However, it is not clear whether any of them might counteract the others. More on the contrary, a synergic effect between them is more plausible, on the basis of the existing studies referred above. The combination of this strategies for adapting to rising water costs gives the values of apparent water productivity of income per m^3 to be 1,34 €/m³ (+25% after CAP reform) and net income is 0,39 euro/m³ (+29% after CAP reform).

7.3 Analysis of water pricing and water allocation policy

This chapter includes information and analysis about enforcement problems, weaknesses of the system impact of policy on water use behaviour, etc, water imbalance in the case study area, adherence to article 9, etc.

7.3.1 Drivers and Barriers

The following parameters have been identified as drivers and barriers for a WFD-compliant water allocation and pricing system:

- The Guadalquivir RBD suffers from over allocation of water resources, mainly due to irrigation (87% of the water abstraction), and the main performance failures of its water allocation system are caused by:
- Social and user perception of irrigation agriculture as flexible and high-revenue, partially due to lack on information on externalities, converting water availability into a myth (Corominas, 2008)
- An inflexible long-term (75 years) focused water rights system, that does not account for changes in economic and social requests
- Continued politically-driven assignation of water rights despite increasing costs, user conflicts and environmental deterioration; even as non-sustainable precarious water permits.
- Since July 2005, new surface water permits are not issued unless planned on the current RBMP, and applications for new groundwater permits are denied for water bodies with an exploitation ratio higher than 40%. Since July 2008, any new application for a water permit is denied. The new dRBMP is coherent with this position.

- Uncertainty of data regarding per hectare net water consumption in agriculture, accounting for significant average differences. The dRBMP accounts for 3,329 hm³/yr and Regional agriculture authorities and irrigators use water consumption data ideally at a 4,195 hm³/yr level though they recognise that farmer's irrigation decisions and/or under-supply of water reduce water consumption more or less to similar data than used by the dRBMP (Junta de Andalucía, 2011b; WWF, 2011a).
- Permissiveness towards illegal water usage, being manifest in the late (since 1995 via the under-budgeted programmes ARICA and ALBERCA) and uncompleted official Register for water users; and the non-persecution of illegal water abstractions (e.g. De Stefano, 2005)
- Performance of Water Price System
- In an efficient water market, equilibrium price is achieved where the marginal value to each user is equal. However, in the basin, different uses (and crops) generate different rates of productivity and confront different prices and levels of quality of supply according to what level of priority has each sector in case of scarcity or drought, i.e. higher priority users pay a premium for water process (Berbel and Kolberg, 2009), difficulting the efficiency of the water pricing mechanism. Complementary to the modernisation of scheme infrastructure, a shift towards improving efficiency by water re-allocation is under development and envisaged in the Programme of Measures of the dRBMP: irrigation water for herbaceous crops (cereals, horticultural...) is allocated to uses with higher willingness to pay (tree plantations or industry). The prioritisation of uses enforced by the Water Act, the rigidity of the permit system (*concesiones*) and the subsidised (low) prices still paid by agricultural users in comparison with industrial or urban, hinders optimal allocation of the resource. It is worth to mention also that environmental costs are transferred from agriculture to other users, e.g. urban.

Table 40 : Allocation of use, rights and generated GVA in 2005 for the Guadalquivir basin (adapted from Berbel and Kolberg, 2009)

Sector	GVA	Water use	Administrative rights
Agriculture	7% ²¹⁷	87%	89%
Industry	15%	2%	2%
Tourism	6%	<1%	<1%
Urban and others	71%	11%	9%

- Although the Water Act 1/2005 envisages cost recovery and a legal economical-financial regime has been defined for such purpose, several flaws hamper this pursued objective. Indeed, the structure of CR and TUA does not prevent indirect users to be charged for the services offered by the infrastructure (e.g. flood protection). The economic studies elaborated for the dRBMP have been developed according the economic-financial system of the Water Act, with implicit subsidies of 50% on investment costs, around 20% of regulation infrastructure considered of public interest and thus its cost is not recoverable, and that EU financing and public subsidies for infrastructure not been accounted for. Those distortions invalidate the high recovery rates stated in the dRBMP. Alternative estimations reduce cost recovery ratio to 20-23% for RBA services, with the criteria and exemptions envisaged by WFD (Krinner and Segura, 2011; Corominas, 2010). Operation and management costs derived from the modernisation and optimisation of schemes are fully borne by users. Environmental costs are not being charged to the users. The dRBMP approaches estimation of environmental costs as the net negative externalities of water use, measured as the cost of the measures defined to fulfil environmental objectives. For irrigation with surface waters, this

²¹⁷ Irrigated agriculture represents 3,5% of total GVA

cost is estimated in 0,12 €/m³ approximately, from data of on-going modernisation projects of the Irrigation Communities. This cost is partially subsidised (60% - 90% of the investment), justified on the basis of that water savings would result in revision of abstraction permits, which is up to the RBA. Furthermore, after modernisations, volumetric tariffs are implemented and supported by the users. Regarding groundwater irrigation, the dRBMP proposes the creation of a *water planning and control levy* that would not result in an increase of tax burden, but on redistribution among groundwater users, who are currently not being charged. As regards for the resource costs, the dRBMP assumes them to be merged with environmental costs²¹⁸, and estimated to be between 0,18 €/m³ (water rights market 2005-2008) and 0,50 €/m³ (industrial and horticultural uses), but no chargeable in any case to users (MARM, 2010, Annex 9, p.28).

7.3.2 Effects of the water allocation and pricing policies

7.3.2.1 Direct Effects

Official water allocation policy has ranked high agricultural water demand, and therefore pushed this sector, either by prioritising its water consumption in the allocation schemes (e.g. RBMPs, DMPs) or by low pricing (incl. administrative costs, according to Feragua, 2011) of water.

In consequence and considering the larger crop opportunities and production revenues via irrigation, farmers have a strong request to transform their plot into irrigation and even use non-authorized water, being aware about the relatively low law enforcement and corresponding fines, if detected. The main direct consequence is also an increase of the percentage of water exploitation, converting the Guadalquivir basin theoretically into a “closed basin” with increasing supply failure.

There has been however a significant increase in the cost of energy country-wide, which for Fuente Palmera was estimated to be 74% for the 2004-2009 period, resulting in positive effects in water use and productivity. Water cost increased by 28% in real terms, which is compensated by a 14% reduction in water use. The value of production has grown by 6% and the net margin by 11%, due mainly to changes in the crop distribution with an increase in perennials (trees and protected) that grows 36%.

²¹⁸ Environmental costs are insufficiently dealt with in the dRBMP, whis is an structural issue derived from the Spanish Hydrological Planning Guidance (IPH). Another relevant effect of this situation is the cross-subsidisation of agricultural uses for urban users. Moreover, in the context of approaches of water markets as a tool for allocation flexibility in a “closed basin”, poor accounting of environmental costs can have very negative consequences not only on the environment, but also in terms of efficiency and equity of allocation through market mechanisms.

Table 41. Water demand and water use in Fuente Palmera

Crop irrigated	2004 (ha)	2009 (ha)	2009 ETP-field	2009 Gross Demand
Winter cereals	983,3	1684,9	2.821,0	3.526,3
Olive	997,4	1.073,9	2.378,0	2.642,2
Citrus	360,1	1,072,3	4.017,0	4.463,3
Maize	754,8	549,0	5.938,0	6.597,8
Cotton	1.196,2	415,0	6.168,0	6.853,3
Other	344,8	356,6	3.500,0	4.375,0
Sunflower	260,2	213,8	3.548,0	4.435,0
Fruits	35,0	170,0	3.320,0	3.688,9
Vegetables	364,2	35,4	3.220,0	3.577,8
Protected	0,0	29,3	3.220,0	3.577,8
Total ha/average	5.296,0	5.600,2	3.609,4	4.178,1
Supply m ³ /hectare	2.773,4	2.398,9		
Gross demand	4.717,3	4.178,1		

Table 42. Evolution of land and water productivity in Fuente Palmera

	2004 ²¹⁹	2009	Increase
Fruits and vegetables (ha)	1.756,6	2.380,9	+36%
Extensive crops (ha)	3.539,4	3.219,3	-9%
Total area irrigated	5.296,0	5.600,2	+6%
Production			
Income (€/ha)	3.008,3	3.199,8	+6%
Net margin (€/ha)	841,6	1.021,2	+21%
Water cost			
Fixed cost (€/ha)	242,0	236,2	-2%
Energy cost (€/ha)	0,05	0,08	+52%

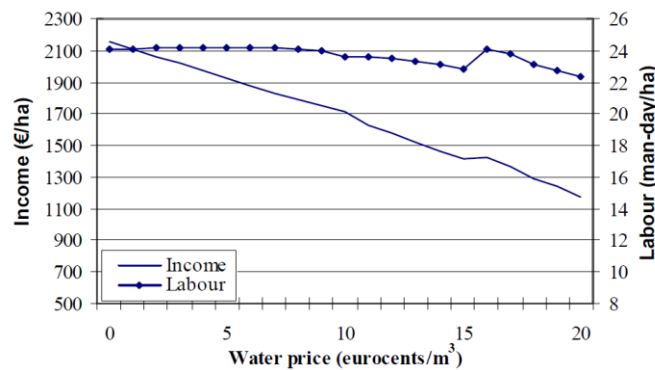
²¹⁹ Data in 2009 constant prices

	2004 ²¹⁹	2009	Increase
Total cost (€/ha)	390,2	431,7	+11%
Water demand and water use			
Water demand (m ³ /ha)	4.717,3	4.178,1	-11%
Water use (m ³ /ha)	2.773,4	2.398,9	-14%
RIS	59%	57%	-2%
Water productivity and cost			
Income (€/m ³)	1,08	1,33	+23%
Net margin (€/m ³)	0,30	0,43	+40%
Cost water (€/m ³)	0,14	0,18	+28%
Cost water / Income	13,0%	13,5%	4%
Total production and labour for Irrigation Community			
Total income (€)	15.931.969	17.919.449	+12%
Total labour (days)	105.823	146.793	+39%

Despite the water saving derived from pricing, the dRBMP envisages a variation on the irrigated surface at basin level from 845,986 hectares nowadays to 880,557 hectares in year 2015, which is a 4% increase. The total water demand is expected to increase in 2%.

7.3.2.2 Indirect Effects – demand responses of users to water prices

- Social
 - Analyses of real cases in Spain show small elasticity on closed basins (e.g. Guadalquivir, Segura) where price increases will mainly impact agricultural income –rather than water savings- and agricultural labour in a lesser extent. An scenario analysis of water pricing policies (Berbel et al., 2004) shows that a raise in water price to 0.10 €/m³ would lower farm income approximately 20%, differing from survey results at Fuente Palmera, where (per-hectare) income variation has been reported to be +6.4% since 2004, due to the shift in cropping patterns towards more productive crops and diminished water demands.

Diagram53. Socioeconomic impacts of water pricing in Guadalquivir basin (Berbel *et al.*, , 2004)


- The increased efficiency in water usage with new technologies is improving farmer's life quality. Nonetheless, it is unclear how the modernisation is affecting on direct employment.
- The overall increasing water allocation level in the RBD is placing additional stress in irrigation farmers, as there are significant shortcomings for full water supply in an increasing number of years, and farmers have to either reduce their water consumption and agricultural production (Camacho & Rodríguez, 2005) or use complementary illegal water sources, usually from less-controlled groundwater “buffers”. This happens either temporarily limited to drought years or by assigning (provisionally) “precarious water rights” if full water demands cannot be met with the average available resources.
- It is unclear how increasing cost recovery will reduce costs to other users. Since there is a prioritisation of water use for irrigation, some negative impacts exist concerning hydroelectric power stations. Moreover, water allocations to agriculture (*concesiones*) may have disavouring consequences on urban supply during drought events, not due to the permitting system (since drinking water supply is the top priority), but as a result of management: the RBA might not allocate enough reserves to guarantee urban water supply in the event of severe and prolonged drought risk, thus prioritising *de facto* agricultural use.
- Economic
 - Agriculture and associated industry are strong sectors in the Guadalquivir RBD, that are driving GDP in large parts of the basin
 - Other economic sectors (industry, renewable energy, recreation, etc.) have severe difficulties to access water rights for their activities, though upcoming formal and possible non-formal water markets may solve some of these situations
 - Modernisation of equipment to avoid losses and innovation, although currently subsidised would result in increased cost recovery once the subsidy horizon (25 years) expires, as it would alleviate budgetary pressures on the state.
 - Price increases as a result of (partial) cost recovery from modernisation investments derive in a shift to more productive crops, thus more GVA generated by the agricultural sector. If water permits are rescued/revoked by RBA as a result of savings, water can be re-allocated to other economic activities, overcoming the rigidity of the system

- Apparently, water prices have decreased or not increased since the WFD (Feragua, 2011²²⁰; CHG, 2011b), though farmers have to assume increased energy costs due to the efficiency modernisation process.
- Environmental
 - Water savings derived from irrigation modernisation can be allocated to fulfil environmental objectives. However, water efficiency gains in farm use also imply a reduction in return flows available downstream, thus when considering a basin-scale approach, water savings are smaller than expected.
 - The overall level of water exploitation leads to a significant deterioration in the RBD, and e.g. 19 out of 73 groundwater bodies will not reach good quantitative status by 2015. These figures can even be higher if regional data of per-hectare water abstractions are taken into consideration²²¹.
 - Illegal abstraction is a relevant feature in the basin (3-15%), in particular in several areas (olive plantations in Eastern Andalusia and Huelva coastal area) and affecting more significantly groundwater and dependent wetlands (e.g. Doñana).
 - There is a lack of identification and internalisation of environmental costs

7.4 Conclusions

The Guadalquivir is a “closed basin” in terms of existing over-allocation of available water resources (WEI of >57%; water gap of 562 hm³/year). The main water user is agriculture (87%), in particular the (drip) irrigation of formerly dry land crops, such as olives, grain cereals and industrial crops (MARM, 2010) which assigns a special responsibility to agriculture). Supply risks occur at the average inter-annual level and in particular during drought years and seasons; and no practical new water supply developments are feasible. Thus, the main problem of the basin is to ensure that demand adjusts to a limited (and probably shrinking) supply without continuing freshwater ecosystem deterioration.

Water allocation is crucial for agricultural, but also overall economic development; and over the last century a strong development of water infrastructure has been publicly supported, in particular for irrigation purposes. The current allocation scheme strengthens agriculture (as it is high ranked in water uses priorities), though in drought periods agriculture suffers the most severe cuts from allocation.

Cost recovery data have a significant uncertainty, and estimations for agriculture rank from 50-98% of water services (Krinner and Segura, 2011; MIMAM, 2007); with the particular case of significant groundwater usage. In fact, private groundwater users do not pay currently any public fee for the water, with the exception of their own on-farm costs (100% recovery) However, they benefit from RBA services such a spill pollution prevention or groundwater monitoring. The dRBMP envisages the collection of a new fee to cover administration costs of the RBA, currently being charged to users of surface waters. The dRBMP estimates 81% of cost recovery for RBA irrigation services (85.22% reported for Fuente Palmera) recovered by CR and TUA, and 76% for the costs of distribution in Irrigation Communities (100% reported in Fuente Palmera); with a global average of 78% (Fuente Palmera reports 95%). Environmental or resource costs are not

²²⁰ Referring to a lowering of administrative costs (estimated water tariff -11.5 M€/yr payments by Guadalquivir irrigators; and -2M€ from the exemption of the Andalusian Water Law tax)

²²¹ Many water bodies are in “less-than-good” due to urban/industrial pollution. Specially in summer, when the river flow is only urban wastewater. It is not only a problem of quantity, as other factors play a role.

considered, though they are relevant in this closed basin, with a significant proportion of water bodies under risk to not achieve the WFD environmental objectives by 2015.

The **tariff system** is currently undergoing a significant transformation, with many areas still sticking to a per-hectare (lump-sum) price; and others (e.g. Genil-Cabra, where water is pumped upwards) switching towards metering and prices/m³.

The existing water pricing policy for irrigation has not been significantly reviewed according the WFD, though the datasets have been adapted to the WFD requirements. Partial cost recovery at RBA level does not provide incentive to use water efficiently and therefore CAP reforms and energy costs (for surface and groundwater pumping) are being much more relevant to ensure efficiency (Corominas, 2011a). Indeed, increasing costs of infrastructure derived from scheme modernisation and optimisation (i.e. energy) boosted transformation of farms towards higher value crops and adoption of water saving techniques, not only technical (drip irrigation) but also managerial (volumetric tariffs or deficit irrigation practices).

The financing regime established by the Water Act is not correctly enforced. There is a legal issue regarding cost recovery, for which about one-third of users do not pay any cost to the RBA: the CR and the TUA are only applied to the direct beneficiaries of the regulation and distribution infrastructures developed, and payments from direct beneficiaries represent less than 20% of total cost recovery (Corominas, 2008). In addition, the formulae applied for updating past capital expenses to calculate the CR and TUA, tend to cover only a portion of the total cost (Krinner and Segura, 2011). Environmental and resource costs are not being applied, although the dRBMP proposes an approach to internalise them in the future.

Besides the effect of the water policy on the agricultural sector, this case study also had a look at the main drivers and barriers that drive or hamper the impact. Datasets on current and future water consumption in the RBD are vast and cover a significant part of the dRBMP. Nonetheless, **datasets are not fully reliable** and create uncertainty regarding the overall RBDs water balance (WEI of +54%), in particular regarding

- per hectare water consumption in irrigation agriculture (with a significant difference between officially supplied water and ideal water demands/consumption of farmers)
- expectations of the impact of the PoM on water efficiency and 9% water savings by 2015 (conflicting with a 0% change considered in Regional official Plans)

The main driver is that **water usage continues increasing** in the basin. Though the increase of new irrigation areas has been officially limited to +37,000 hectares (2010-2015), new illegal water usage in agriculture is reported from different areas despite the RBAs proposals for regulation (mainly in Loma de Úbeda and Doñana areas). Furthermore, more profitable water users (Pérez Blanco *et al.*, 2010; Corominas, 2011b) as **industries or renewable energy** are requiring new water rights; and the increasing scarcity of the resource motivates water rights holders to defend those (either for increasing activity, as risk minimisation tool for climate change and drought water-quantity-related risks or for trading).

The water allocation is based on an **outdated water rights system that had been strongly neglected over decades** (updating, cross-checking, allowances). Due to the basin's situation and the combination of agricultural subsidies/revenue and absence of law enforcement, illegal water usage has increased significantly (estimated between 3-15%), and the official process to get water rights under control is only slowly catching up. Several water markets have been in place during drought events, including transfers out of the basin, but it is still unclear how this system can contribute effectively to ensure priority water supply and WFD objectives.

The dRBMP and the Irrigation Modernisation Plan foresee a **significant water consumption reduction per hectare** due to the increased efficiency, but in practice it looks very certain that this extra-water is being re-used by the proper farmer either to enlarge the proper irrigated area or to intensify farming practice; and that the benefits for sustainable water management at the RDB level will be low or non-existent.

Regarding **water pricing and cost recovery**, there is a strong lack of transparent data (e.g. Fuentes, 2011:20) on different aspects, e.g. the water charging, so as to provide information on the different costs involved in the calculation of tariffs, including environmental and scarcity costs, e.g. based on water scarcity indicators in the relevant river basins.

Furthermore, the current Spanish legislation hampers **cost recovery** by not creating any room for charging for environmental costs from water abstraction that result from changes in river flow, morphology or water quality and their impacts on human health and ecosystems, as well as regarding diffuse pollution of groundwater. In order to recover the costs that result from the scarcity of water, prices for users of a common water resource pool should be developed according to the marginal cost of the costliest water supply source (Fuentes 2011:19), which current legislation does not permit. Improvements may also need to be considered concerning the recovery of capital costs of infrastructure, by establishing rigorous criteria to attribute infrastructure to different uses (CICCP, 2010 in Fuentes, 2011:20) to explain exemptions for public goods provision; and some management costs of the RBA and the interest charge of 4% could be revisited to ensure more transparency and a better cost recovery rate. The drivers behind the lacking adaptation of cost recovery are most possibly laying in the user's interest of maintaining the current status of cost recovery (e.g. Feragua, 2011) and the resistance to address this issue of high administrative complexity.

Some additional mechanisms can be used to make water allocation and pricing work better. Regarding water markets, they alone cannot resolve environmental, economic and social issues involved in the allocation of water across different uses (OECD, 2009), and further steps should be based on meaningful outcomes from the follow-up of previous experiences, and an analysis of learned lessons and improvement potentials.

Environmental impacts and thresholds of droughts have not been adequately identified. The recent WFD-based draft proposals for (minimum) environmental stream flow regimes are similar to the previous situation

since 1996 and strongly debated whether they will avoid further deterioration of water bodies, species and habitats or simply fit into the water exploitation index datasets (FNCA, 2011; WWF, 2011 a).

Regarding **efficiency**, legislation states that from 2015 onwards, the water rights will be revised after a modernisation process, but it is uncertain whether the officially established maximum water usage/hectare/crop type of the dRBMP are respected in practice. **Metering** is expanding but still insufficient to verify if the water allocation plans are followed, or if the gap between water availability and consumption continues increasing; and monitoring of abstractions is also considered weak (Custodio *et al.*, 2009; López-Gunn, 2009).

Regarding **illegal water usage** in agriculture, several attempts have been made by the RBA and regional authorities for roundtable-based trade-offs; with some successful results in Mancha Real-Pegalajar and Loma de Úbeda aquifers (Caro, 2010), and currently being frustrated in the Doñana area (e.g. WWF, 2011b; Junta de Andalucía, 2011a). They have shown that agreements are only viable if increased control and enforcement are envisaged and –despite their political costs – assumed by the Competent Authorities.

Regarding **water pricing**, much work is still needed to ensure data transparency (e.g. Fuentes, 2011:20) and to ensure the application of cost recovery for all costs, in particular regarding environmental costs (see above). Water pricing needs also to be legally clarified to ensure all costs are recovered, and shifted from flat tariffs towards consumption- and pollution-based tariffs.

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Annex 5 : Conference on Water pricing in agriculture: on track for a fair and efficient policy in Europe?

September 14, 2011. Gromada Airport Hotel, Warsaw Airport 32, 17 Stycznia Street, Warsaw, Poland

Objectives of the conference

The conference, co-organised by the Water Directorate of Poland and the Directorate-General for Environment of the European Commission, is part of the work carried out by the Common Implementation Strategy Expert Group on the WFD & Agriculture. The initiative aimed to contribute to the 2012 Blueprint to Safeguard Europe's Waters.

This Conference wanted to provide a better understanding of the concept and policy application of water pricing and water allocation in agriculture. Based on the intermediate results of a study commissioned by the Water Protection Unit of DG Environment on “The role of water pricing and water allocation in agriculture in delivering sustainable water use in Europe”, the conference provided an opportunity to review the current situation of water pricing and water allocation policies in agriculture across the European Union and discuss the way forward.

Within the framework of the same water pricing and allocation study conducted by a team consisting of ARCADIS Belgium, InterSus, Fresh-Thoughts Consulting, Ecologic and Typsa, seven case studies have been analysed in detail: Australia - Murray-Darling, Cyprus, France - Adour-Garonne, Mexico - Lerma Chapala, the Netherlands – Scheldt, Romania - Buzau Ialomita and Spain – Guadalquivir.

The aim of the case study analysis is threefold:

- To illustrate practical applications of water pricing and allocation policy in agriculture
- To assess the impacts of policies' implementation in order to identify good practices
- To draw EU level conclusions of practical implementation

During the conference the cases of Australia, Cyprus and France were presented. Experiences from the other case studies were also presented, referring to impacts of different implementation options and success/limiting factors of implementing good practices. However, it should be of note that the case studies are in a state of work in progress, with feedback on certain issues still being expected from the river basin authorities.

Audience of the Conference

The conference was addressed to national policy makers of EU 27 (ministries and administrations related to agriculture and environment), European Farmers' unions and organisations, NGOs, researchers from the area of agriculture and water management and EU policy makers.

Conference presentations and discussion sessions

The Conference combined individual presentations, parallel (discussion) sessions as well as a roundtable discussion. The outcomes of the two discussion sessions ("break-out sessions") are described in the next paragraph conference outcomes.

Session "Opening of the Conference"

The conference was opened by Mr. Stanisław Gawłowski, Secretary of State of the Polish Ministry of the Environment. Mr. Gawłowski indicated the rationale for the conference from a Polish viewpoint.

Session "Perspective by the European Commission"

This session concentrated on the current state of play of relevant EU policy. Mrs. Henriette Faergemann, European Commission DG Environment, provided insight in relevant legislation, existing Communication related to Water Scarcity and Droughts and the forthcoming Communication on the 2012 Blueprint. Mrs. Henriette Faergemann underlined some critical issues that needed to be discussed during the conference.

Session "Overview of agricultural water use in Europe"

Mr. Robert-Peter Collins from the European Environmental Agency presented an overview of agricultural water use in Europe. He also set the scene by bringing some broad messages regarding water pricing (allocation) and agriculture.

Session "Conceptual framework of water allocation and pricing mechanisms"

Mr. Davide Viaggi from the University of Bologna (replacing Mr. Eduard Interwies from InterSus) introduced the basic economic principles behind water pricing and water allocation in general and specifically in the agricultural sector. The theoretical concepts have been related to the requirements of the WFD and especially Art. 9 regarding the agricultural sector. This presentation served as a basis to the Conference for common understanding of the issues at hand.

Session "Tendencies in water pricing and water allocation policies in the European Union"

Mrs. Sarah Bogaert from ARCADIS Belgium NV illustrated the diverse landscape of pricing and allocation mechanisms throughout the EU, confirming the long history and spatial variation of installed mechanisms to

ensure water availability for different uses. She further described the tendencies in the current 'baseline' situation regarding water pricing and water allocation policies in the European agricultural sector.

Break-out session 1: Experiences with Water Framework Directive Art. 9 implementation

The audience of the conference was split up in three different groups. Each of the break-out sessions started off with a brief presentation related to the mentioned case studies including some specific water pricing and allocation issues:

- The Cypriot case was presented by Agathi Hadjipanteli of the Cypriot Ministry of Agriculture, Natural Resources & Environment.
- The Australian Murray Darling river basin case was explained and illustrated by Gert-Jan De Maagd of the Dutch Ministry of Infrastructure and Environment.
- The French case, with a focus on the Adour Garonne river basin, was presented by Thierry Davy, Representative of the Water Agencies of France.

After the testimony, the discussion among group members was structured along a set of questions. It is of note that not all questions could be addressed in all sessions. The main outcomes of these sessions can be read in the next paragraph.

- What is the current situation in your Member State for the agricultural sector to meet the requirements of Article 9? Issues that were addressed:
- How are the objectives of recovery of financial costs and environmental & resource costs, incentive pricing, polluter-pays principle reflected in the pricing policy?
- To what extent is cost recovery achieved? What is the reason for not achieving a higher degree?
- Are there any subsidies (State, Municipality,...) included in the water pricing policy? Are there any which can be harmful to environmental objectives?
- Which specific rules/conditions can lead to efficient and fair water allocation (water metering, measures to tackle illegal abstraction, priority rules advisable in the allocation process among different economic sectors as well as among different agricultural sectors, etc.)?
- How are socio-economic implications (e.g. impact on farmer's income) and environmental implications (e.g. environmental vulnerability) considered in the pricing policy?
- How are the requirements of Article 9 met in RBs where water resources are abundant and agricultural water use is insignificant?

Session “Lessons learned from water allocation and pricing implementation within the EU and beyond”

Thomas Dworak of Fresh-Thoughts Consulting further amplified intermediate results of the DG ENV study on the role of water pricing and water allocation in agriculture in delivering sustainable water use in Europe. He presented some key issues from implementing water pricing in different RBDs in Europe based on the investigated case studies:

- SWOT of the current agricultural water prices as an incentive to save water
- Importance of a mix of policy instruments to improve environmental effectiveness
- Potential of frameworks based on environmental flow regimes
- Recommendations to achieve appropriate cost recovery, including environmental and resource costs
- Better understanding of the value of water for the economy and for the sectors as a basis for allocation
- Importance of registration, monitoring and enforcement of allocation
- Potential of paradigm shift driven by the evolution of demand for the goods and services provided by land.

Session “A few thoughts on fair, efficient and sustainable management of agricultural water”

David Zetland, working at the University of Wageningen, is the author of the book “The end of abundance, economic solutions to water scarcity”. He shared his view on the impact of scarcity on our many water uses, on how the “institutions of abundance” may fail in scarcity, or on how economic ideas and tools could help us direct water to its highest and best use. David Zetland, known by his appreciated sense of provocation, provided some examples and illustrated new ideas for water management in Europe.

Break-out session 2: The way forward to the Blueprint to Safeguard Europe's Waters - success and limiting factors of implementing good practices

Similar to the morning break-out session, the audience was again split up in three groups. For these sessions, the chair briefly recalled recommendations from the earlier presentations. Questions that were discussed during the session:

- Which issues can be shared by the MS? What are additional issues of implementing different policy options or other success/limiting factors involved?
- What is needed from or at the EU European level to strengthen the success factors identified?
- Which mechanisms are needed to avoid disproportional adverse social and economic implications?
- What are the experiences or expectations of the MS present about the contribution of higher water prices to water savings? Which other solutions are considered (more) effective?
- Which instruments could ensure that aims and requirements (cost recovery, polluter-pays principle) of the art 9 of the WFD are better understood and accepted on the farm level?

Roundtable discussion with the following participants:

European Commission - Peter Gammeltoft

WWF - Sergiy Moroz

COPA-COGECA - Niels Peter Nørring

EUROVIA - Jacques Pasquier

EEB - Michael Bender

EUREAU - Daniel Tugues

Member States – Thierry Davy

Moderator: Professor Marek J. Gromiec, representative of the Ministry of the Environment

The round table discussion was inspired by the discussions in the breakout sessions, repeated and further elaborated the different views of Member States, the EU, NGOs and farmers associations. Participants of the round table provided their insights on the following 2 key questions:

1. How to deal with Art. 9 implementation in an agricultural context?
2. How to deal with ecosystem payments in the future?

Besides these key questions, participants were also invited to reflect on following issues and could include elements during the roundtable session:

Water allocation issues

- Should the definition of minimum environmental stream flows and groundwater balances be promoted in order to ensure that there is no over abstraction/allocation or are there other options?
- Should RB authorities be forced to set a hierarchy of water use? Which criteria should be considered? How could the economic value of water be considered in the allocation rules?

Water Pricing issues

- How to achieve appropriate cost recovery, including taking into account environmental and resource costs? How should proper Art. 9 interpretation be promoted? What alternatives (e.g. payments for ecosystem services) could be considered?
- Metering is considered as an essential issue for making water pricing work. How could be ensured that metering is enforced on the EU level?
- Which mechanisms are needed to avoid disproportional negative social and economic implications from water pricing?
- What is needed to address illegal abstraction and how could that be better linked to cross compliance?
- Which actions should be taken to better enforce water related legislation on the EU level?

Outcome of the discussion sessions

Break-out session 1: Experiences with Water Framework Directive Art. 9 implementation

KEY ELEMENTS FROM THE DISCUSSION

- Starting up the process regarding Article 9 requirements can be difficult, even with economic guidance documents available. Water pricing is directly related to economics as well as water management, environmental and social issues. It seems advisable to rely on mixed teams to prepare solutions (e.g. combining economists, environmental experts and social scientists), in order to ensure a better adoption of the proposed action plan by all parties, e.g. overcoming farmer's resistance by considering broad impacts (environmental, socio-economic, ...). Allocation and pricing issues are interrelated; therefore a policy should combine these instruments.
- Farmer's perception regarding water saving in agriculture is necessary, in a sense that farmers may need to understand that water saving (at the individual level, and as a sum at the basin level) can help to preserve their future income, e.g. ensuring water supply in crisis situation as severe droughts. Incentives for water saving are sometimes seen as a threat as water comes at higher costs while receiving less water.
- The level of water use efficiency through the use of water saving technologies (not used at all or already at a very high level like in Cyprus) is an important issue when pricing schemes are introduced (timing), as it determines the degree to which farmers may actually save water.
- Metering can sometimes face rejection by farmers because of additional costs and additional controls which are not accepted.
- Complex: according to certain participants metering may not be always possible, e.g. water availability instead of abstractions (water level management in the Netherlands), gravity-fed systems (quantity to individual farmers?) or from cost-perspective (suggestions to have approximation of quantities for groups of farmers in certain situations).
- Acceptance: shift to metered systems may be difficult, especially in specific situations with area-based systems, or no history of metering (as water has simply been available for agriculture), or other circumstances. Several options have been mentioned to increase the level of metering, for example: one of the GAEC relates to compliance with national rules on water extraction.
- The point was raised that farmers make their own decisions regarding the use of certain crops or the change of cropping pattern. The authorities have to determine the amount of water available at a certain price. The authorities should also incentivise sustainable practices through public funding. Farmers will then be guided in their decision by economic considerations.
- CAP-reform might be used as a facilitator to shift from water intensive crops to other crops (e.g. it was mentioned that cotton subsidies are still foreseen in the latest drafts of the reform proposal, despite their significant water consumption).
- Environmental costs should also be considered in the CAP-reform. Today, it is acceptable for farmers to use fertilisers up to certain amounts and farmers are polluting what they are allowed to. It is argued that a shift might be needed where every kg (of pollution) is paid for.
- Tackling illegal abstraction should be a priority.
- "Farmers are harming themselves" when doing unsustainable practices and should be aware of that.

PRICING

What is done in the agricultural sector of the Member States to meet the requirements of Article 9?

- **Cost recovery:** Agriculture is most likely not adequately recovering (both in water-scarce and – abundant RBDs). Independently from the fact that agriculture will not adequately recover, there is a need to understand the rationale of cost recovery behind the RBMPs by analysing the information of the RBMPs on transparency and exemptions used for agriculture. This should help to understand the situations under which agriculture should be exempted, as well as those under which agriculture has been (partially) included in cost recovery. Methodologies for assessing cost recovery and level of cost recovery differ (financial costs including/excluding subsidies, environmental and resource (E&R) costs assessment). Adequate contribution should be transparently explained, even if water resources are abundant. Large differences between MS, e.g.:
- IT: negligible basic fee to abstract water. Charges by the irrigation boards to cover their operational and maintenance (O&M) costs. State investments in infrastructure are not recovered. E&R costs are not recovered in present legal framework.
- NL: nearly 100% cost recovery, no clear reference to agriculture though. Groundwater abstraction levy above certain threshold is taking into account E&R costs (i.e. where impact is expected). Farmers are paying for irrigation infrastructure (availability of water).
- ES: user pays according to law, < 100% of financial costs are recovered. One aim of pricing in Spain is water saving. Prices differ according to the water source (dams, pumping, desalination...). For groundwater (GW), farmers do not pay anything.
- PL: Charges on irrigation could be disastrous for ecosystems, because current water used for irrigation agriculture benefits also closeby located peatbogs, so the irrigation has significant positive effects. There is a lack of information on the corresponding proportion of water that is finally used by either irrigation or peatbogs, and there are difficulties to measure the water usage and impacts, both in terms of quantity (no knowledge of how much is irrigated) and in quality (how to measure (diffuse) pollution from agriculture)? These information gaps result in difficulties to implement polluter-pays-principle, set prices or estimate cost recovery, difficulties to implement polluter-pays-principle, set prices or estimate cost recovery.
- **Incentive pricing:** A discussion was started around the point whether pricing schemes without thresholds/abstraction limits are effective, or how pricing policies should be combined adequately with allocation policies. Some examples brought in the discussion:
- IT: irrigation boards have no legal obligation to put incentives in pricing for sustainable water use.
- NL: Minimum threshold values for both permits and charging. Avoid dehydration (impacts) because of larger GW abstractors.
- CY: Higher water prices are expected to have no effect on water use, because demand management measures towards efficiency are applied for a long time, while availability is of a larger importance than the price, and the overall share of water in total production cost is low. On the other hand, however, a steep overconsumption charge proved effective in limiting wasteful water use. It is of note that electricity costs for pumping (for groundwater abstraction) take a significant share of the cost for irrigation and are already paid by farmers.

ALLOCATION

- Metering, monitoring and control are key issues (especially GW): there is generally a lack of information, but ongoing discussions (e.g. UK) to use CAP funds to support metering. Remote sensing might be a technology opportunity to widely spread metering systems and facilitate control in large irrigation areas and at low costs.
- “Illegal” abstractions: it was raised that strategies need to be developed to decide whether to start an overall amnesty versus a major control either of water users or of boreholes-drilling companies (e.g. implemented in ES). There are also difficulties to tackle illegal abstraction if it overlaps geographically with (public) projects for GW-recharging, considering that illegal abstractions can continue with this additional supply. One way could be to legalise („amnesty“ and control by WUA) the boreholes.
- MT is confronted with the same situation as CY: no rivers, no lakes, only groundwater. The last decades, many more boreholes are appearing, also on fossil waters (unsustainable extraction). There is no legal basis, making it not an illegal activity (simple registration until 2010). CY recently introduced a strengthened legal framework regarding the regulation and control of groundwater abstraction.
- PL: no idea of illegal abstraction. Objections from farmers to metering are expected, as there is no history. But metering is not the perfect solution (irrigation for peatbogs), as it is difficult to meter the right water recipient.
- ES: Legal wells (legal when before 1985); metering will be compulsory for the legal wells, a programme is in place since 2009, but no results are public so far.
- IT: Illegal abstraction recognised as a key problem (GW more than SW). Water metering: what level/approximation are we talking about? Individual farmers (high costs?) or for groups of farmers?
- Metering is not always possible: water level management (dykes) in the Netherlands also makes water available for farmers but is impossible to meter. Companies digging boreholes have to be monitored, not only the farmers.
- Water markets: start with pilot and learn lessons, but little to no experience in EU:
- IT: No legal basis for water markets and ethical objections. This is critical however, see Australian case where some uses are blocked out from markets.
- NL: There have been studies on water markets; but in Polder areas it is not realistic as a relevant option. No water scarcity so no good basis for trading. Moreover, in polder areas there is quite a small number of farmers which does not appear useful for trading (insufficient supply and demand). Neither for water quality, there are markets: Regarding quality, the Laws state "no deterioration of present quality", BAT need to be in place and there is no option not to satisfy BAT. Agriculture: limits to amount of nutrients.
- PL: Trading like in Australia? No common denominator in the EU to set-up a similar scheme (water is no commodity – WFD). EU-wide policy should take into account local situations.
- WWF on water trading: necessary link to water pricing (e.g. Australia) and the importance of environmental flows.
- Water rights have to be on consumptive use. Else, selling water might result in over-allocation.
- Priority rules?
- IT: in an emergency situation (shortage problem), such rules are working and have been installed since longtime.
- CY: Priorisation for drinking water (domestic sector & livestock needs). Irrigation last, partly taking economic output of crops into account (greenhouses), and needs of crops.

Break-out session 2: The way forward to the Blueprint to Safeguard Europe's waters - success and limiting factors of implementing good practices

PREVIOUS PRESENTATIONS: FEEDBACK AND LESSONS LEARNED

- One tool may not solve all problems. It is likely that future policy strategies may need to mix different tools and combine “carrots” as well as “sticks”.
- The option of environmental flows (EF), which are seen as the starting point for allocation deserves to be explored further, in particular in relation to:
 - Robustness over time (for example climate change)
 - Link between groundwater recharge and surface water
 - Administrative costs for setting and controlling them. It has to be ensured that these costs are feasible.
 - How to set them locally?
- How to establish a link between GAEC and EF in practice (individual farm level): it was argued that it could be very challenging to relate environmental flows (complex concept and dynamic) with the individual farmer level and to control this effectively. However there is a clear need to discuss potential opportunities and challenges further.
- A CIS-discussion process on environmental flows is a crucial issue. It needs to define EF as a reliable starting point for allocating a scarce resource (e.g. definition, methodology and good practice) to other users than the environment. This discussion process could be stimulated by existing examples (e.g. as given in Australia).
- Cost-Benefit Analysis of economic instruments (NL) can be useful to decide if they are relevant.
- Paradigm shift: it would be useful to promote an understanding (and perceiving) of water not only as a resource, but also as a risk for businesses and society, e.g. when water is scarce or missing. This understanding can introduce risk mitigation actions, with a similar approach to the Floods Directive.
- Change of allocation process based on the feasibility of technology.
- Approach integrating pilot projects, learn with “early adopters”.
- Mandatory metering needs to be explored further, in particular:
 - Option 1: should only be mandatory in the case of water shortage, but then a clear definition of water scarcity is needed (not based on WEI).
 - Option 2: Mandatory for all basins, as it also related to hydropower and low flow conditions. Improving knowledge is key.
- ... Cost of metering might outweigh the benefits
- ... Not all agricultural uses can be metered (water level management equally for dykes)
- ... Subsidies for metering (e.g. payments from CAP?)
- “Illegals”: In order to address illegal water usage properly, a significant set of proposals was already made at last year’s conference (CIS conference in Louvain-la-Neuve in September 2010 on the “enforcement of European water related policies at farm level”). It is important to ensure an adequate capacity of the River Basin Authorities (RBA) to deal with the control of illegal water usage, improve the control with technology, and to an adequate size of penalty being higher than the benefit of the farmer by irrigation with non-authorised abstracted water. Furthermore, the public perception of illegal water usage is still not supporting full action against legal infringements.
- Taxes on fertilisers and pesticides might weaken competitiveness of EU agricultural products on the global market.
- Payments for Ecosystem Services (PES) can go beyond the Polluter-Pays-Principle (PPP), and there seems not to be a contradiction between both.

WHAT'S THE ROLE OF THE EU?

- MS are not convinced that new regulations are needed. One particular area of difficulty is the local aspect of water-related challenges.
- For some participants, there is a concern that a WFD under Cross-compliance may restrict opportunities to apply best measures for each situation.
- There is a need to have EU reflection on alternative supply (e.g. standard on waste water reuse).
- Set clear baseline of regulations defining the “polluter pays principle”.
- Need to exchange on cost calculations and methodologies to learn from what is already happening today. Different definitions and approaches exist in the EU making it difficult to compare between MS and their own context. The option of working groups was raised.
- Increase the exchange of practice and approaches between current WSD regions and future regions. This should increase the adaptive capacity of these future WSD regions.
- Measures for integrating water policy into other policies have to be included in the Blueprint.
- The European Environmental Agency's (EEA) Water Exploitation Index (WEI) may not be the best tool for defining water scarcity at a RBD level. There is a need to have a more comprehensive approach (and on a monthly rate) which also takes into account further uses and climate change. Water scarcity today differs from tomorrow (dynamic) and makes an EU wide identification challenging. It should be noted that a CIS Expert Group is developing an Indicator Set to deal with water scarcity and drought, including a significant testing exercise to promote a practical approach.
- Use Annex III and RBD characterisation to identify future water scarce areas.
- Watch out that support to water scarce areas does not increase demand in these areas.
- More support on how to manage that new efficient technologies are required under the Rural Development Regulation (shift to new technologies without advice e.g. on timing will not save water sufficiently).
- More demonstration projects at farm level are needed.

MECHANISMS TO AVOID DISPROPORTIONATE IMPLICATIONS?

- Possible shifts in crop selection and farming practices. Drop in production = cost to society/employment.
- A redefined CAP with more specific targeted measures should be explored.

RELATION WATER PRICING AND WATER SAVINGS? OTHER SOLUTIONS?

- Re-bound effect of increased efficiency; pricing can ensure that overall water consumption does not increase when efficiency is increased.

HOW TO ENSURE ACCEPTANCE OF ART.9 AT FARM LEVEL

- Identify positive aspects for farmers, and ensure that the wording is not negative. As examples, “polluter pays” seems to place the farmer on the negative side; “water” might be described as an input to the farm (such as other resources), and when talking about water allocation or pricing, it should be made clear that there are (shared) risks at the basin level, that users can approach jointly.
- Increase advice to farmers. Projects at local level funded by parties having an interest in the outcome of the project: point source pollution → diffuse pollution (more difficult). For water quantity, no financing parties identified to date.

OTHER ELEMENTS

- Advantage of self-funding mechanisms.
- UK environmental tax to revoke harmful licenses/uses.

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