Infrastructure and economic incentives to reduce vulnerability to drought in Segura and Tagus basins [1]

The Segura River Basin in the south east of Spain suffers from a structural condition of water scarcity and drought occurrence. For decades, the focus for dealing with this condition has been placed on instrumental objectives such as increasing water transfer facilities (i.e. Tagus Segura Water Transfer, a major diversion project), developing alternative sources (i.e. desalination and reuse) or making use of water in a more technically efficient way (i.e. irrigation modernization). So far, mainly the highly disputed water resources transferred from the Tagus basin have satisfied water demand. The changing climate is increasing drought frequency in both basins; requiring the implementation of additional strategies to adapt. A recent strategy, currently under implementation, is introducing a set of Economic Policy Instruments aimed at addressing structural modifications of the long-term water demand in the Segura basin to achieve efficient use of the limited water resources available.

Case Study Description

Challenges:

Tagus is the largest river basin in the Iberian Peninsula. Its Spanish section covers an area of 55,781 km2 and hosts a population of 7.2 million inhabitants highly concentrated in Greater Madrid (TRBA, 2013). Average consumptive water use amounts to 2,893 million m3/year (ibid.) with an average natural renewable resource availability of 10,214 million m3/y (1940/41 – 2005/06). Despite significant local scarcity challenges (mainly in the Upper Tagus) and high variability in water resources, severe scarcity is not pervasive and drought vulnerability is still relatively moderate in the watershed.

By contrast, the Segura river basin with a smaller area (19,025 km2) and lower population (1.98 million inhabitants in 2010, increasing in peak seasons up to 2.1 million, depending on tourist inflows) is experiencing a growing demand for water. In 2010, water demand hit 1,760 million m3 per annum (SRBA, 2013), while average renewable rainfall and runoff over the last 40 years is estimated to be only 848 million m3/year (704 million m3/year when considering the period 1980-2006) (ibid.). Water demand composition is mainly driven by the agricultural sector, accounting for around 85 per cent; the remaining part is mainly determined by domestic consumption (10 per cent of the total). Industrial demand for water in the Segura basin is almost negligible (Calatrava and Martínez-Granados, 2012).

Vulnerability to water scarcity and drought has increased due to the joint effect of three driving factors: a large inter and intra-annual variability in the precipitation patterns with implications for water-dependent economic and social development; powerful incentives in the economy leading to increased water use in the short term; and the relative failure to implement public policy responses to water scarcity, with the implications that the overall objectives of water policy have not been met.

Water scarcity in the resource scarce Segura basin is partially compensated by transferring water from relatively more abundant watersheds such as the Tagus basin via water transfer infrastructure that has been in operation since 1978. These water transfers have only been operated to provide a fraction of the planned capacity of 600 million m3 per year. The remaining deficit is mostly covered through the overexploitation of groundwater sources (a buffer stock), sometimes via illegal abstraction, re-used water, and alternative resources from desalination. It has been estimated that, even considering the water transferred from the Tagus basin, the water demand in the Segura basin exceeds the availability of renewable water resources by around 370 million m3/year. This deficit is mainly covered through non-renewable deep groundwater withdrawals.

Several extremely intense drought periods have affected both basins in the past two decades. The persistent water scarcity conditions of the recent past are projected to increase in severity if the climate change driven negative trends of rainfall and runoff continue in the future. Both the fourth and fifth Assessment Reports of the Intergovernmental Panel on Climate Change classified the southern part of Spain among the portions of Europe most likely to be severely impacted by a radical change in precipitation. In addition, the extreme variability of natural supply along with lower ability of water infrastructures and aquifers to store water and stabilize water supply, have severely reduced the robustness and resiliency of the entire water supply system and increased both the likelihood and the severity of droughts (Gómez and Pérez, 2012). By contrast, the economic value generated by the water-dependent agriculture has increased, consistently increasing the demand for the scarce water resources.

Current trends in water use can only be tackled and reversed by putting in place an appropriate set of incentives. Economic incentives will need to be central elements of any water policy alternative that focuses more on the so-called soft options of water management rather than just on hard (physical capital) solutions. Once the potential for additional infrastructural measures has been fully explored, as in the Segura case, available alternatives to match water supply and demand, to reduce water scarcity, to enhance drought resilience and to improve water security must be found. These could be comprised of a combination of new alternatives such as water demand management, an increase in the technical efficiency with which water is applied to any economic use, and/or the development of non-conventional sources such as regenerated or desalinated water.

Objectives:

In combination with the infrastructural measures already in place, the current strategy consists of the design and implementation of a set of incentives (economic policy instruments), as part of an overall policy mix. The strategy also includes supply approaches, in such a way that decisions adopted by individual water users are compatible with the overall objectives of water policy, which in this case is intended to reverse current water scarcity trends, and reduce drought risk so that water security and resilience are enhanced while improving the long-term sustainability of water management. The aims of these incentives are to reduce vulnerability to extreme weather events, and to cope with drought risk and water scarcity in face of projected climate change that suggests worsening of the current situation.

Solutions:

Several responses to increasing water scarcity and drought risk have been implemented in the past. The focus has been placed on instrumental objectives such as increasing water conveyance facilities, developing new sources or making use of water in a more technically efficient fashion, i.e.:

- The Tagus-Segura Water Transfer: The TSWT was not conceived as a climate change adaptation measure but rather to promote regional development, and has been one of the driving factors pushing irrigation development. The policy debate around the transfer has increasingly focused on whether it has spread water scarcity elsewhere rather than allowing Segura to cope with its water supply deficits.
- Improved irrigation technology: The Segura basin is characterised by very efficient irrigation technologies. However, improved water efficiency has lowered the relative cost of using water, which in turn is an incentive to use more water. This increased water use potentially outweighs any savings from increased efficiency, reducing physical return flows, and increasing energy consumption.
- Diversification of sources; such as groundwater, desalinated water and recycled wastewater. Desalination facilities are being used at less than one fifth of their installed capacity.
- Drought Management Plan: In the case of drought events, these plans set up more stringent constraints to the access of publicly provided water. However, neither the Plan nor water authorities have actually introduced any ad-hoc instrument to tackle outlawed groundwater abstraction.

The economic policy instruments hereby proposed are a means to deliver the actual water policy objective which in this case consist of reversing current water scarcity trends and reducing drought risk, so that long-term sustainability of water management is improved. These ambitious objectives can only be achieved provided other intermediate and more instrumental objectives are also met. To contribute to sustainable water management, economic policy instruments must also be consistent with (and not be in contradiction with) the purposes of cost recovery such that financial sustainability in the provision of water services is guaranteed and all water users receive adequate signal of the environmental costs associated with water use and of the benefits foregone for not using water. The following are examples of opportunities to make the objectives of water policy compatible with the maintenance and enhancement in market-driven welfare:

- Increase in the efficiency with which water is used so that production can be increased or maintained with lower pressures on water sources.
  Reallocation of water from less to more productive uses, especially within the agricultural sector, so that the overall value of goods and services produced can be preserved or increased while reducing water abstractions.
- Use of alternative resources to replace freshwater to increase adaptive capabilities in dry periods and, especially for domestic consumption, water security overall.
- Introduction of formal insurance systems provided by the financial sector that will reduce exposure of farmers' incomes to water uncertainty.

The following are the three basic instruments that have been considered:

1. Water security pricing scheme; In addition to its contribution to cost recovery, the proposed reform is meant to make pricing a real mechanism to match water supply and demand, including by assigning each water source a price depending on its role in terms of the supplied quantity and its relative water security in the short and the longer term. The price of water security is introduced as a financial mechanism to guarantee the existence of buffer stocks and to allow for the recovery of depleted aquifers, as well as to reduce water demand relative to the current baseline.
2. Drought insurance; An insurance mechanism provided by financial markets (covering irrigated ligneous crops) may favour the transfer of the burden of drought risk from the natural to the financial sector. The main hypothesis is that stabilizing farmers' income is a way to reduce incentives to withdraw more water from ground sources that are already being used unsustainably.
3. Water use rights trading scheme: A combination of intra-basin markets to improve water allocation efficiency at local levels and to enhance water usage technical efficiency, combined with an inter-basin water market scheme to transfer water from relatively more scarce to the less scarce areas.

The three Economic Policy Instruments, after a long period of preliminary assessment, are currently in the implementation phase. Water pricing schemes have been partially implemented; water trading schemes have been adopted to cope with water scarcity in case of drought events resulting in emergency situations; and the drought insurance schemes are currently under discussion at the national political level.

Importance and relevance of the adaptation:
Case developed and implemented and partially funded as a CCA measure.

Additional Details
Stakeholder engagement:
Regarding the infrastructural management, the Segura river basin authority maintains an approach aimed at enhancing public participation, especially regarding the planning activities.

For the specific discussion on the introduction of economic policy instruments for water demand management, facilitated stakeholder consultations were carried out through a series of meetings with selected stakeholder groups and complemented with telephone and web conferences. More than a 100 stakeholders were actively engaged in the process aimed at designing the economic policy instruments. The main actors involved were: national authorities, river basin authorities, members of the academia, irrigators, consumers associations, insurance companies, NGOs, and international experts. Meetings were held in Madrid in April 2012, November

2012, April 2013, and June 2013, and were focused on the assessment of the three economic policy instruments considered.

Success and limiting factors:
Regarding traditional strategies, such as increasing water transport facilities, developing new sources or more technically efficient use of water, when judged separately and against these technical objectives those alternatives have been successful. Current infrastructure allows for the reallocation of significant amounts of water; alternative or non-conventional sources do already exist and might provide significant and reliable water services; and water use, particularly in those areas where water is scarcer, is close to the standards of best available technologies. In the same sense drought management plans have been successful in setting contingent water constraints on resources controlled by the water authority and seem to be progressing preceding from reactive, discretionary and emergency responses towards a new anticipated, contingent, and planned response to water risks.

Unfortunately, continuous adjustment of the supply side does not favour a reduction of the demand for water. It was assumed that the social and economic cost of leaving most water demands unattended would be too high; besides neither any national management plans nor alternative water resources were available at that time. In order to expand supply, controlled and temporal over-exploitation of aquifers was approved. The environmental outcome was clear: withdrawals during 1989-1993 amounted to 148 million m3/year; these became more than 314 million m3/year during 1993-1995, which means an increase of 112% in over-exploitation.

Although such policies have made new irrigation developments possible and these have helped invigorate the local economy whilst stabilizing population in rural areas, they have also caused severe environmental problems, such as aquifer depletion and the destruction of riverine ecosystems (e.g., the formerly perennial Segura River does not reach now the Mediterranean Sea during most of the year). Attending to Segura River Basin Authority (SRBA, 2013), 14 groundwater bodies have been officially declared as overexploited in the Segura; while 10 additional groundwater bodies are in the process of obtaining an official declaration of aquifer overexploitation.

The proposed set of economic policy instruments have the potential to be extremely efficient in controlling and containing increasing demand, but the solutions proposed to face water policy challenges in the Segura and the Tagus involve significant transaction and transformation costs. However, in comparison to traditional infrastructure-driven alternatives, the choices proposed are not intensive in transformation cost (of fixed capital, operation and maintenance) but rather transaction costs (including information, bargaining, monitoring, enforcement, etc.) (Williamson, 2000; North, 1990, 1994; and Ostrom, 1990).

Budget, funding and additional benefits:
The infrastructural interventions implemented over the past decades have driven the economic development of this area of Spain, characterized mainly by an agricultural economy. Unfortunately, rather than solving a water scarcity problem, the set of infrastructure has become a driver for enhancing the adoption of unsustainable (for this semi-arid region) agricultural practices and for massive urban development along the coastal areas. A further increase of water supply from external sources, mainly through the construction of new desalination plants, has represented a large economic investment, and yet less than one fifth of their installed capacity is actually used due to its high per unit cost (4 to 5 times higher than groundwater). Demand management, through economic policy instruments in the form of water pricing or water trading schemes, is one of the most cost-effective solutions for a more efficient allocation of the water resources among the users.

Although the average bulk water price for agriculture in the Segura basin is the highest in Spain (0.096 €/m3 for conventional water sources, almost twice as large as the Spanish average of 0.05 €/m3) (SRBA, 2013d; Maestu and Villar, 2007), this price only reflects the higher financial cost of supplying water in that basin district as compared to other basins in Spain. The price is determined, in part, by the cost of the infrastructures that have been constructed over time to minimize water scarcity in the area. However, this price does not take into account either the scarcity value of the resource or the environmental costs of water supply, which, if taken into consideration, would significantly increase water price. Moreover, the observed water price is not even high enough to guarantee full-cost recovery, with cost recovery ratios ranging between 54.08% for intra-basin surface water resources and 80.82% for the Tagus Segura Water Transfer (Maestu and Villar, op. cit.). This situation is even more striking when considering that most of these investments were ultimately aimed at guaranteeing water security in agriculture, a private endeavour. This alone could justify a price increase on the grounds of cost-recovery, as required by the EC Water Framework Directive. On the other hand, of additional concern is that such a policy may result in adverse effects on the local economy, which heavily relies on agriculture.

Water pricing re-design is meant to address a critical issue: how much would current water prices need to increase to guarantee water provision in dry periods. The suggested water pricing security scheme works as a cost-sharing mechanism among those interested in having a secure water supply.

The analysis on drought insurance shows that between the fair risk premium and risk-averse farmers' willingness to pay, there is space for insurance systems that would stabilize income and reduce incentives for groundwater overexploitation during dry periods. Charging households for the capital costs of desalination plants would result in a negligible effect on household water demand (estimated in less than 0.7%). Urban water security through desalination increases water availability and security for agriculture, which results in reduced income variability, stable employment and positive forward linkages in other economic sectors (i.e. agro-industry). This provides the rationale for sharing costs.

Water use right trading has been designed on the basis of an analysis of actual opportunities for water transfers among different users. This analysis included identification of operational costs implied in those trades and the analysis of third-party effects. Even ignoring other transaction costs, this analysis shows that opportunities for water trading decay with distance as transport costs increase. Neither transport costs nor third-party effects are very significant when water is traded on a local basis among users of the same kind (i.e. irrigators within the same irrigation district).

Legal aspects:

The Water Framework Directive explicitly states that water pricing has to be used as an incentive to adapt water demand to the EU environmental standards, especially in overexploited areas such as the SRB (EC, 2000). Higher prices for conventional water sources in agriculture may improve the status of water bodies in the SRB in two ways. On the one hand, they can reduce the expected income and thus limit water demand from low productive crops; on the other, they favour the replacement of overexploited conventional water sources by largely idle non-conventional ones.

The EU Blueprint to Safeguard Europe's Waters regards water pricing as "a powerful awareness/raising tool for consumers and combines environmental with economic benefits, while stimulating innovation" (COM, 2012). By including environmental and resource costs in water service tariffs, the EU Water Framework Directive requirement of cost/recovery points towards establishing a pricing system that deals better with environmental externalities.

The legal framework that regulates the agricultural insurance system in Spain is laid out in the 87/1978 Law of December 28, on combined agricultural insurances, and the 2329/1979 Government Decree of September 14, which approves the Regulation for the application of the Law. The EU Strategy on adaptation to climate change, published in April 2013, aims at encouraging the development and implementation of adaptation action by the MS, with special focus on win-win, low-cost and no-regret options. As one of the actions to be promoted under its adaptation strategy, the Commission included the expansion of insurance and other financial products in the context of natural and man-made disasters (COM, 2013).

The reform of the Spanish Water Law in 1999 (Law 46/1999, BOE 14-12-1999) introduced the so-called lease contracts (contratos de cesión) and water banks (centros de intercambio) that paved the way for certain transfers of water rights for a given period of time including a pecuniary compensation. The transfer contract for exclusive water use rights on public-domain waters is regulated under articles 67 and ulterior ones of the Water Law, approved by Government Decree 1/2001, of July 20th, 2001 (Vázquez, 2010).

Implementation time:
Structural measures have already been implemented. The described Economic Policy Instruments are currently in the implementation phase. The complete implementation of Economic Policy Instruments is expected in the reasonable time of a decade.

Reference Information

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http://www.feem-project.net/epiwater [3]

http://www.chsegura.es/chs_en/index.html [4]

http://www.chtajo.es [5]

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