6 Assessment: Water use and water pollution

This section considers the pricing of water usage and water pollution in Andalusia. Regarding water usage, the focus is on the design of current Andalusia-specific taxes, and deals with all water users: agriculture, households and industry. The assessment includes, but is not restricted to, the general service fee on water usage that is under discussion at the time of writing. The analysis is on fees in place in 2022.[1] For water pollution, the focus is on the introduction of new taxes in agriculture, particularly through taxing the use of pesticides and fertilizers. Industry and households already face a price on water pollution, which is set at a national level. The section deals with some of the main issues related to water pollution and usage but does not aim at being exhaustive about these complex and constantly evolving issues.

Water use and water pollution are analysed separately, even though both are interlinked. Indeed, on the one hand, water use may engender water pollution. The reasons for this include groundwater extractions beyond the capacity of aquifers deteriorating their quality and favouring the seeping of seawater into the aquifer (Aznar-Sánchez et al., 2019[1]); excessive irrigation causing erosion and transporting nutrients, pesticides, and heavy metals to surface water;[2] or reduced capacity for dilution when point sources are discharged to surface waters (OECD, 2017[2]). On the other hand, water pollution increases the costs of water use by increasing treatment requirements and increases water scarcity by reducing the quantity of water that is safe to use (FAO & IWMI, 2017[3]).

The focus is on market-based instruments (mainly taxes, fees and charges) even though other non-market instruments, such and command-and-control (CAC) type instruments (e.g. regulation and technology standards) are briefly discussed at the end of the section. Theoretically, along the same arguments as in the case of climate mitigation instruments, market-based instruments are generally more cost-efficient. Prices allow to decentralise the decision to abate by leaving it up to the users to determine where it is most efficient to reduce water consumption and pollutant use. However, in the case of water, if the price cannot align closely with the source of pollution (due to many diffuse pollution sources) or if, for water use, supply and demand curves are not known, hard to measure and vary too frequently, command-and-control type instruments may be better suited or used as a complement. As a reminder, a distinction is made between taxes on the one hand, and fees and charges on the other hand. The term "levy" covers taxes, fees and charges (see Box 1.2 in Part I for additional details).

Existing levies and the possible introduction of new taxes will be assessed in the context of European legislation, national laws and existing taxes. As exposed in Section 5, the Water Framework Directive (WFD) was introduced in 2000 at the European Union (EU) level and determines all EU member states' water regulatory framework. It incorporates or is complemented by eight other directives (see Box 5.1). From 26 June 2023, the European Union Water Reuse Regulation will set minimum requirements for water reuse for agricultural irrigation. At the Spanish national level, the Water Law was introduced in 1985 and has since been adjusted to the various EU-level directives. The Basin Plan was introduced in 1998, the 2001 National Hydrological Plan proposed large scale projects to transfer water from basins with excess water supply to basins in deficit and the 2005 A.G.U.A. Programme brought forward desalinisation and water reuse as national priorities. Finally, Spain – as all OECD members – is an Adherent to the OECD

Council Recommendation on Water, which puts forward four key principles in water management matters (see Box 6.1.).

Box 6.1. The OECD Council Recommendation on Water

In 2016, OECD member countries unanimously adopted a Council Recommendation on Water. The adoption marked the outcome of a two-year consultation process.

The Recommendations fall into five categories: (i) managing water quantity, (ii) improving water quality, (iii) managing water risks and disasters, (iv) ensuring good water governance, (v) ensuring sustainable finance, investment and pricing for water and water services.

Water management services (for both usage and pollution) are recommended to be financed with the following four key principles in mind, which might apply to either pollution, usage or both:

The Polluter Pays principle – which applies to pollution – to serve the following purposes:

Influence behaviour to reduce pollution,

or generate revenues to alleviate pollution and compensate for social costs.

The Beneficiary Pays principle – which applies to usage:

Aims at sharing the costs of water management between different water users such as industry, households and agriculture.

The Equity principle – which applies to both pollution and usage:

Focuses on who, within a group of users, bears the costs and benefits of water management.

Aims at ensuring equity in the access to water services and protection against water-related risks.

The Policy Coherence principle – which applies to both pollution and usage:

Ensure that different policy areas (agriculture, energy, land use, urban development or trade) do not have negative impacts on water availability, quality and freshwater ecosystems, or increase the cost of water management.

Source: Adapted from OECD (2016[4]).

In Spain, water use and water pollution policies take place at the river basin level (see Section 5). They fully fall under Andalusian authority for river basins that are entirely within the Autonomous Community. Only urban water management takes place at the municipality level.

Andalusia is part of six river basins, three of which are entirely within Andalusia. These are the Andalusian Mediterranean Basins, which make up 20.6% of the territory and the Guadalete-Barbate and Tinto-Odiel-Piedras river basins, which taken together make up 15.4% of it. Even though it does not fall entirely within the region, Guadalquivir is the greatest river basin in Andalusia. It makes up 60% of the Andalusian territory. The other river basins make up 3.8% of the territory for the Guadiana river basin and 0.2% for the Segura river basin.[3]

6.1. Pricing water usage

After a brief discussion on the reasons why pricing water usage properly is becoming an increasingly pressing issue worldwide and in Andalusia more specifically, this subsection first provides a general description of water users in Andalusia. This is followed by an analysis of water costs in general along with the criteria water pricing should address – in particular environmental economics principles. A description of water pricing instruments in Andalusia is then provided. This enables an analysis of the alignment of water pricing in Andalusia with sound economic principles. The analysis highlights that a better setting of objectives along with a better knowledge of demand patterns and service costs for different users would improve supply cost-recovery, sustainable use and equity. Finally, the introduction of water abstraction charges or taxes are discussed.

6.1.1. Water use and scarcity in Andalusia

In the coming decades, freshwater availability is projected to decrease and drought cycles to increase, including in Andalusia. Climate change models project warming temperatures, increased variability in precipitation patterns, and more frequent and extreme weather events (OECD, 2020[5]). Assuming no efficiency gains, some research finds that the world is to face a global freshwater deficit[4] of 40% by 2030 (2030 Water Ressources Group, 2009[6]). Andalusia will be particularly affected by these issues, as in the southern part of Spain drought cycles will very likely become more frequent as the 21st century progresses. Decreases in rainfall adversely affect groundwater recharge as well as the availability of surface water reservoirs. Moreover, higher temperatures increase evaporation, so that lower water inflows into the ground are complemented by greater water exits from the ground due to the phenomenon of evapotranspiration (Luis Caparrós-Martínez et al., 2020[7]). General decreases in precipitations are to be felt in certain river basins in particular, among which the Guadalquivir river basin,[5] which in recent years, has been experiencing increasing drought events.[6]

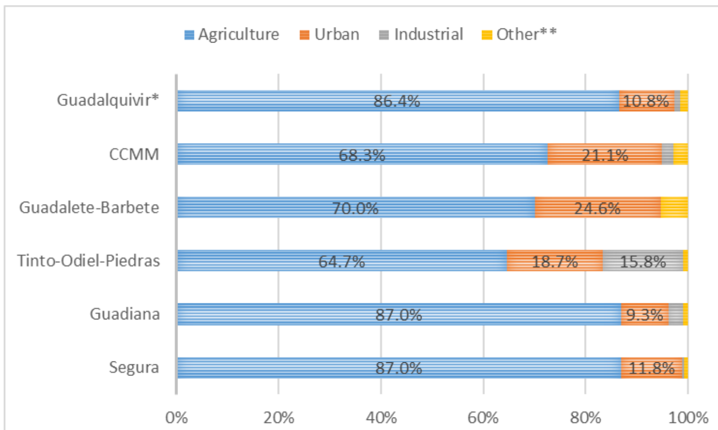
Spain is characterised by a high temporal and spatial variability in water resources, with certain regions – especially in the South – experiencing water scarcity and long periods of droughts. Mean annual precipitation varies from 2,200 mm in northern areas to 120 mm in the South-East. Consistent with this observation, mean annual runoff[7] varies from 50 mm/year (in particular in South-Eastern areas of Spain) to more than 800 mm/year (Northern areas and some mountainous areas) (Estrela and Sancho, 2016[8]). The important heterogeneity in water resources has resulted in the construction of numerous hydraulic works, such as dams[8], reservoirs and inter-basin water transfers (e.g., the Tagus-Segura Water Transfer), and the intensive use of groundwater through the drilling of wells. These supply-side strategies have helped deal with water scarcity in Spain so far, but the increasing risks linked to climate change and increasing water scarcity over the world call for a focus on demand-side instruments (such as taxes and levies, or certain non-market-based instruments) – even if used in parallel with other supply-side strategies such as desalination and reuse.

Water use is generally divided into agricultural, industrial and urban use. Energy and recreational uses are relatively less important and are not always documented. Urban use refers to grid use, as opposed to non-grid use which is taking water directly from rivers, sources, etc. More precisely, the Draft Hydrological Plan for the Mediterranean river basin defines urban water use as uses by households, regulated accommodation (e.g., hotels, rural tourism, campsites), non-regulated accommodation, industry connected to the urban grid, commercial and institutional uses, losses and uncontrolled uses. The definition is very similar in the other Hydrological Plans. Industry is understood as "industry not connected to urban grids".

In Andalusia, water is principally used for agriculture and urban supply. Depending on the river basin, between 65 and 87% of water use is for agriculture purposes, and between 9 and 25% is for urban supply (see Figure 6.1).[9] Agricultural use is mainly for irrigation: where data is available, use for feedstock is limited to between 0.2 and 2.2% of all agricultural water use. Urban use includes industrial, business and residential users connected to the grid, but the figures do not enable differentiating between these. Industrial use is generally limited (below 3%) except in the Tinto-Odiel-Piedras river basin, where it makes up about 16% of water use. The figure for recreational water use, including swimming pools and golf courses does not always exist, but where it does it hovers around 1% of water use except in the Mediterranean river basin where it goes up to 2.6%. Finally, energy production makes up 1.4% of water demand in the Guadalquivir river basin and 3.9% in the Guadalete-Barbete river basin. Projections to 2027 and 2039 from the six Draft Hydrological Plans indicate the shares of users in water demand are not expected to change much.

Hovering around 80%, the share of water demand for irrigation in Andalusia is above the worldwide average (around 70%), and reflects the fact that Spain is a country where irrigation as opposed to rain plays a major role in agricultural practices. Agriculture holds an important part in the Andalusian economy. It made up 6.7 of Andalusian GVA in 2021[10] and made up 30.8% of Spanish agricultural GVA (INE, 2023[9]).

Figure 6.1. Water demand by user



Note: The data presented is for 2021. Only percentages above 9% are indicated in the graph.
* The Guadalquivir Draft Hydrological Plan presents the demand for principal uses.
** Other stands for energy production use in the Gudalquivir river basin, for recreational use in the Mediterranean river basin, is composed of 3.9% for energy production and 1.4% for recreational use in Guadalete-Barbete, stands for recreational use in the Tinto-Odiel-Piedras river basin and recreational use (golf) in the Segura river basin.
Source: Table 56 in https://www.juntadeandalucia.es/medioambiente/portal/documents/20151/497870/DI_MEMORIA_GB.pdf/caaf7b70-5ec4-61ee-795a-5377b35f8d73?t=1582033431000 for the Guadalete-Barbete river basin, Table 30 in https://www.juntadeandalucia.es/medioambiente/portal/documents/20151/773714/DI_MEMORIA_TOP.pdf/5a437aad-1f91-6268-308d-7434e69f21c0?t=1582039745000 for the Tinto-Odiel-Piedras river basin, Table 161 in https://www.juntadeandalucia.es/medioambiente/portal/documents/20151/1152494/DI_MEMORIA_CMA.pdf/fd981d2a-5d61-ea14-8788-c52a0d3f03ad?t=1582032688000 for the Mediterranean river basin, Table 34 in https://www.chsegura.es/export/sites/chs/descargas/planificacionydma/planificacion21-27/docsdescarga/docplan2227Consolidado/01_MEMORIA/Memoria_PHDS_2022-27VCAD.pdf for the Segura river basin, Table 25 in https://www.chguadalquivir.es/documents/10182/2322527/PHGuadalquivirCAD_Memoria.pdf/b0a2577a-ac09-073e-29e6-12f2d3e37e9e for the Guadalquivir river basin and Table 38 in https://www.chguadiana.es/sites/default/files/2022-04/Memoria_1.pdf for the Guadiana river basin.

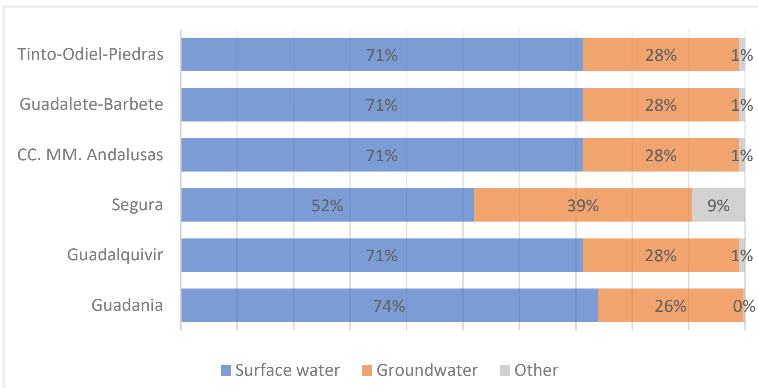
StatLink https://stat.link/f2ciuw

Water used for irrigation in agriculture is mainly abstracted from surface water and groundwater. For all river basins of which Andalusia is part except for Segura, in the period of 2011-2014, between 71 and 74% of water abstraction for irrigation is from surface water, while between 26 and 28% is from groundwater; a very low share is not freshwater (Figure 6.2). In a similar period (2012-2015), overall use of unconventional water resources (i.e., desalination and reuse) was highest in the Andalusian Mediterranean Basins and the Segura river basin.

Using groundwater instead of surface water for irrigation has several advantages, among which its availability even in times of drought, a lower need for investment at first and its immediate accessibility. In Spain, until 1985, a landowner owned the groundwater underneath their land. This situation changed with the Spanish Water Law of 1985, which established the public nature of all water resources as a general rule and the priority status of Hydrological Planning. Still, many users who extracted groundwater before 1986 were able to maintain their private water rights, and as a consequence a large amount of water used for irrigation has remained under private ownership, which in many cases has led to overexploitation (Luis Caparrós-Martínez et al., 2020[7]).

According to the Hydrological Plan of the second EU WFD cycle,[11] groundwater bodies in the six river basins districts in Andalusia present heterogeneous quantitative statuses. In five of the river basin districts, at least one fifth of groundwater bodies had poor quantitative status. Quantitative statuses ranged between the Tinto-Odiel-Piedras river basin, where all four associated groundwater bodies had good quantitative status and the Segura river basin, where 63% of its 63 groundwater bodies had poor quantitative status.

Figure 6.2. Origin of water used for irrigation in agriculture, 2011-2014



Note: "Other" includes desalination and reuse.
Source: Table 62 in the Draft Hydrological Plan of the Guadalete-Berbete river basin, https://www.juntadeandalucia.es/medioambiente/portal/documents/20151/497870/DI_MEMORIA_GB.pdf/caaf7b70-5ec4-61ee-795a-5377b35f8d73?t=1582033431000.

StatLink https://stat.link/qfsa42

The White Book for Tax Reform in Spain (Comité de personas expertas, 2022[10]) defines two phases of the water cycle: upstream and downstream. The 'upstream' phase, which the Hydrographic Confederations regulate, directly supplies consumers of non-potable water (agriculture, energy sector, large industries). The 'downstream' phase begins with the transfer of water for treatment to become drinking water. It also covers distribution to consumers by the municipalities, as well as its collection and treatment before its return to the natural environment, in which the Autonomous Regions play an important regulatory role.[12] Table 6.1 presents the different services and users they concern.

Table 6.1. Water services and users concerned

Service	User concerned
Upstream surface water services	Agriculture (irrigation, livestock farming) / Industry / Hydroelectric industry
Upstream groundwater services	Agriculture (irrigation, livestock farming) / Industry / Hydroelectric industry
Downstream distribution of water for irrigation	Agriculture (irrigation)
Downstream urban supply	Households / Industry
Self-provision	Agriculture (irrigation, livestock farming)
Reuse	Urban / Agriculture (irrigation, livestock farming) / Industry
Desalination	Urban / Agriculture (irrigation, livestock farming) / Industry

Source: Authors.

6.1.2. The costs of water use

If the water market is properly managed,[13] the costs related to water use include: (i) supply costs, (ii) administrative and governance costs and (iii) environmental externalities[14] (OECD, 2010[11]; Rogers, Bhatia and Huber, 1998[12]; Rogers, 2002[13]; Cardone and Fonseca, 2003[14]). Supply costs may be understood as operation, network and maintenance costs as well as capital costs – they can include a fixed and variable component. Administrative and governance costs include those incurred in regulating the service, institutional capacity building, and the cost of devising and implementing the policy and enabling environment for the sector. Environmental externalities arise because harm is imposed on the ecosystem.

A recent European Commission report (Mottershead et al., 2021[15]) discusses analyses of environmental externality costs in the water use context (which are referred to as scarcity costs in the report), with a focus on the externalities associated to ecosystems. They provide various examples of such externalities. These can relate to depriving fish of water as their habitat, but also to a lack of water as a support to wetlands, as a necessity for healthy vegetation or again as a carbon sequestration provider.

Putting a number on the different cost dimensions of water use is not straightforward. While supply costs along with administrative and governance costs may be measured in a similar fashion to other services (with certain difficulties), externalities can prove harder to measure. Some difficulties are discussed in (OECD, 2010[11]). For example, relating to capital costs, it is not clear whether capital charges relating to "stranded assets" that no longer provide a useful service should be included.

Regarding the valuation of externalities linked to water use, difficulties arise from the various parts of the ecosystems concerned. For now, no single estimate incorporating all externalities exists, but some do for specific externalities to ecosystems. Mottershead et al. (2021[15]) for the European Commission review Australian and Spanish studies and retain an environmental cost value of EUR 0.30 per cubic metre of extracted water. The recently released White Book for Tax Reform in Spain presents total environmental costs by river basin. According to those calculations, environmental costs represent between 6 and 10% of costs in all river basins other than Segura, and 23% for the Segura river basin district.

Water is generally not properly managed through a market mechanism, and allocation between users is not always well defined. In this case, opportunity costs can arise, whereby for example, the upstream user of a river may deprive the downstream user from getting enough water. Moreover, the fact that water is generally not managed through a well-functioning market engenders a lack of consideration for the scarcity this can cause.

6.1.3. Criteria for pricing water

The overall pricing of water usage seeks to satisfy several criteria, and addressing one does not guarantee that the others are addressed as well – in fact there might even be trade-offs between them (Grafton, Chu and Wyrwoll, 2020[16]; OECD, 2010[11]). The five main economic and environmental criteria are the following, in the order of the discussion to follow (not their importance):

1) Cost of service recovery (i.e., water prices cover the full current and future supply, administrative and governance costs of water use and guaranty financial sustainability);
2) Universal access and affordability;
3) Promotion of sustainable water use for human populations;
4) Internalisation of externalities caused to ecosystems;
5) Equity.

Cost of water service recovery (criterion 1) should theoretically be guaranteed through long-run marginal cost of supply (LRMC) pricing (Olmstead and Stavins, 2009[17]), even though in practice, water prices lie well below these costs. LRMC pricing is supposed to reflect the full economic cost of water supply (since fixed costs are taken over the long term, so allowed to vary). This includes the sum of the transmission, treatment and distribution cost, as well as some portion of the capital cost of current reservoirs and treatment systems. In practice, LRMC pricing reveals complicated to measure (it requires full metering of consumption as well as full information on capital costs in the long run) and implement (e.g., prices should vary over the course of the year, and with the source from which water is abstracted). Moreover, it might not fit all criteria of financial sustainability (e.g., it does not ensure that utilities can accumulate sufficient funds for investment) (OECD, 2017[18]). Alternatives to LRMC pricing include, but are not restricted to, average cost pricing, short-run marginal cost pricing combined with public provisions guided by cost-benefit analysis, etc. Australia is one of the only countries to use LRMC pricing in practice (Tooth, 2014[19]).

Most countries price water using a fixed charge, which covers connection costs to the public water supply and sewerage systems, and a volumetric rating system, which covers the volume of water supplied at a fixed specific rate per cubic meter. This approach is closer to *average cost pricing*, but may leave out an important component of cost of water recovery, i.e., the inclusion of a forward-looking aspect in the service cost recovery. Indeed, anticipating future costs by investing ahead of time is key to ensure financial sustainability.

Affordability concerns (criterion 2) are generally addressed through reduced rates on low levels of water consumption or preferential rates for certain groups. It is worth stressing here that affordability and distributional concerns do not only arise for households, but may also arise for small farmers, for instance. In the face of increased prices on water, this population could also face strong adaptation and hence affordability issues.

For now, many countries address affordability concerns by charging lower rates to vulnerable households, but as in the case of energy prices, higher efficiency would be achieved through targeted support policies (Arbués and García-Valiñas, 2020[20]; Van Dender et al., 2022[21]). Reduced water tariffs may be relatively simple to introduce and to communicate in general, but are not necessarily well targeted to the most vulnerable consumers and weaken incentives to reduce water use when supply is tight. Affordability can be addressed through targeted support. Public transfers can be justified by the need for public policies to guarantee access to a minimum level of water for everyone. Indeed, on 28 July 2010, the United Nations General Assembly adopted a historical resolution that recognised "the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights".[15] In order for this basic need to be satisfied, two-part water tariffs may be used that charge less or nothing for the amount of cubic meters per person which are deemed to be the necessary minimum level. Public transfers to water companies could help cover the foregone cost-recovery from the lower rates on small volumes of water.

Cost of service recovery and hence financial sustainability on the one hand and affordability and social concerns on the other, face trade-offs but also go hand-in-hand. Financial sustainability, by increased costs, can jeopardise affordability. However, if financial sustainability is not guaranteed, this increases the risk of underinvestment (e.g. to renew urban water infrastructures) and more remote and poorer areas not being furnished in water. For now, the whole Spanish population is connected to water provision networks,[16] but care should be taken for this not to become a concern in the future.

Given the lack of a water market, sustainable use for human societies (criterion 3) is threatened through potential overuse by households, firms or farmers, which should be addressed through some form of management – ideally through pricing. Instruments or mechanisms used to ensure sustainable water use will depend on administrative capacity and formality or informality of water use. On top of potential overuse by households, firms or farmers, it is also important to stress another source of inefficiency in this regard: water losses in networks. In Spain, this is an issue for importance, given that leakage rate for public water supply is estimated at 30%.[17]

Demand and supply curve estimates may provide a better framework set the right prices to encourage sustainable water use. However, whether sustainable water use is managed through pricing or non-pricing policies, it is important that alternatives to certain levels of water use are promoted which enable demand elasticities to be high enough so as to ensure effectiveness of the policy and avoid affordability, productivity (especially in the agricultural sector) and political feasibility issues. Moreover, salience of water prices is also key to ensure significant responsiveness (García-Valiñas, Martínez-Espiñeira and Suárez-Varela Maciá, 2021[22]).

In the medium-term, supply-side solutions to sustainable use also exist, such as reuse and desalination. However, their high costs can jeopardise financial sustainability and desalination is very energy-intensive (even though it is becoming increasingly efficient (OECD, 2020[23])), which can cause other environmental, in particular climate-related, issues.

Regarding externalities to ecosystems, theoretically, when externalities can be measured, a form of Pigouvian taxation can be introduced. Pigouvian taxation aims to reflect the external costs that individual water consumption puts on society through the ecosystem in the decision making of the individual water user and hence to steer behaviour accordingly.

In line with the OECD Council Recommendation on Water, pricing should be such that the burden falls in an equitable way on users (criterion 5). The water pricing system as a whole should avoid one type of user generating the greatest costs for the system, while the other users bear the price. However, it is important to bear in mind the interlinkages between the various water users, and in particular general equilibrium effects. Indeed, while households are at the very end of the supply chain, firms and farmers use the water to produce goods for consumption, ultimately, by households in Andalusia or Spain more generally or for export. Hence, cost pass-through should also be accounted for, especially for the Equity principle. In the following, equity is only assessed in a partial equilibrium setting. Its evaluation in a general equilibrium context would require a much deeper analysis.

Equity can positively impact sustainable use. Indeed, sharing the burden in an equitable manner can have an effect on sustainable use by making users responsible for their water consumption.

6.1.4. Policy instruments for pricing water in Andalusia

Spain and Andalusia more specifically currently recover water-related costs through user charges and through public spending. At the Spanish national level, slightly above half of water management is funded through the public budget as opposed to water tariffs charged to individual users (OECD, 2021[24]). Most national and Andalusian water-use tariffs include a mix of cost-recovery, sustainable use and affordability criteria.

Table 6.2 presents the pricing mechanisms that apply in Andalusia in 2022 (i.e., Spanish, Andalusian and more local levies) and maps them to the different pricing criteria they address (intentionally or not), and the phases of the water cycle they concern. As exposed in Section 5, on top of multiple national levies, there are two Andalusia-specific levies, one local levy and one municipal levy. These four levies are discussed in more detail below.

Table 6.2. Criteria addressed by water-use levies in Andalusia

Levy	Service concerned	Brief description	Criteria effectively addressed
Regulation fee (National)	Upstream surface water services /	The persons benefitting from surface water or groundwater regulation works, financed wholly or partially by the central government, are charged a fee to cover the costs related to the building, operation and maintenance of these works. The fee is to be distributed among the different hydrological exploitation systems according to criteria of rationalisation of water use, fairness in the distribution of obligations and self-financing of the service	Cost of service recovery (Sustainable use and equity)
Water use tariff (National)	Upstream surface water services /	The persons benefitting from other hydraulic works than those falling under the regulation fee (e.g., works to correct the deterioration of the public hydraulic domain) are charged a tariff to finance the investment, operation and maintenance costs of these works.	Cost of service recovery (Sustainable use and equity)
Fee for the use of public hydraulic goods (National)	Upstream surface water services	Concessionaires and authorised persons are charged a fee for the use or occupation of a public hydraulic domain that requires administrative authorization. It aims to finance the protection and improvement of the public hydraulic domain.	Environmental cost
Hydroelectric development fee (National)	Upstream surface water services	The holders of a hydroelectric exploitation are charged a fee for the use and exploitation of the public hydraulic domain for hydroelectric development purposes. It aims to finance the protection and improvement of the public hydraulic domain.	Cost of service recovery
Irrigation charges (National)	Downstream distribution of water for irrigation	Irrigation water users of the same water concession are charged to finance the construction, maintenance and improvement of irrigation infrastructure in the Community. These charges are regulated by each Irrigation Community.	Cost of service recovery / Equity
Amortisation rate and operating rate of water companies (National)	Downstream urban supply	The rates are applied to compensate water companies for their costs associated with the investment, operation, and maintenance of hydraulic infrastructures. The contributions are paid by the River Basin Authority under the terms defined in an agreement between the water company and the River Basin Authority, which is regulated under the Spanish Water law.	Cost of service recovery
Fee for occupation and use of the public maritime-terrestrial domain (National)	Desalination	Concessionaires and authorised persons are charged for the use or occupation of maritime-terrestrial public domain. This fee was established to cover the costs associated with the protection and enhancement of the maritime-terrestrial domain.	Environmental cost
Improvement fee* (Andalusia & local)	Downstream urban supply	The fee applies to water users. The base is the volume of water invoiced by the water supply companies. The fee is levied through two modalities: (i) a regional fee and (ii) a local fee. It aims to finance hydraulic infrastructures for the provision of water supply, sewage, and wastewater treatment services.	Cost of service recovery / Sustainable use / Affordability
General service fee** (Andalusia)	Upstream surface water services / Upstream groundwater services	The aim of the fee would be to cover administrative expenses of the Andalusian Water Administration to guarantee the proper use and conservation of water.	Cost of service recovery / (Sustainable use and equity)
Municipal fees for the provision of water supply, sewage, and	Downstream urban supply / Reuse	Municipalities may establish fees related to the provision of water supply, sewage and wastewater treatment services. The fees are levied on users of drinking water, sewerage and	Cost of service recovery / Sustainable use

wastewater treatment services		wastewater treatment services in a given municipality. The fees aim to compensate the local water supply company for the operating costs associated with the provision of urban water services (including supply of drinking water, sewage and wastewater treatment).	/ Affordability

Note: * In the Fall 2022, the Andalusian government has just set (Decreto-Ley 7/2022, de 20 de Septiembre) the temporary suppression of the Improvement fee from 1 January to 31 December 2023.
**As indicated in Section 5, the general service fee has not been implemented yet and is currently under discussion.
Source: Authors, based on the detailed description of the fees provided in Section 5.

The Andalusian **improvement fee** concerns the availability for urban use of drinking water from any source, supplied by public or private supply networks. It is meant to provide compensation for the costs of investment in hydraulic infrastructures of any nature corresponding to the integral cycle of water for urban use[18] borne at the Autonomous Community level and declared to be of general interest. The base and rates of the fee are further described in Box 6.2. . Water supplying entities and the natural or legal persons who own other supply networks are liable for water losses in supply networks. In addition, local improvement fees exist with very similar features to the Andalusian-level one and are meant to cover the costs of investment in water infrastructure borne by *local authorities*.

Box 6.2. Base and rate of the Andalusia improvement fee

Base

The base is the volume of water invoiced to urban users[19] by the supplying entities, expressed in m^3. In the event of water losses in the supply networks, the base is calculated as the difference between the volume supplied to the supply entity and the volume invoiced by the same.

Rate

The total charge is the result of adding a variable charge for consumption and, where applicable, a fixed charge for availability.

The fixed charge is at EUR 1 per month per user for domestic use. No fixed amount is charged to non-domestic users.

The variable charge is exposed in Table 6.3.

Table 6.3. Variable charge for the improvement fee

Type of use	Bracket	Rate (EUR/m3)
Domestic use	Consumption between 0 and 2 m^3/hh/month	0
	Consumption between 2 and 10 m^3/hh/month	0.10
	Consumption between 10 and 18 m^3/hh/month	0.20
	Consumption over 18 m^3/hh/month	0.60
Non-domestic use	n.a.	0.25
Losses in supply network	n.a.	0.25

Note: hh stands for household.

If the number of members in a household exceeds four, the upper limit of each of the progressive rate brackets may be increased by 3 cubic metres for each additional person living in the dwelling.

In the first 5 years of application of the fee, the application of the variable fee is progressive over time with the following percentages: 30, 45, 60, 80, 100%.

Note: Note that the improvement fee has been temporarily suspended by the Andalusian government from 1 January to 31 December 2023.
Source: Based on https://www.juntadeandalucia.es/medioambiente/portal/web/guest/areas-tematicas/agua/gestion-del-agua/recuperacion-de-costes/tarifas-y-canones-uso-agua-dominio-publico-hidraulico-dph-y-dominio-publico-maritimo-terrestre-dpmt, as accessed on 14 June 2022.

The **municipal fees for the provision of water supply, sewage, and wastewater treatment services**, are by definition set at the municipal level, and may widely differ across municipalities (Arbués and García-Valiñas, 2020[20]). As their name indicates, they are meant to cover the operating costs of the supplying entity for the provision of urban water cycle services. The fee may consist of a fixed part per user (which often depends on the metre calibre) and a variable part (generally progressive with the amount of water use, for households) depending on the cubic metres of water billed within the settlement period considered. A distinction is made between the types of domestic, commercial, industrial, official bodies and other uses, with no explicit mentioning as to why differential treatment applies. The tariff system can be complemented with a system of bonuses, linked either to the sustainable use of water or to social criteria.[20] The Andalusia or local improvement fee applies in addition to this fee, as it is meant to cover different costs.

The **general services fee** is to be introduced at the Andalusia level with the aim of compensating the administration costs of the Public Administration to ensure the proper use and conservation of water.[21] At the time of writing, the fee is still being discussed and no clear schedule for implementation is available. This fee would come on top of the existing national regulation fee and water use tariff, which are both meant to cover administrative costs as well administrative costs that are covered by the general services fee are to be subtracted from the level of administrative costs covered by the current regulation charges and water use tariffs. Like these two national-level charges, the payable amount determined by the general services fee is to be distributed among the different hydrological exploitation systems according to criteria of rationalisation of water use, fairness in the distribution of obligations and self-financing of the service.

6.1.5. Alignment of the Andalusian water pricing system with economic and environmental criteria

In order to assess the alignment of the Andalusian water pricing system with economic and environmental criteria, it is key to not only consider the Andalusia-specific levies (including local and municipal levies), but also to consider the system as a whole (and not instrument by instrument), including national-level levies. Thus, the following first provides an economic and environmental analysis of Andalusia-specific instruments taken separately. Then, it provides an assessment of the overall water pricing system that applies in the Autonomous Community.

Andalusian fees

The improvement fee addresses the criterion of cost of service recovery. Indeed, the fixed and variable charge for domestic users are a way to address cost recovery, and so is the variable cost for non-domestic users. It is however not clear why the variable cost is progressive for domestic users and not so for non-domestic ones, nor why domestic users are the only ones liable for the fixed cost. This is further discussed on the basis of the other three economic criteria.

The improvement fee's progressive rate structure for households and its differential rates between domestic and non-domestic users can help deal with affordability, can ambiguously affect sustainable use, and may not align well with equity concerns. First, the exemption of the first two cubic metres consumed per household per month can help address affordability issues for the poorest households. However, this same feature might engender sustainable use issues, by creating no disincentive for consumption below

2m³/month. Given that today, the average daily consumption of water per person in Andalusia is around 128 litres,[22] this amounts to about half of a one-person household water consumption being provided for free.[23] A more precise characterisation for this would require defining minimum levels of necessary water consumption per person, which could better help set a per person threshold below which water consumption is provided for free.

Second, the progressive rates on water consumption faced by households may help discourage water overconsumption (Olmstead and Stavins, 2009[17]), which contributes to more sustainable water use. However, the unit to which these progressive rates apply being the household and not the user, can create equity issues between households depending on their size. Indeed, as shown in a few examples in Box 6.3 , this creates a penalty the larger the household is, for dwellings of four or less individuals. The adjustment of the upper limit of each of the progressive rate brackets for larger households then advantages them as compared to smaller households.

Third, the differential rate between domestic and non-domestic users may create an equity issue between the two (see Box 6.3). This is reinforced by the exemption from the fixed fee for non-domestic users. However, this could be justified on a sustainable use or cost-recovery basis if water demand of non-domestic users was more elastic than that of domestic users or if service costs were lower for that sector, hence calling for lower rates.

Fourth, base coverage of the fee encourages sustainable use by covering water losses in the supply networks, a novel and important feature of this fee. Indeed, as stressed in section 6.1.3, water losses in networks are important in Spain, and worldwide and generally do not face any cost associated to this. This in turn generally provides no incentive for better management or renewable of obsolete infrastructure, and can help address future service-cost recovery, hence financial sustainability.

Finally, affordability is also tackled through the progressive introduction of the fee in time: this provides time for households to adapt. It also gives them visibility on what costs they will face going forward.

Box 6.3 Equity issues created by the progressive rate structure of the improvement fee

To see how equity issues may arise between households of different sizes, Table 6.4 presents the variable fee (i.e. abstracting from the EUR 1 fixed charge paid by households for infrastructure reasons) paid by user for an individual consumption of 4m³ per month, depending on the size of the household. This table highlights how both due to the 2m³/month exemption, the progressive rate structure of the fee, and the adjustment in brackets for dwellings of more than 4, households of different sizes end up having different liabilities *per user*.

Table 6.4. Variable fee paid by individual for an individual consumption of 4m³ per month

Household size	Total household consumption (m³)	Total variable fee per individual (EUR)
1	4	0.2
2	8	0.3
3	12	0.4
4	16	0.5
5	20	0.44
6	24	0.4

Note: The calculations were based on hypothetical households that would have been liable for this fee for more than five years.

To see how equity issues may arise between domestic users and non-domestic users based on the variable part and the fixed part of the improvement fee, Table 6.5 presents the improvement fee liability faced by a household and that by a firm for the same volume of water consumption. The amount to be paid would be lower for the business than for the household, who, however, would generally have a smaller monthly budget. Again, however, this different may be justified by other factors such as different demand elasticities or different service costs.

Table 6.5. Total fee paid by a household and by a business for a total consumption of 32m^3 per month

Type of user	Total fee per user (EUR)
Household of 6	8.2
Business	8

Note: The calculations were based on a household liable for the improvement fee for more than 5 years.

The municipal fees address similar criteria to the Andalusia and local improvement fees. Sustainable use is addressed with the additional instrument of a bonus system and affordability with lower tariffs for households considered as vulnerable. However, such measures do not exist in all municipalities. In Malaga and Seville, for example, lower tariffs do not exist. In Cordoba, they exist for certain retired people, families where all members are unemployed or families at risk of social exclusion (Arbués and García-Valiñas, 2020[20]).

The general services fee addresses cost of service recovery and covers an important element of service costs: administrative costs. However, given that administrative costs (albeit possibly different ones) are already covered and in a similar fashion by the existing national regulation fee and water use tariff, one can question the efficiency of introducing yet another levy to the system. While this might cover previously uncovered costs, this introduces additional complexity to the system, as well as potential additional administrative costs. Consolidating fees covering administrative costs might be a more efficient way forward.

It would also seem like the general services fee is meant to address sustainable use as well as equity. Indeed, the payable amount determined by this fee is "to be distributed among the different hydrological exploitation systems according to criteria of rationalisation of water use [and] fairness in the distribution of obligations." The calculation of the distribution of the amount payable between users (proportionally to water use or not) is key to determining whether rationalisation is indeed promoted. Indeed, some research points to higher responsiveness to progressive rates (Olmstead and Stavins, 2009[17]). Rationalisation effects will also depend on responsiveness of hydrological exploitation systems to incentives provided by this calculation. However, and as discussed below, it may not be required to incorporate rationalisation objectives in this levy itself.

The Andalusian water pricing system as a whole

Overall, the water pricing system in Andalusia contains many national-level instruments meant to recover service costs and certain regional and local-level instruments that might help promote affordability, sustainable water use as well as equity.

Despite the multiple cost of service-recovery instruments, the recovery of costs from water use is far from complete across the Andalusian river basins, according to the analysis presented in the 2022 White Book for Tax Reform in Spain (Table 6.6). This indicates that the Andalusian water management cycle is forgoing revenues that can be justified based on the costs related to water use. In the four main Andalusian river basins (Guadalquivir, CC. MM. Andalusas, Guadalate-Barbate and Tinto-Odiel-Piedras), cost recovery rates are around 80% and even reach about 87% for Guadalate-Barbate. While these are amongst the highest in Spain, they still fall short of full recovery rates, i.e. 100% – even with environmental costs left out. Moreover, these estimates do not include all costs mentioned previously, such as administrative and governance costs. It is not clear either whether the costs considered in this table are existing costs, or also include a forward-looking view on future costs. As mentioned in the economic and environmental criteria discussion, this is key to encourage investment.

Table 6.6. Annual cost of water use and revenues at river basin district levels

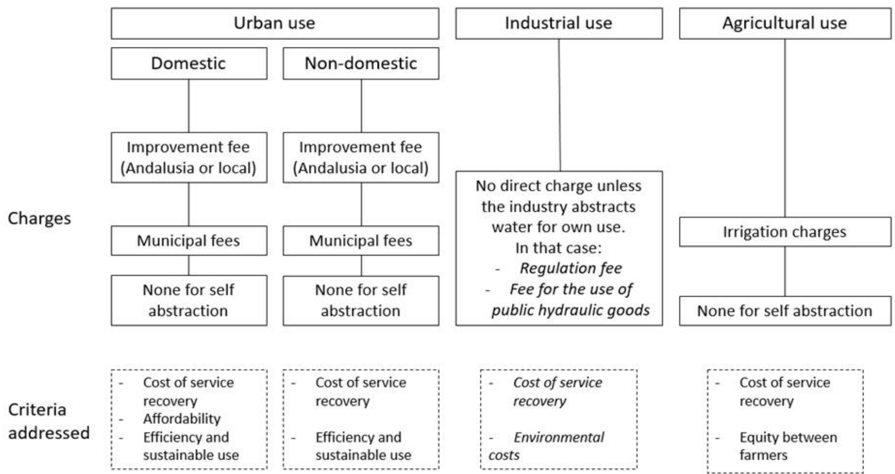
In Million Euros

River basin	Financial cost (operating and maintenance costs, AEC of investment)	Environmental cost (AEC)	Total cost	Revenues	Cost recovery rate (including environmental cost)
Guadiana	537.81 (91.72%)	48.57 (8.28%)	586.38	353.06	60.21%
Guadalquivir	1032.00 (93.66%)	69.88 (6.34%)	1101.88	870.76	79.02%
Segura	805.70 (77.22%)	237.67 (22.78%)	1043.37	700.02	67.09%
CC. MM. Andalusas	743.90 (90.43%)	78.70 (9.57%)	822.60	659.65	80.91%
Guadalete-Barbate	163.78 (91.89%)	14.46 (8.11%)	178.24	154.11	86.46%
Tinto-Odiel-Piedras	121.15 (92.30%)	10.47 (7.70%)	131.26	109.37	83.01%

Note: AEC stands for annual equivalent cost. Environmental costs represent the following: "Environmental costs are valued at the economic cost of the actions necessary to minimize the environmental cost associated exclusively with the provision of water services." The percentages in parentheses represent the share of costs finance and environmental costs respectively in total costs.
Source: Hydrological Plans (2022-2027) of the river basin districts (in approval process), available at: https://www.miteco.gob.es/es/agua/temas/planificacion-hidrologica/planificacion-hidrologica/PPHH_tercer_ciclo.aspx. The whole table with all river basin districts information is Table 24 in the Libro Blanco.

From a partial equilibrium point of view,[24] the current water pricing system in Andalusia is not well aligned with the equity criterion, both due to coverage and to rates. Figure 6.3 summarises the levies directly faced by the three main water users. Regarding coverage, irrigation is only subject to fixed fees to cover principally the costs of construction, repair and improvement of related works and installations of the Community as well as common operating and administration expenses.[25] Regarding overall rates, the fee depends on the share of each irrigator in the Community but not directly on the volume of water used. For this reason, it may be that the agricultural sector bares a lower cost for water-related services, while it is the principal sector in terms of water demand (about 80% in Andalusia). Regarding rates facing urban users, the design of Andalusian and local taxes often exempts or offers reduced fixed rates to industries for water supply access. Moreover, the progressive rates faced by households are applied at a dwelling level with certain provisions for larger households, so that equity between individuals may not be respected. The rates faced by industry not connected to the grid are not straightforward to infer from the pricing system. A caveat is called for regarding rates on different users, however, as it might be the case that certain users face lower rates because the cost of service linked to their water usage is lower or because their demand elasticity is higher.

Figure 6.3. Direct levies faced by users for their water-use



Source: Author's own elaboration.

Setting clear objectives is key to addressing all five criteria for good water management exposed in section 6.1.3. Regarding cost of service recovery, it would be important to know the costs each user type are responsible for. Is it the case that water use for urban purposes is more costly due to higher treatment and control requirements? If this were known, then this could be a rationale for lower rates facing industries not connected to the grid and agriculture. It could help set recovery rates in line with the service costs that should be recovered. Regarding affordability, it is important to know who the most vulnerable households and other water users (certain small farmers for example) are. This would enable directly targeting them. In the case of water, income for households and size of farm for farmers could constitute indicators to work with. Regarding sustainable water use, in the absence of a market, maximal amounts of acceptable water use should be set.[26] Once these three objectives are set, it is more straightforward to ensure equity between the different users. Finally, environmental costs could be accounted for by using as a base, for example, the EUR 0.3/m^3 highlighted in the European Commission study by Mottershead et al. (2021[15]).

Last but not least, the economic and environmental criteria for water pricing discussed above do not cover the last recommendation of the OECD Council Recommendations on Water related to water use, the Policy Coherence principle,[27] which certain regional, national or EU-level policies sometimes negatively affect. According to Box 2 in Fuentes (2011[25]) regional governments are in charge of natural resources, agricultural policies – subject to European Union directives and central government guidelines – as well as of land-use planning. While cereals (such as wheat and rice) are associated with low value added relative to their water needs, they are essential in ensuring national food security. However, the recent take-off of avocado and mango culture (Campos, 2021[26]) in Andalusia, and in particular along the Costa del Sol, questions the Policy Coherence principle, given the very important water needs of these crops as compared to the traditional olive and vine cultures. On the other hand, while probably not sustainable in the long-run, these cultures might have helped promote rural communities' well-being in the short run. These issues are further discussed in the last subsection on non-pricing policies. At the EU-level (and hence not in the resort of Andalusia), a recent report of the European Court of Auditors (2021[27]) highlights that Common Agricultural Policy (CAP) funds are generally not aligned with efficiency water use requirements and instead risk promoting greater water use.

6.1.6. Policy instruments to address environmental concerns: sustainable use for water preservation

While service cost-recovery, affordability, sustainable use, environmental externalities and equity, affordability are all important components of water pricing, sustainable use is currently the most pressing and least accounted for issue at a region-wide level. Indeed, for now, households appear to be the principal bearers of this criterion, while neither water pricing in agriculture nor in industry accounts for this. Given that agriculture represents about 80% of water use in Andalusia, it is important that sustainable use is also promoted in this sector.

Regarding sustainable use objectives, the EU WFD sets certain goals in terms of water preservation. In particular, it establishes the target of "good" quantitative status for all groundwater bodies by 2027 and specifies limits to water abstraction. These could be minimal targets for a potential future environmental component of water pricing in Andalusia. In particular, the Hydrological Plan of the second EU WFD cycle[28] presents the results of analyses of the ecological status of surface water bodies and of the quantitative status of groundwater bodies, classifying them under "Good" or "Poor". Such classifications could serve as a basis for target-setting also in Andalusia.

An abstraction tax on water abstracting entities could be introduced to address water scarcity and help reach water preservation and environmental objectives. If not done at a national level, this could be envisaged at the Andalusian level. In theory, levies on abstraction are designed to reflect externality costs of water use and to discourage low value uses. The rates could differ across water sources (surface or groundwater) and water bodies (depending on their stress level). This tax would then be passed through onto the different water users. Box 6.4. provides examples of abstraction levies in other jurisdictions.

Box 6.4. Abstraction charges

France and Estonia present two examples of jurisdictions which apply abstraction charges.

In Estonia, the tax does not applies to all users seeking to abstract water. Exceptions apply to small volumes of abstracted water, to irrigation and fish farming use as well as to use for energy purposes. Higher rates apply, the deeper the water abstracted and for the Tallin catchment areas as opposed to other areas. Abstracting water from deeper surfaces can indeed have more consequences for the environment, as the deeper it is, the more lengthy aquifer recharge may be. Slow or limited aquifer recharge, in turn, can have important consequences for river flows in the summer, for soil and eventually for desertification phenomena.

France has a tax that applies to all abstraction activities, except for sea water and certain activities including some mining activities, aquaculture, geothermal energy and frost control for perennial crops. Where a person has a borehole for their water supply, they are required to install a metering device that measures the volume of water abstracted. Rates are differentiated according to the intended use, are highest for drinking water supply and lowest for gravity-based irrigation. They may also differ across water basins.

Note: For further information, see Annex Figure 6.A.1.
Source: (Andersen et al., 2006[28]) for Estonia and https://www.legifrance.gouv.fr/codes/section_lc/LEGITEXT000006074220/LEGISCTA000006159222/2008-01-01/#LEGISCTA000006159222 (Article L213-10-9) for France.

An abstraction tax would be legally implementable at the regional or national level (see Section 5) and has been suggested at the national level in the White Book for Tax Reform in Spain. Such a tax could be more effective regarding national water conservation and planning if implemented at a national level, because it would ensure all water potentially abstracted in Spain would be included in the tax. However, different

Spanish regions have different needs in terms of water use and different risks of water shortages, which can be present a justification for policy action at the regional level. Moreover, pushing for abstraction taxes at the regional level first could also support building political momentum for a national-level instrument and public acceptability, similar to how regional carbon taxes in Andalusia and certain other Autonomous Communities have contributed to the promotion of such a tax at the national level (see the recommendations of the White Book for Tax Reform in Spain). Cooperation with river basin authorities will be key, as they are in charge of granting rights for and controlling water abstraction. Tight control should be ensured in order to monitor levels of water abstraction.

Setting the abstraction tax at the required level to reach water conservation objectives, would require a better understanding of demand curves for the different types of users: households, businesses, industry and agriculture. Moreover, for the abstraction tax to fulfil its water conservation objective, alternative means for lower water use should be promoted for all users. This would help effectiveness of the policy as well as help overcome political barriers and affordability concerns for all users as well as productivity and competitiveness issues in the industry and agriculture sectors. Finally, water user responsiveness can be increased by public awareness campaigns. Recent findings point to the importance of a mix of pricing and non-pricing policies measures to better manage water demand (European Environment Agency, 2017[29]; Leflaive, 2022[30]). Measures to increase user responsiveness and price elasticities of water users are further discussed in section 6.3.

Abstraction taxes may be a useful instrument to target formal abstraction activities – and would target most uses – but are more challenging to implement on self-water abstraction, which is a significant, albeit not a majority, practice in the Andalusia agricultural sector. For example, in the Guadalete-Barbete river basin, water self-abstraction represented about 14% of water use in the sector.[29] Indeed, monitoring self-abstraction is not straightforward. Fuentes (2011[25]) suggests a mechanism that would introduce monitoring through user associations (also referred to as Communities) to avoid over-use induced by this highly decentralised water abstraction source. This is a means that has observed in many communities where water use is informal and hence hard to regulate (Ostrom, 1965[31]). While user associations do not typically deal with these issues, there are some examples of successful resource management among Andalusian Communities, which have set up internal mechanisms of abstraction controls and fines, without the need for government intervention. This could be promoted at a larger scale, by supporting user associations in their monitoring effort, organising exchange of best practice amongst associations or by introducing financial incentives (such as fines) for those associations whose users are globally responsible for over-abstraction of aquifers. Indeed, as was seen above, over-abstraction is regularly measured by River Basin Authorities. If the financial incentive imposed on user associations is then passed on to farmers it would represent a type of decentralised abstraction fee. Legally, such provisions would have to be implemented at the national level, however (see Section 5).

Another way of pricing water abstraction is to allocate water usage quotas to introduce “cap-and-trade” water markets. Australia has been a leader in the development of such water markets, especially in the Murray-Darling Basin. This long-term experience of over thirty years now has enabled to gather enough evidence for in-depth analyses (Grafton and Wheeler, 2018[32]). While cap-and-trade systems present usual benefits and drawbacks, in the case of water, the administrative needs for implementation have proven to be extremely complex and require sophisticated administration. More precisely, in the Australia example regulating numerous small farmers and helping them adjust to the complex functioning of a water market was a challenge. Moreover, setting water quotas may prove to induce perverse effects: opportunity costs of not using up or selling assigned quotas are high, which provides an incentive to use up the entirety of available quotas in a given period. This does not incentivise sustainable water use, can lead to over-exploitation and is said to have led to the drying-off of certain riverbeds in Australia. The OECD toolkit for water policies and governance (OECD, 2021[24]) provides additional details on the lessons from the Australian water market experience.

This being said, the management of water resources through robust allocation mechanisms has been extensively analysed in a recent OECD note (Leflaive, 2022[30]) and a report (OECD, 2015[33]). These expose how designed and implemented allocation regimes can perform well under average and extreme conditions and can be adapted to changing conditions at the least cost over time. They can be more effective at managing water scarcity, allocating sufficient shares of water to the ecosystem and addressing equity issues than pricing. This is especially the case because of the relatively low responsiveness of water users to prices (which can be addressed through other policies, as discussed in the following). However, in practice, several issues arise such high degree of path dependency – hence difficulties to effectively adjust the allocation arrangements – or reduced return flows.[30]

Finally, as highlighted in section 6.1.3, ensuring financial sustainability of the water network can help reach goals of sustainable water use and equity. In this regard, a discussion, along with case studies on the United States and on the United Kingdom, on possibilities for improving financing models and public-private partnerships to finance investments is provided OECD (2017[2]). A recent OECD note (Leflaive, 2022[30]) points to findings relating to more efficient of water appliances and networks contributing to decreasing domestic demand for freshwater. Another alternative consists in building dual networks.

Dual water distribution networks would separate the distribution of potable water from that of non-potable water, that would either be untreated or poorly treated. The former would be supplied for drinking purposes and the latter for purposes such as street-cleaning or recreational uses (e.g. private gardening, swimming pools). Dual networks could have the benefit of increasing water reuse (reclaimed wastewater), which is a strategy used in Israel for instance (see (OECD, 2017[2]) for additional details on the surge of water reuse in Israel). They could also enable differential pricing for high and low water uses. The trade-off here stands between the costs of building and maintaining two distinct networks and the costs of water treatment.

6.2. Pricing water pollution

After an exposition of the main sources of water pollution, this subsection discusses the main externalities from water pollution and presents estimates of their costs. It then analyses the water pollution pricing mechanisms in place today in Spain and hence Andalusia, their alignment with the Polluter Pays and Equity principles of the OECD Council Recommendation on Water and exposes additional instruments that could be introduced to deal with water pollution. The Policy Coherence principle is also briefly discussed.

6.2.1. Sources of water pollution

Water pollution comes from urban, industrial and agricultural users and may originate from point sources or diffuse sources. Point sources of pollution refer to “direct discharges to receiving water bodies at a discrete location, such as pipes and ditches from sewage treatment plants, industrial sites and confined intensive livestock operations”. Diffuse (or non-point) sources of pollution refer to “indirect discharges to receiving water bodies, via overland flow and subsurface flow to surface waters, and leaching through the soil structure to groundwater” (OECD, 2017[2]).

In the urban and industrial sectors, water pollution is mainly due to wastewater and direct industrial discharges. In the past decade, there has been an increased focus on contaminants of emerging concern (CECs). “Emerging” refers to their recent appearance in water, or to a recent detecting of these contaminants at concentrations significantly higher than expected. Moreover, their risk to human and environmental health may not be fully understood. Examples include pharmaceuticals, industrial and household chemicals, personal care products, manufactured nanomaterials, and their transformation products (OECD, 2020[5]).

The usual water pollution sources from the agricultural sector include sedimentation[31] and pesticides use[32] as well as certain practices of nutrient use (applied in the form of chemical fertilisers, manure, and sludge), animal feeding, livestock grazing and irrigation (EPA, 2005[34]). CECs are also a concern for the agricultural sector and were analysed a decade ago already in Boxall (2012[35]). These include manufactured nanomaterials (e.g., nanopesticides or nanomedicines), veterinary medicine or increased pollution risk from manure and sludge (as feedstock and plants have ingested CECs from other sources).

Moreover, the widespread of antibiotics by humans or in the agriculture sector has been increasing the presence of antibiotic residues in surface and groundwater. This in turn facilitates a permanent exposure of microorganisms that can reinforce resistance to antibiotics (Cycoń, Mrozik and Piotrowska-Seget, 2019[36]), which is a growing threat today.[33]

6.2.2. External costs of water pollution

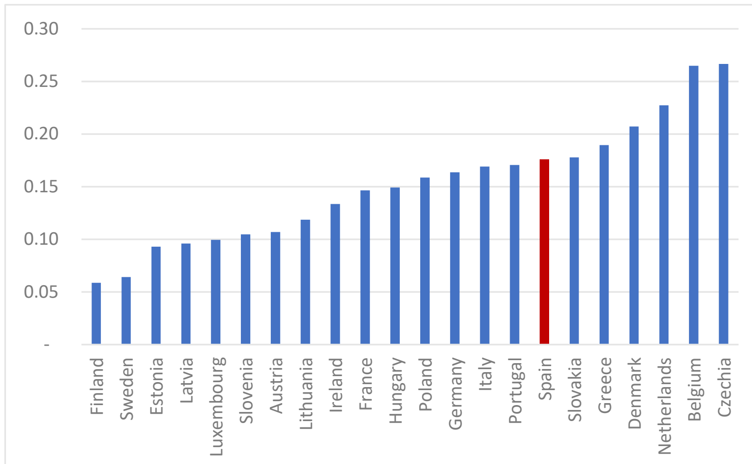
The main externalities from water pollution relate to health and ecosystems (which shall be referred to as environmental externalities), but are also economic. For example, groundwater provides a non-negligible share of drinking water to both humans and the agricultural sector so the higher its pollution level the higher treatment costs are. In 2021, groundwater accounted for 11.5% of water use in the urban sector in the Guadalquivir river basin, for about 13% in the Guadalete-Barbete river basin and about 5% in the Tinto-Odiel-Piedras river basin. In 2010 already farming was the main source of groundwater pollution in many countries, and increasingly so (OECD, 2010[37]).

Mottershead et al. (2021[15]) calculates external costs from water pollution for the European Commission. They consider water pollution from nitrogen and phosphorus use, which arises primarily from non-point sources, in particular agriculture. Nitrogen and phosphorus are present in most fertilisers currently used in farming (European Commission, 2019[38]). These pollutants have two main environmental externalities: (i) eutrophication,[34] which causes damages to ecosystems and loss of amenity to households with waterfront properties and recreational water users and (ii) human health impacts, and mostly cancers from nitrite pollution of drinking water due to nitrogen as well as osteoporosis due to the presence in food of cadmium contained in mineral phosphorus. Their impact is due to the surplus of nitrogen and phosphorus, which is not absorbed by plants. The costs of pollution from these two inputs vary with geographical area, due to differences in population density (higher density increases the number of people exposed to the risks of eutrophication or health impacts), proximity to surface and coastal waters and sources of drinking water supply.

According to the study, Spain is amongst the median countries in terms of the size of external costs induced from both nitrogen surplus (EUR 0.85/kg/year[35]) and phosphorus (EUR 0.9/kg/year[36]). However, when taking the volume discharged into account and looking at total annual costs (i.e. in EUR/year) and when adding wastewater costs due to households and industries, Spain is amongst the EU member countries with the highest annual costs – both in total (2,113 million euros per year) and as a share of GDP (see Figure 6.4).

Figure 6.4. Annual costs of water pollution as a share of GDP for selected EU countries

In percentage



Note: Annual costs of water pollution as a share of 2018 GDP.
Source: Mottershead et al. (2021[15]).

StatLink https://stat.link/4qklvr

6.2.3. Pollution pricing in Andalusia

Taxation is typically used as an instrument to internalise external costs from water pollution but a decision should be made as to whether the tax is targeting pollution or inputs creating pollution. Which instrument is most appropriate will depend mainly on how well polluter and toxicity of pollution can be identified:

Pollution taxes or charges can be designed to cover external costs from point sources. Typically, they apply to industrial users and households.

Input taxes may be more appropriate when facing diffuse pollution, which makes it difficult to identify polluters clearly, such as agriculture.

The state of water pollution pricing in Spain and Andalusia: description and analysis

In Spain, and hence in Andalusia, a **pollution control fee**[37] applies to both urban and industrial[38] wastewater on the persons who carry out discharges into the public hydraulic domain. The national pollution control fee is proportional to the volume of water discharged but also takes into account its polluting impact. Urban wastewater discharge faces a basic volumetric price of EUR 0.01751 per m^3 and industrial wastewater of EUR 0.04377 per m^3. Then, urban and industrial users are charged the product of the volume they discharge by the basic price of the discharge to which a coefficient is applied according to three factors. The first is the nature and characteristics of the discharge, the second is the degree of pollution and the third depends on the environmental quality of the physical environment into which it is discharged.

The pollution control fee addresses the purely economic costs of water pollution. Indeed, by charging a fee proportional to the volume of water discharged, it at least partly covers the monetary costs that pollution imposes on the assessment, control, protection and enhancement of the river basin district where pollution is emitted.

The fee also has an environmental component to it. Indeed, the coefficient applied in the calculation of the charge includes three different factors that account for its environmental impacts. Depending on how these are measured, they may have the feature of accounting for environmental externalities or of discouraging water pollution – this is especially so for the degree of pollution factor (second factor). In the industry sector, the design of taxes discouraging the release of polluting substances into water is complex, as estimating firm-level emissions and their damages may be prohibitively costly, due to the presence of multiple small producers and to chemical and weather factors addressed above (OECD, 2017[18]). The Spanish pollution control fee constitutes an attempt to do so, but the effectiveness of this tax will depend on the level of the three factors. Box 6.5. presents the example of France, which has a tax targeting the pollution level of water discharges.

Box 6.5. The French pollution tax on non-domestic activities

In 2006, France passed a law to tax pollution generated from non-domestic activities, which was implemented in 2008. This tax applies to a yearly average of polluting substances rejected by different industrial and agricultural activities. The rates are set per polluting substance. For agricultural activities, it also applies to livestock farms with more than 90 (or in some cases 150) animals.

For point source pollution, the pollution levels are determined by a regular measurement of industrial discharges. When direct measurement is not possible or when facing diffuse pollution, a theoretical level of pollution based on the activity is computed. The theoretical pollution level of an activity is calculated based on magnitudes and coefficients which characterise that activity. It is determined from general measurement campaigns or studies based on representative samples.

Table 6.7 presents some rates and inclusion thresholds applied since 1 January 2021. Different rates apply depending on whether the pollutants are discharged into surface or ground water and whether they are discharged into the sea or into rivers.

The tax is of EUR 3 per livestock units when there are more than 1.4 livestock units per hectare of utilised agricultural area.

Table 6.7. Tax rates and inclusion thresholds applying to non-domestic water pollution, France

Selected pollutants

Pollution component	Tax rate (in EUR per unit)	Threshold
Suspended solids (per kg)	0.3	5 200 kg
Chemical oxygen demand (per kg)	0.2	9 900 kg
Five-day biochemical oxygen demand (per kg)	0.4	4 400 kg
Reduced nitrogen (per kg)	0.7	880 kg
Oxidised nitrogen, nitrites and nitrates (per kg)	0.3	880 kg
Total phosphorus, organic or mineral (per kg)	2	220 kg
Environmentally hazardous substances discharged to surface water bodies (per kg)	10	9
Environmentally hazardous substances discharged to groundwater bodies (per kg)	16.6	9
Heat discharged into the sea, except in winter (per megatherm)	8.5	100 Mth
Heat discharged to river, except in winter (per megatherm)	85	10 Mth

Note: For further information, see Annex 6.A.
Source: https://www.legifrance.gouv.fr/codes/id/LEGIARTI000041528273/2021-01-01/.

Finally, by differentiating the rates paid by urban users and industrial users, the pollution fee acknowledges that the pollution impact of wastewater from the latter is greater than from the former. This can both address economic costs (treating industrial wastewater is on average more costly than treating urban wastewater) but also environmental costs. Indeed, the environmental costs of industrial wastewater discharges are typically higher than those of urban wastewater discharges.

No such fee applies in the agricultural sector, even though as highlighted earlier it is the main sector responsible for aquifer pollution today. This may be due to the fact that, as discussed above, diffuse pollution is not well targeted by such a tax. Input taxes, which do not exist nor in Spain nor in Andalusia, and other means of addressing water pollution originating from agriculture are discussed in the next part.

In terms of the OECD Council Recommendations on Water, the current system falls short of aligning with both the Polluter Pays and the Equity principles. The Polluter Pays principle is not respected for the agricultural sector, since as of now, water pollution is not priced in that sector – neither through a pollution levy nor through an input tax. The lack of price paid for water pollution for agriculture users is not only mis-aligned with sound environmental tax policy principles, but it also impacts the Equity principle. Indeed, it results in an important share of water polluters not paying for the pollution they generate.

Many mechanisms aim to contribute to Policy Coherence as defined in the OECD Council Recommendations on Water, especially in the agricultural sector where many practices responsible for water pollution cannot be dealt with through pricing directly. In particular, not only are there limits to input (fertilisers and pesticides mainly) usage but there also exist many policies to limit the polluting impacts of these inputs. The Common Agricultural Policy (CAP) for example forbids farmers from applying nitrogen-based fertilisers on bare land. Farmers should grow temporary crops on these lands that have the sole purpose of absorbing extra nitrogen from the soil, and avoiding the contamination of groundwater. However, direct pricing mechanisms lack. The possible introduction of pricing measures is discussed in the following.

6.2.4. Pricing water pollution in the agricultural sector: proposals

For the agricultural sector, a tax on polluting inputs can be a way of dealing with the environmental impact of water pollution from that sector. While limits on usage of fertilisers and pesticides exist in Andalusia, currently no pricing mechanism to deal with this issue is in place. Limits on polluting inputs may be relatively simpler to introduce and to communicate in general. However, strict implementation in the case of regulation is key, and Spain has recently been referred to the Court of Justice of the European Union by the European Commission for poor implementation of the Nitrates Directive.[39] Moreover, pricing, as opposed to command-and-control policies is a more cost-effective way of dealing with over-use. It decentralises abatement decisions, and leaves it up to the agents for whom marginal abatement costs are lowest to abate first. More concretely, for example, it leaves the decision to use more or less fertilisers to the farmer who knows best about the cost and benefits implied in lower fertiliser use. In that sense, the famer to whom it is least expensive to reduce or avoid fertiliser use (e.g. in terms of forgone yields), will do so first. A further discussion on non-pricing instruments is conducted in the last subsection.

If there is no action at the central government level, Andalusia could introduce a tax on pesticides and fertilisers at the regional level to target water pollution in the agricultural sector. Such a tax would target the quantities purchased of a specific product (that would need to be defined), where rates depend on their respective environmental impact. Polluting substances and water quality are discussed in many EU directives (see Box 6.6).

Box 6.6 EU directives relating to water pollution

As highlighted in Section 5, the EU WFD defines water quality levels to be pursued, which are defined for aquifers in the EU Groundwater Directive. The EU Environmental Quality Standards Directive provides the list of priority hazardous substances. Other EU Directives related to water pollution are integrated into the Water Framework Directive. The EU Nitrates Directive requires EU member states to establish agricultural action programme measures to prevent nitrate pollution from reaching water bodies. The EU Biocides Directive relates to the authorisation and placing on the market of biocidal products such as pesticides, herbicides, or fungicides that may be harmful to the environment and in particular to groundwater quality.

Pesticides on the European market are already risk assessed by the European Chemicals Agency, so defining products to be targeted by the tax and grouping them into different rate bands would be relatively straightforward. For example, since 1999, Norway has had a pesticides tax with seven tax bands which depend on the environmental health- and ecosystem-related risks of the specific pesticide (OECD, 2017[2]; Böcker and Finger, 2016[39]) (see Box 6.7.).

Box 6.7. The Norway banded tax system for pesticides

In 1999, Norway passed a law to introduce a banded tax system for pesticides, in order to reduce the use of pesticides that represent the greatest risk to human health and the environment.

Pesticides are sorted into seven different categories, which depend on (i) risks for human health and (ii) environmental risks. All pesticides for professional use are tested according to several criteria and then categorised as a low, medium, or high risk. Each category is assigned a specific factor, which ranges from 0.5 to 150.

The tax applies per hectare, and is calculated by multiplying NOK 25 times the factor associated with the pesticide category.

Note: For further information, see Annex 6.A.
Source: Böcker and Finger (2016[40]) (2016[39]), Spikkerud (2006[41]) (2006[41]).

Regarding fertilisers, a tax on quantity used or purchased is not necessarily the best way to address their environmental externalities. In particular, tax rates could only constitute a proxy for their pollution potential, as the principal negative environmental impact of fertiliser use comes from an application in excess of plant needs or in unsuitable weather conditions (washout is particularly strong when applied just before rain episodes) (EPA, 2005[34]). Such situation-specific conditions are difficult to assess and reflect in a general tax rate.

The effect of taxes on fertilisers and pesticides will depend on the responsiveness of input use to increased price rates and again, their general equilibrium, affordability, yield and political feasibility[40] effects should be carefully assessed. Regarding pesticide use, a meta-analysis by Böcker and Finger (2016[39]) finds a median price elasticity of demand for pesticides of −0.28.[41] This means that a tax increase of 1% is estimated to reduce demand for pesticide inputs by 0.28%. These relative low price elasticities make it very improbable that dealing with water pollution from these inputs can be tackled through taxation only. It may also be a sign that farmers do not see (or have) alternatives to pesticide use given current constraints. This stresses the importance of complementary policies, which can help farmers reduce pesticide use without risking an important decrease in yield or at least income[42] or of a broader policy environment that is aligned with water protection objectives (such as policies that promote quality of agricultural production over quantity). Public awareness campaigns, stressing the risks for the environment as well as farmers themselves and their business may also help increase responsiveness levels.

It is also important to bear in mind that there is a risk associated to unilaterally introducing input taxes at a regional level with no concerted action with neighbouring regions. Indeed, the price-elasticity of input demand may also be low due to mobility of the base, which is not an issue encountered in the case for water usage. Indeed, it could be feasible for farmers to get their input provisions from other regions with no input tax. This issue would be worsened by a unilateral imposition of such a tax at a local level as opposed to the national level. It could however be dealt with through certain regulatory provisions.

From a political feasibility perspective, introducing taxes relating to inputs used by farmers may encounter resistance that needs to be managed well. Skou Andersen (2016[42]) for example, exposes the political difficulties surrounding the possibility of reintroducing a fertiliser tax in Sweden. These stem from an opposition to it by farmers, from a lack of a solid environmental impact assessment of this tax in the past and possibly from a shift of concern from water pollution to climate change.[43] Söderholm and Christiernsson (2008[43]) draw lessons from the European experience in fertilizer taxation and find that a form of earmarking of tax revenues can help increase the legitimacy of such taxes and that rates which achieve a close proportionality to damage done have a greater chance of being perceived as fair. Again, this highlights the importance of knowing about the effectiveness of these policies in order to make them politically acceptable.

Solutions to political frictions could be better communication on evidence-based results of pollution pricing mechanisms and earmarking of revenues. Use of revenues to encourage best-performing farmers in terms of pollution, through systems akin to a bonus-malus could increase effectiveness of the policy. These exist for vehicle taxation, for instance, and could be adapted to the context of water pollution. An example for the former is Italy, where vehicle taxation follows a bonus-malus system (also referred to as a system of *feebates* in other countries or regions) that penalises CO_2-intensive vehicles and subsidises cars emitting 60 grams of CO_2 or less per kilometre.

Advances in nutrient pollution modelling can provide an opportunity to tax diffuse pollution outputs directly, rather than taxing proxies such as fertiliser and pesticide inputs. Such models could allow setting pollution levies at levels that are directly proportional to the simulated amount of pollution generated by farm. For example, OverseerFM[44] is a New Zealand national model for farm-scale nutrient budgeting and loss estimation, which also identifies risks of environmental impacts through nutrient loss, including run-off and leaching (OECD, 2017[2]). New Zealand farmers are increasingly required by regional councils to use the model to develop nutrient management plans and budgets (OECD, 2021[24]), but it has not been used for direct pricing yet. The better alignment of taxes that would rely on such models with actual pollution effects could increase their efficiency, political acceptability and provide additional options for farmers to adapt, by helping them take agency on monitoring the polluting effects of the practices they choose to implement. Moreover, this could enable the introduction of an additional factor to tax rates, which would account for the state of potentially affected soils and aquifers.

As in the case of the French tax on water pollution (Box 6.5.), livestock could also be included in the base of water pollution taxation. The Wallonian tax on environmental impacts from farming (see Annex 6.A) seeks to water pollution through nitrogen, by targeting the number and type of livestock units as well as the land area and type of cultivation (organic or non-organic crops and organic and non-organic grassland). The design of the latter tax can encourage a switch to organic farming cultivation, to less polluting livestock or at least a smaller number of livestock units. Moreover, such taxes could target modes of production deemed to be more polluting. This would be the case for example of intensive as opposed to extensive livestock farming. However, again in this case, Policy Coherence is key – this issue comes up because for example of the push in the last decades towards more intensive modes of farming. Support for farmers in the transition is also key, as well as encouraging consumers to switch to more sustainable food consumption. These points are further discussed in section 6.3.

Another way of dealing with water pollution from agriculture would be similar to the collective responsibility mechanism described in Fuentes (2011[25]) for water quantity of aquifers. This could be used for pollution caused by input use to groundwater. Given that the chemical status of groundwater bodies is also measured for all river basins in Spain,[45] the idea would be to create financial incentives for Communities to keep pollution levels in aquifers at a reasonable level. The costs would then be passed on to farmers. Quality status of water bodies in Andalusia can also be informed by the Andalusian quality of water bodies atlas.[46]

Finally, water pollution in the agricultural sector does not only occur through the use of polluting inputs but also, as for the other two users, through the wastewater discharged in surface water. In that respect, the existing pollution control fee could also be extended to farmers – possibly through a separate instrument. Given that the irrigation fee depends on volumes used, the administrative capacity to implement such a tax exists.

6.2.5. Extending the coverage of the pollution control fee to contaminants of emerging concern

The increasingly pressing issue of CECs in wastewater was discussed at the beginning of this subsection, and it is not clear whether the pollution control fee accounts for these in one of its factors. The issue with CECs is that it is not necessarily possible nor advisable to call for a reduction in their use – the case of pharmaceuticals is particularly striking here. Countries have adopted a host of response packages to this rising phenomenon, which to date, however, focus on upgrading wastewater treatment plants (WWTP). In Switzerland, for example, the Waters Protection Act was revised in 2014 to further improve wastewater treatment for the removal of CECs, including pharmaceuticals. This included the introduction of a new technical wastewater treatment standard and public subsidies to fund technical upgrades of WWTPs. Some countries implement complementary measures, such as France, which has introduced financial incentives aimed at stimulating new innovative projects to manage CECs (OECD, 2020[5]). A recent OECD report (OECD, 2019[44]) outlines a policy mix of source-directed, use-orientated and end-of-pipe measures to manage pharmaceuticals harm to the environment.

6.3. Non pricing policies

Non pricing policies can be declined along two categories: (i) command-and-control measures that are used as substitutes or complements to pricing policies and (ii) accompanying measures to pricing policies. The first set of policies are generally deemed less efficient than pricing policies, which decentralises abatement choices, leaving the decision up to consumers as to the best way of reducing consumption and possibly encouraging technological innovation. However, they may help address targets more easily as responsiveness levels to prices are not always known or too low and they may also help deal with political frictions. The second set of policies contribute to the overarching Policy Coherence principle and are briefly discussed.

Command-and-control measures to ensure water conservation have long been used alongside or instead of pricing measures. Regulatory measures used for short-run water use and pollution management include restricting water usage during certain high-temperature periods or water shortage episodes or restricting the use of polluting inputs. Long-run water conservation policies are often technology standards. For example, in the United States, the National Energy Policy Act has, since 1992, required that all new construction install low-flow toilets, showerheads, and faucets (Olmstead and Stavins, 2009[17]).

While command-and-control measures may be easier to implement from a political point of view and may seem to be more straightforward than pricing policies in reaching certain targets,[47] they come with many drawbacks. The following discusses three of those. First, mandating technology standards that result in lower water flow can create rebound effects through income effects: lower water flow implies lower water bills, which in turn can encourage increased water use. Second, these measures are only effective if incentives such as monitoring and significant fines are implemented and implementable in case of non-compliance. Third, technology standards can actually dampen incentives to innovate and lock-in of current technologies once the standard is passed (Olmstead and Stavins, 2009[17]).

Accompanying measures to pricing policies are key to ensure their effectiveness and political feasibility. Three important policy instruments are discussed here. First, much evidence on low responsiveness of consumers to water prices (see Box 6.8) has been found to stem in particular from the low salience or high misperception of these prices. Gaudin (2006[45]) finds that demand responsiveness may increase when price information is posted on water bills. García-Valiñas et al. (2021[22]) find that policies aiming at promoting the careful reading of one's bill, providing additional detail about water consumption and tariffs or also promoting individual metering can significantly increase the impact of water pricing. Second, innovation support is key in enabling substitution possibilities and fostering adaptability. Innovation support has been discussed in the case of France for projects aiming at managing CECs. This has also been the case for new irrigation technologies which require much less water. Finally, measures to ensure affordability are key, from a political feasibility perspective certainly, but also because of the specific status of water as a necessary good for survival. Targeted measures to compensate poorer households for unaffordable water bills or to accompany small farmers through water price increases can become essential. Annex 6.A presents options to address affordability issues in the case of France.

Box 6.8. Water users' responsiveness to water pricing

Recent findings show that responsiveness depends on the type of user considered. In particular, industrial users' responsiveness to water pricing is generally found to be higher than that of agricultural users', higher in turn than residential users'.

The responsiveness of industrial users is heterogenous across firms and is generally found to be higher when the firm has the potential for in-plant recirculation of water as substitution for freshwater.

Recent evidence (Chakravorty, Dar and Emerick, 2023[46]) highlights that when farmers face a price per volume of water used, they have higher chances of adopting water-saving technologies, hence reduce their consumption than when facing a fixed fee for water access.

Responsiveness of agricultural users and households is generally higher when measuring long-run elasticities, when enough time is given to these users to adapt, change water-saving habits and adopt water-saving technologies. This has been shown in the case of New Zealand after volumetric water pricing was introduced and in Denmark, where water prices increased by 54% over two decades.

Moreover, low-value water use from households (e.g., gardening, swimming polls) is more elastic than high-value water use (e.g., drinking, cooking).

Finally, some studies find that the price elasticity of water use increases with higher prices – since higher water charges then account for a larger share of household expenditures. Given that water prices are generally low, this can help explain why responsiveness estimates are generally low as well.

Note: This Box is largely based on an OECD note (Leflaive, 2022[30]), pp. 17-18 and Box 3.2.
Source: Chakravorty et al. (2023[46]),Leflaive (2022[30]), Leflaive and Hjort (2020[47]), Reynaud (2015[48]).

Policy coherence is also called for by the OECD Council Recommendations on Water and is central to avoid conflicting signals and incentives. This holds particularly true in the case of farmers. For example, many policies that support agriculture production encourage greater land use change and intensive use of inputs, such as fertilisers, pesticides or irrigation (OECD, 2017[2]). In Andalusia, an example of potential misalignment of broader policy objectives with environmental policy relates to the recent rise in avocado production, a crop which is highly water-intensive. Policies or policy strategies that incentivise more avocado production – or do not disincentivise it – may be misaligned with water-conservation policies as under current circumstances (no appropriate water pricing and water pollution policies are in place for agriculture) it exacerbates environmental problems related to extreme water use.

Relatedly, changing agricultural and cultivation plans according to water sustainability can also help avoid lock-in effects. Given the predicted rise in temperature and water shortages in the South of Spain, the cultivation of many water-intensive crops is bound to become unsustainable in the years to come. For example, a recent study by the University of Cordoba and the Centre for Research in Geospace Science (Arenas-Castro et al., 2020[49]) found that the cultivation of many olives varieties in Andalusia was likely to become unstainable in the years to come. Certain varieties of olives, such as the Picual variety were found to be more resistant to climate change and to require less water. Switching to the cultivation of such varieties could help promote sustainability and avoid future lock-in effects.

Ensuring policy coherence but also setting clear policy goals and priorities is key in achieving water use and pollution sustainability and fairness without prejudice to other policy areas, including economic development. Indeed, all policies come with trade-offs. In the agricultural sector, national or regional agricultural planning policies may negatively affect water conservation (rice cultivation requires more water than certain vegetables) but ensure food security and competitiveness on the global market. Irrigated agriculture can also contribute to rural development (OECD, 2010[37]). For example, the recent rise in avocado cultivation in Andalusia enables farmers to make a decent living, since the global demand for this fruit is increasing and its price relatively stable (at EUR 2.4/kg on average in the recent years) (Campos, 2021[26]). However, given the urgency of the water scarcity issue in Andalusia and given the resulting long-term unsustainability of such agricultural practices, setting water conservation as a priority in policy decisions in Andalusia could be envisaged.

The White Book for Tax Reform in Spain has called “priority attention to the water-energy nexus and tax treatment that results in best practice for the whole” (Comité de personas expertas, 2022[10]). And indeed, climate change mitigation and adaptation policies may also come with trade-offs concerning water conservation and pollution issues. For example, desalination may help adapt to water scarcity but is very energy-intensive. On the other hand, setting higher energy prices for the pumping of water from wells could be an alternative way of restricting water abstraction from private wells (Ryan and Sudarshan, 2022[50]).

6.4. Key findings and strategic recommendations

Spain is characterised by a high temporal and spatial variability in water resources and the Southern part of the country regularly experiences water scarcity and long periods of droughts. The important heterogeneity in water resources has resulted in the historical use of a supply-side response, through the construction of dams, reservoirs, inter-basin water transfers and the intensive use of groundwater through the drilling of wells. However, the increasing risks linked to climate change and changing precipitation patterns calls for a focus on demand-side instruments (such as taxes and levies, or certain non-market-based instruments) – even if used in parallel with other supply-side strategies such as desalination and reuse.

In Andalusia many pricing instruments apply to the use of water. These are national-level, Andalusian-level and more local instruments. The national level instruments principally address service-cost recovery and environmental costs related to the installation of water extraction activities. The Andalusian and local charges address service-cost recovery as well as, to a certain extent, affordability and sustainable use criteria.

The main water uses in Andalusia are agriculture (about 80%, above the world average of 70%) and urban use. Industry not connected to the grid presents a much smaller share of water use, except in the Tinto-

Odiel-Piedras water basin. While many instruments are in place to directly price water use for urban users and only one is in place for pricing water use from agriculture. This instrument principally seeks to cover service-related costs and address equity between agricultural users. Urban users, however, face prices that do not only cover service-related costs but also seek to ensure affordability and sustainable use.

The equity principle between users could be improved in Andalusia. This holds between agriculture and urban uses as well as within urban uses. The differential rates and coverage observed, however, could be due to other factors, general equilibrium reasons (an increase in prices for farmers ultimately results in an increase in prices for households) and to different demand elasticities of users.

The improvement fee (though temporarily suspended by the Andalusian government from 1 January to 31 December 2023) could be better designed in terms of equity between households of different sizes and between households and firms. However, it holds the interesting feature of charging water suppliers for water losses in the network – an important issue in Spain. The low price levels for this fee, however, might imply that the resulting total water charge does not weigh much in households' budgets and hence does imply behavioural changes on their part. Accompanying measures, such as public awareness campaigns about water scarcity, information on water fees themselves aimed at increasing their salience or smart metering devices can contribute to increasing responsiveness.

In order to better balance cost-recovery and financial sustainability needs, equity, affordability and sustainable use, clear sustainable use objectives should be set and more information on costs and demand elasticities should be acquired. Environmental costs of water abstraction could then also be included in prices.

Given the special status of water as a good for which "the right to safe and clean drinking water and sanitation as a human right […] is essential for the full enjoyment of life and all human rights" (United Nations General Assembly resolution, 28 July 2010), usual market forces that would increase prices and decrease demand when supply is tight are not in play. Hence, government intervention can be justified to ensure sustainable use.

For concessions extracting water for urban, industrial and agricultural uses, an Andalusian-level abstraction charge could be put in place, to align with the sustainable use goals of Andalusia. This is also a recommendation for the national level of the 2022 White Book for Tax Reform in Spain. For informal extraction of water (through wells, whether legal or not), which is a non-negligible share of agricultural water use, monitoring mechanisms could be put in place at the user association level. Monetary fines, for example, could be put in place if the groundwater body to which they are attached reaches poor quantitative status. This latter mechanism, however, would fall within the jurisdiction of Spain.

Water pollution comes from urban, industrial and agricultural users and may originate from point sources or diffuse sources. In the urban and industrial sectors, water pollution is mainly due to wastewater and direct industrial discharges. The usual water pollution sources from the agricultural sector include sedimentation and pesticides use as well as certain practices of nutrient use (applied in the form of chemical fertilisers, manure, and sludge), animal feeding, livestock grazing and irrigation. Contaminants of emerging concern (CECs) are an increasing issue for all users.

The main externalities from water pollution relate to health and ecosystems (environmental externalities) but are also economic, due to the need to sanitise polluted water for consumption. These externalities are addressed by a pollution control fee on discharges of water from urban and industrial use. However, no pollution tax or fee applies in the agricultural sector, even though it is the main sector responsible for aquifer pollution today.

While the lack of water pollution pricing for agriculture may be due to the diffuse nature of the pollution arising from this sector, the pricing of polluting inputs, such as pesticides and fertilisers – both responsible for an important share of water pollution – may be considered. Such taxes would target the quantities purchased of a specific product and rates would depend on their respective environmental impact.

Pesticides on the European market are already risk assessed by the European Chemicals Agency, so defining products to be targeted by the tax and grouping them into different rate bands would be relatively straightforward. Norway has such a tax. Taxes could also target number and type of livestock as well as area and type of cultivation, such as in Wallonia in Belgium.

Evidence points to low responsiveness of farmers to input taxes and high political barriers. This stresses the importance of complementary policies, which can help farmers reduce pesticide use without risking an important decrease in yield or income or of a broader policy environment that is aligned with water protection objectives (e.g., policies that promote quality of agricultural production over quantity). Coordination with other Autonomous Communities is also key, as farmers could get their input provisions from other regions with no input tax. Finally, political barriers may be addressed through better communication on evidence-based results of pollution pricing mechanisms and earmarking of revenues.

Advances in nutrient pollution modelling can provide an opportunity to tax diffuse pollution outputs directly, rather than taxing proxies such as fertiliser and pesticide inputs. This could increase the efficiency of water pollution taxes and might reduce political friction, by promoting a tax which would be closer to direct environmental damage and hence be perceived as fairer.

Finally, ensuring policy coherence but also setting clear policy goals and priorities is key in achieving water use, pollution sustainability and fairness without prejudice to other policy areas, including economic development. In this respect, long-term and short-term goals and sustainability should be carefully assessed. However, given the urgency of the water scarcity issue in Andalusia, setting water conservation as a priority in policy decisions in Andalusia could be envisaged.

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Annex 6.A. Detailed case studies: water pollution and usage

This annex presents selected case studies in the domain of water pollution and usage across the OECD.

Germany: Baden-Württemberg Water Abstraction Charge

Annex Table 6.A.1. Baden-Württemberg water abstraction charge (Germany)

Legal bases	Baden-Württemberg's Water Act (1988 amended in 2010)
Objective	To raise awareness about water scarcity issues, to incentivise water-saving behaviour, to reduce the economic advantage of agents benefiting from the direct abstraction of water in comparison to those who do not benefit from it and to compensate investments of water bodies in charge of maintenance and cleaning.
Level of responsibility	Region (Baden-Württemberg)
Tax setter(s)	Region (Baden-Württemberg)
Revenue beneficiary(ies)	Region (Baden-Württemberg)
Tax payer(s)	Industries (including energy) and, indirectly, households receiving water from public water suppliers
Tax base (including main exemption(s), credits or deductions)	The tax base is the annual volume of water abstracted in cubic metres. Since the amendment of 2010, exemptions apply to the following cases: • Minor uses, such as abstractions below 4 000 m3/year, • The use of groundwater for heating and cooling buildings when the water is returned to the groundwater, • Use of groundwater to avert hazards in the context of groundwater remediation. • Reductions apply to the following cases: • Up to 90% for water-intensive industries that prove the abstraction charge undermines their competitive position, • Up to 75% of the abstraction charges can be offset by investments that reduce pollution related to heating, enhance waterbodies or enable the substitution of groundwater with surface water, • Up to 25% for specific industries when environmental management systems are in place.
Tax rate(s) (including their calculation)	The tax rate depends on the water source and type of extraction, ranging between EUR 0.01/m3 and EUR 0.051/m3, as shown in Annex Table 6.A.2.
Governance and implementation	The implementation of the charge involved a high level of openness and dialogue between different stakeholders (e.g. associations, committee meetings of the Länder parliaments, online stakeholder consultations) to design the legislation.
Environmental, social & health impacts	Water abstraction decreased by 34% between 1987 and 2007. Other factors may have also affected it, such as technology (Möller-Gulland and Lago, 2011[51]).

Annex Table 6.A.2. Tax rates (Baden-Württemberg Germany)

Sources	Cost categories	Tax rates (EUR/m3)
Surface water	Public water supply	0.051
	Others	0.010
Ground water	Public water supply	0.051
	Others	0.051

Source: (Möller-Gulland and Lago, 2011[51]), (European Environment Agency, 2013[52]; Möller-Gulland and Lago, 2011[51]; OECD, 2010[53]; European Commission, 2021[54]).

Norway: Banded Tax system for Pesticides

Annex Table 6.A.3. Banded tax system for pesticides (Norway)

Legal bases	Regulations on plant protection products (1999 amended in 2015)
Objective	To reduce the use of pesticides that represent the greatest risk to human health and the environment.
Level of responsibility	Central government (Norway)
Tax setter(s)	Central government (Norway)
Revenue beneficiary(ies)	Central government (Norway)
Tax payer(s)	Wholesalers
Tax base (including main exemption(s), credits or deductions)	The tax system is area-based and consists of seven tax bands based on patterns of use, human health, and environmental risk. Products allowed in organic farming are exempt.
Tax rate(s) (including their calculation)	The system is area-based as the tax rate is calculated according to the pesticides' specific standard doses per hectare and consists of seven tax bands based on the risks posed to human health and the environment. Each pesticide is evaluated against human health and environmental risk criteria. The former is based on intrinsic properties and exposure, which depends on the type of formulation and application method. The environmental criteria consider toxicity, bioaccumulation, persistence and leaching potential. All pesticides for professional use are tested according to several criteria and then categorised as a low, medium, or high risk. The categorisation of the factors can be seen in Annex Table 6.A.4, which gives rise to different tax bands. To extra tax bands arise for products for hobby use. The tax per hectare for each tax band is calculated by multiplying the base rate of NOK 25/ha (EUR 2.4/ha), which is set by the central government and the same for all products, by the tax band factor: Tax per hectare = base rate x factor for the given tax band This is converted to a tax per gram or milliliter considering as the Standard Area Dose (SAD), which is the maximum application rate for the main crop for which the pesticide is used, applying the formula Tax per kg or liter = (base rate x factor) x 1 000 / SAD
Governance and implementation	The Norwegian Crop Research Institute proposes the SADs and SAD guidelines. The Norwegian Food Safety Authority approves the SADs and determines the tax bands for each pesticide.
Environmental, social & health impacts	Between 1998 and 2011, a decline was reported in the sales of pesticides from categories 4 and 5, which are the most taxed, while an increase was observed in the sales of categories 1 and 2. In 2014, the Norwegian Food Authority reported no sale of pesticides in category 5. At the crop level, pesticides of higher categories have also been substituted for lower-category products. However, because of the hoarding effect on sales before the tax increase, the reduction of pesticide risks could only be observed years later (Böcker and Finger, 2016[40]).

Source: (Spikkerud, 2006[41]; Norwegian Ministry of Agriculture and Food, 2015[55]; Böcker and Finger, 2016[40]; UN Environment Programme, 2020[56])

Annex Table 6.A.4. Categorisation of pesticides factors (Norway)

Tax category		1	2	3	4	5	6	7
Pesticide characteristics	Human health risks Environmental risks	Both risks low	One low and one medium risk	One low and one high risk or both risks medium	One medium and one high risk	Both risks high	Concentrated products for hobby use	Ready-to-use product for hobby use
	Factor i (* NOK25/ha)	0.5	3	5	7	9	50	150
	Tax (NOK/ha)	12.5	75	125	175	225	1 250	3 750

Source: (Böcker and Finger, 2016[40]).

Belgium: Wallonia Tax on Environmental Impacts from Farming

Annex Table 6.A.5. Wallonia tax on environmental impacts from farming (Belgium)

Legal bases	MB 29.12.2014 of the Environmental Code of Wallonia
Objective	To internalise external environmental costs linked to agricultural activities' impacts on water resources and the use of fertilisers and phytosanitary products in crops
Level of responsibility	Region (Wallonia)
Tax setter(s)	Region (Wallonia)
Revenue beneficiary(ies)	Region (Wallonia)
Tax payer(s)	Farmers meeting specific criteria, of which the number of animals owned and farming area.
Tax base (including main exemption(s), credits or deductions)	The annual tax is based on two components: animals and land. Exemptions apply to each component as follows: • The livestock environmental component is nil when the farm holds a certificate of compliance for the livestock manure storage infrastructure or when the issue of this certificate is under examination. • The land component determines that the first thirty hectares of a farm are exempt from the tax.
Tax rate(s) (including their calculation)	The tax system is based on two components, which are summed to calculate the number of environmental load units. The two components are: • Livestock: measured by the number of livestock held or environmental charges generated by run-off from on-farm livestock effluent storage facilities that reach groundwater and surface water. • Land: measured in hectares for the area where agricultural activities require fertilisers. The environmental load unit is calculated by applying the formula: $N = 2 + N1 + N2$ Where N = the number of environmental load units, N1 is the livestock environmental load, and N2 is the land environmental load. The livestock component is calculated by summing the products of the multiplications of the number of animals by their nitrogen coefficient using Annex Table 6.A.6. The land component is calculated by adding the products resulting from the multiplication of crop and grassland areas by nitrogen coefficients, which reflect the average nitrogen residue in the soil, the average use of pesticides and the erosive potential of the crop. The coefficients are: • "Crop" coefficient = 0.3 • "Organic crop" coefficient = 0.15 • "Grassland" coefficient = 0.06 • "Organic grassland" coefficient = 0.03 These coefficients reflect the soil's average nitrogen residue, pesticide use, and the erosive potential of crops and grasslands. The base rate of the environmental load unit was EUR 10 in January 2015, and is indexed by inflation.
Governance and implementation	The tax supports the long-term plans outlined in Wallonia's First Strategy on Sustainable Development (2013). This strategy aims to internalise the external environmental costs of multiple activities, including the production of food products. Consultations with the Wallonia Council for Environment and Sustainable Development (CWEDD), the Wallonia Council for Economy, Society and the Environment (CESW) and the Wallonia High Council for Cities, Towns and Provinces were also held to develop the strategy.

Source: (Wallonie agriculture SPW, 2017[57]; OECD, 2020[58]; European Commission, 2021[54])

Annex Table 6.A.6. Animal categories and nitrogen coefficients (Wallonia, Belgium)

	Animal category	Nitrogen coefficient
Bovines	Milk cow	0.5538
	Suckler cow	0.4062
	Cull cow	0.4062
	Other cattle over two years old	0.4062
	Cattle with less than six months old	0.0615
	Heifer from six to 12 months	0.1723
	One to two years old heifer	0.2954
	Young bull from six to 12 months old	0.1538
	Young bull from one to two years old	0.2462
Sheep and goats	Sheep and goats under one year old	0.0203
	Sheep and goats over one year old	0.0406
Horses	Equine	0.3446
Pigs	Jerseys	0.0923
	Treason	0.0923
	Fattening pigs and gilt	0.0480
	Fattening pigs and gilt on bio-controlled litter	0.0277
	Piglets (four to 10 weeks old)	0.0117
Rabbits	Mother rabbits	0.0222
	Fattening rabbits	0.0020
Poultry	Broilers (40 days)	0.0017
	Laying or breeding hens (343 days)	0.0037
	Pullets (127 days)	0.0017
	Breeding roosters	0.0026
	Ducks (75 days)	0.0026
	Geese (150 days)	0.0026
	Turkeys (85 days)	0.0050
	Guinea fowl (79 days)	0.0017
	Quail	0.0002
	Ostriches and emus	0.0185

Source: (Wallonie agriculture SPW, 2017[57])

France: Water Management and Taxes

The French water taxation system aims to finance the protection of water resources and the aquatic environment. It is based on the polluter-pays and user-pays principles This system is implemented by the water agencies *(agences de l'eau)*, which aim to collect water levies from water users and to distribute water aids. They also determine tax rates within national statutory limits. There are six water agencies in France (Annex Figure 6.A.1). Each is composed of a board and a basin committee. The board defines action programmes and water levies that it submits to the basin committee and it determines how aids are allocated. The basin, which is made up of state representatives, subnational governments' elected officials and water users, is responsible for assessing the board's programmes and water levies, for planning actions related to water management in the basin and for evaluating regulations and projects with a direct effect on water and aquatic environment. This participatory model aims to facilitate the acceptance of taxes by liable entities. The model also includes the possibility for periodic adjustments to fairly represent water usage and retain its acceptability level. Tax revenue is earmarked for reinvestment in water quality and for dealing with scarcity at the basin level and is managed by the water agencies. The main beneficiaries of water aids are subnational governments to finance projects related to water protection. The other beneficiaries are businesses, farmers, associations, etc.

Annex Figure 6.A.1. Mapping of the basin committee in France

Source: Agence de l'eau Loire-Bretagne (Agence de l'eau Loire-Bretagne, 2017[59]) (2017[59])

Since the 1 January 2020, there are eight water-related levies (*redevances*) in France, defined under article L213-10 of the Environmental Code (Legifrance, 2018[60]), which aim at internalising the externalities of water uses by different user groups and to finance water protection activities. Four of the taxes are associated with water pollution (Legifrance, 2018[60]):

- **Tax on domestic water pollution** (*redevance pour pollution de l'eau d'origine domestique*) (art. L231-10-1 to 10-4) (Legifrance, 2018[60]): charges domestic users for their water consumption. The tax rates lie within the national limit of EUR 0.50/m^3.
- **Tax on non-domestic pollution** (*redevance pour pollution de l'eau d'origine non domestique*) (art. L231-10-1 to 10-4) (Legifrance, 2018[60]): charges any economic or industrial activity that discharges pollution. Pollution is assessed directly by monitoring systems and, when not possible, a theoretical level of pollution is calculated using benchmarks. The tax base is the annual pollution discharged above a threshold and the rates are different for each pollutant (Legifrance, 2018[60]).
- **Tax on sewer systems modernisation** (*redevance pour modernisation des réseaux de collecte*) (art. L231-10-5 to 10-7) (Legifrance, 2018[60]): charges all domestic or non-domestic users

connected to a public sewerage network for the volume discharged in the sewer network. The tax rates lie within the national limit of EUR 0.30/m^3.

- **Tax on diffuse pollution** (*redevance pour pollutions diffuses*) (art. L231-10-8) (Legifrance, 2018[60]): charges users of phytopharmaceutical products (i.e. pesticides) according to the substance class and quantity applied. The tax rates are different for each substance class.

The remaining four levies charge particular economic activities mostly related to water use (Legifrance, 2018[60]):

- **Water abstraction charge** (*redevances pour prélèvement sur la ressource en eau*) (art. L231-10-9) (Legifrance, 2018[60]): charges all users (e.g. households, industries and agriculture) for water withdrawal from the water resource. Exemptions apply to withdrawals of sea water, excavation of mines whose activity has ceased as well as withdrawals necessary for underground works and withdrawals during drainage to keep buildings dry, withdrawals related to aquaculture, geothermal energy, frost control for perennial crops, withdrawals outside the low water period or withdrawals intended exclusively for the supply of water to heritage fountains located in mountain areas and within the limit of a maximum of 5,000 m^3. The rates depend on the water use and the water basins. They are determined by the water agencies in EUR/m^3 within the national limits (Annex Table 6.A.7).
- **Hydroelectricity production charge** (a particular case of the water abstraction charge) (art. L231-10-9) (Legifrance, 2018[60]): it charges hydroelectric operators relatively to the volume of diverted water. The water agency sets the tax rate of the fee within the limit of a ceiling of EUR 1.8 per million m^3 and per meter of fall.
- **Tax on storage in low water level periods** (*redevance pour stockage d'eau en période d'étiage*) (art. L231-10-10) (Legifrance, 2018[60]): charges any person who has a storage facility of more than a million cubic meters of water and who stores the volume discharged into a watercourse during low water periods. The tax base is the water stored during the low water period, and the water agencies determine the rate within the limit of EUR 0.01/m^3.
- **Tax for the protection of freshwater environments** (*redevance pour protection du milieu aquatique*) (art. L231-10-12) (Legifrance, 2018[60]): it charges recreational fisheries per recreational fisher. The rates are set annually by the water agency, with the following limits: EUR1 per individual who fishes for one day, EUR4 per individual who fishes for seven consecutive days and EUR10 per individual who fishes for one year. An additional EUR20 per individual is required for fishing eel fry, salmon and sea trout.

Annex Table 6.A.7. National limits on water abstraction charge according to water uses (France)

Water uses	Category 1	Category 2
Irrigation (except gravity irrigation)	3.6	7.2
Gravity irrigation	0.5	1
Drinking water supply	7.2	14.4
Industrial cooling leading to a return of more than 99%	0.5	1
Feeding a channel	0.03	0.06
Other economic uses	5.4	10.8

Notes: Water resources of each basin are classified in category 1 when they are located outside the water distribution zones defined in the law and in category 2 otherwise.
Source: Author's own elaboration based on (Legifrance, 2018[60]).

Since 2010, the French Law has allowed the introduction of discriminating tariffs amongst consumers. These tariffs can be either based on social criteria, where special rates are offered to low-income families (social tariffs) or based on consumption (Mayol, 2018[61]). The form of the aid may vary from one municipality to another. An example is Dunkerque's "*éco-solidaire*" tariff, which differentiates the rate into three tiers reflecting the amount of water used: (i) vital consumption tier (consumption below 75 m^3/year), (ii) useful consumption (between 75 and 200 m^3/year) and (iii) comfort (above 200m^3/year). Under this system, the social beneficiaries of the universal health care coverage (*couverture maladie universelle*) had a 70% discount for the vital consumption tier (Mayol, 2018[61]).

Other mechanisms exist to support households with difficulties to pay housing expenses, such as the Solidarity Fund for Housing (*Fonds de Solidarité pour le Logement,* FSL). This fund is managed by departments (ie subnational governments in France). It may finance fully or partially water bills for financially distress households through a subsidy or a loan. Departments have also established measures to waive water arrears and provide pre-emptive support to families. In 2013, these measures were applied in 35,000 cases amounting to EUR 2.4 million (Da Costa et al., 2015[62]) (Da Costa et al., 2015[62]). Water voucher schemes are another form of support. They are issued by water operators and allocated to welfare recipients via local social welfare bodies (e.g., *Centres Communaux d'Action,* CCAS). In 2017, these vouchers were distributed to more than 19,000 customers, who received EUR 120 on average (Les entreprises de l'eau, 2019[63]) (Les entreprises de l'eau, 2019[63]).

Notes

[1] Hence, even though the improvement fee has been temporarily suspended by the Andalusian government (Decreto-Ley 7/2022, de 20 de Septiembre) from 1 January to 31 December 2023, it is still discussed in this section.

[2] https://www.epa.gov/sites/default/files/2015-09/documents/ag_runoff_fact_sheet.pdf.

[3] The Segura river basin is shared between Murcia (59%), Castilla La-Mancha (25%), Andalusia (9%) and Valencia (7%) (https://hispagua.cedex.es/en/instituciones/demarcaciones/segura, as accessed on 20/06/2022). The Guadalquivir river basin is shared between Andalusia (90.2%), Castilla La-Mancha (7.1%), Extremadura (2.5%) and Murcia (0.2%) (https://hispagua.cedex.es/en/instituciones/demarcaciones/guadalquivir, as accessed on 20/06/2022). Finally, the Guadiana river basin is also shared with Portugal. Within Spain, the division is as follows: 48% is within Castilla La-Mancha, 42% within Extremadura and 10% within Andalusia (https://hispagua.cedex.es/en/instituciones/demarcaciones/guadiana, as accessed on 20/06/2022).

[4] More precisely, this deficit is defined as the "aggregated global gap between existing accessible, reliable supply and 2030 water withdrawals, assuming no efficiency gains".

[5] https://ec.europa.eu/environment/water/water-framework/economics/pdf/Country%20fact%20sheet%20-%20SPAIN.pdf.

[6] https://inspain.news/extraordinary-drought-and-extreme-heat-in-andalucia-2021/.

[7] Runoff refers to all the water, such as rainfall or snowmelt that comes into a river water system.

[8] In 2016, Spain had around 1,200 dams, placing it as the ninth country in the world in terms of number of dams (Estrela and Sancho, 2016[8]).

[9] In 2010, similar shares as those presented in Figure 6.1 resulted in an Andalusian-level share for agricultural use of about 82%, for urban use of about 14%, for industrial use of about 3% and of less than

1% for other uses (see Table 106 in https://www.juntadeandalucia.es/medioambiente/portal/documents/20151/518740/PAMA2017_13febrero_portada.pdf/63069352-5250-aea3-3653-7000b57cdfeb?t=1368464000000).

10 This is more than twice as high as the share of national agriculture GVA in Spain's GVA (2.9%).

11 https://www.miteco.gob.es/es/agua/temas/planificacion-hidrologica/summaryrbmp2ndcycledraft_tcm30-379040.pdf.

12 This distinction is further explained here: https://www.juntadeandalucia.es/medioambiente/portal/web/guest/areas-tematicas/agua/gestion-del-agua/recuperacion-de-costes/mapa-institucional-servicios-agua.

13 In particular when allocation between users is well-defined.

14 Economic externalities due to wastewater treatment are discussed in the subsection on water pollution.

15 A/RES/64/292.

16 https://ec.europa.eu/environment/water/water-framework/economics/pdf/Country%20fact%20sheet%20-%20SPAIN.pdf.

17 https://ec.europa.eu/environment/water/water-framework/economics/pdf/Country%20fact%20sheet%20-%20SPAIN.pdf.

18 Article 73 of Law 9/2010 of July 30.

19 As a reminder, the Draft Hydrological Plan for the Mediterranean river basin defines urban use as uses through a connection to the urban grid – i.e., by households, regulated accommodation (e.g., hotels, rural tourism, campsites), non-regulated accommodation, industry connected to the urban grid, commercial and institutional uses, losses and uncontrolled uses.

20 https://www.juntadeandalucia.es/medioambiente/portal/web/guest/areas-tematicas/agua/gestion-del-agua/recuperacion-de-costes/tarifas-y-canones-uso-agua-dominio-publico-hidraulico-dph-y-dominio-publico-maritimo-terrestre-dpmt, as accessed on 14 June 2022.

21 https://www.juntadeandalucia.es/medioambiente/portal/web/guest/areas-tematicas/agua/gestion-del-agua/recuperacion-de-costes/tarifas-y-canones-uso-agua-dominio-publico-hidraulico-dph-y-dominio-publico-maritimo-terrestre-dpmt, as accessed on 14 June 2022.

22 https://www.epdata.es/datos/graficos-situacion-agua-mundo-espana/333.

23 Since 128L x 30 (days) = 3840 and 2m^3=2000L.

24 I.e., taking each user independently and not considering the impact of the increase of costs for one user on the final consumers, households.

25 This does not refer to self-abstraction, which is not covered by any fee.

[26] This can prove to be more complicated when objectives vary with the time of year. For example, in times of drought, it can be urgent to reduce water consumption that in other times would not be problematic. Complementary policies such as temporary bans for certain uses are further discussed in the subsection on non-pricing policies.

[27] This is, however, not the focus of the present analysis.

[28] https://www.miteco.gob.es/es/agua/temas/planificacion-hidrologica/summaryrbmp2ndcycledraft_tcm30-379040.pdf.

[29] Based on Table 55 in the Guadalete-Barbate Draft Hydrological Plan for 2022-2027, https://www.juntadeandalucia.es/medioambiente/portal/documents/20151/497870/DI_MEMORIA_GB.pdf/caaf7b70-5ec4-61ee-795a-5377b35f8d73?t=1582033431000 where water used is defined as the sum of water consumed and waste water.

[30] Defined "how much abstracted water returns to the water body".

[31] Through soil that is washed off fields.

[32] Which can enter and contaminate water through direct application, runoff, and atmospheric deposition.

[33] https://www.who.int/news-room/fact-sheets/detail/antibiotic-resistance, as accessed on 25 January 2023.

[34] Eutrophication is the excessive richness of nutrients in a lake or other body of water, often caused by run-off from the land, causing the dense growth of plant life, in particular algal blooms.

[35] The lowest is at EUR 0.15/kg/year (Lithuania) and the highest at EUR 6/kg/year (Belgium).

[36] The lowest is at EUR 0.21/kg/year and the highest at EUR 4.93/kg/year (the Netherlands).

[37] The pollution control fee is also referred to as the discharge control charge in the Spanish Water Law.

[38] Meaning, here, industry not connected to urban grids.

[39] https://ec.europa.eu/commission/presscorner/detail/en/ip_21_6265, as accessed on 26 January 2023.

[40] https://ieep.eu/wp-content/uploads/2022/12/SE-Fertilizer-tax-final_REV.pdf, as accessed on 29 March 2023.

[41] Peer-reviewed studies, however, tend to find lower responsiveness levels than in grey literature.

[42] Such as income-support measures, that could promote decreased pesticides use, or the promotion of alternative practices such as ploughing.

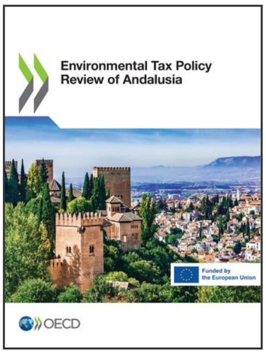
[43] Indeed, when the Swedish tax on mineral fertilizers was abolished in 2009, the reduced diesel tax rate for farmers was increased in exchange.

[44] https://www.overseer.org.nz/. The New Zealand Ministry for Primary Industries, AgResearch, and the Fertiliser Association of New Zealand each hold one-third stake in the Overseer intellectual property.

[45] https://www.miteco.gob.es/es/agua/temas/planificacion-hidrologica/summaryrbmp2ndcycledraft_tcm30-379040.pdf.

[46] https://laboratoriorediam.cica.es/Visor_DMA/?urlFile=https://laboratoriorediam.cica.es/Visor_DMA/service_xml/capas_dma.xml.

[47] As their effect may seem more predictable than in the case of pricing policies where responsiveness estimates are key to predict impact.



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