Water Scarcity and Drought Management, Legislation and Policies in the European Union: The Special Case of the Aqueduct Tajo-Segura in Spain

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Abstract

The European Union (EU) has established a Community framework for water protection and management. The Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishes a framework for Community action in the field of water policy. "Member States must identify and analyze European waters, on the basis of individual river basin[s] and district[s]. They shall then adopt management plans and programmes of measures adapted to each body of water." The Water Framework Directive 2000 has a number of objectives, including preventing and reducing pollution, promoting sustainable water usage, protecting the environment , improving aquatic ecosystems, and mitigating the effects of floods and droughts. An analysis of the implementation of the Directive and the policies developed to manage each river basin can show how to effectively achieve the goals proposed by the Directive. In addition, the study of regional allocation mechanisms such as aqueducts can provide strategies to promote resilience to climate change and reduce the impact of drought conditions. Significant changes in the quality and availability of water resources is an expected consequence of climate change. Moreover, climate change is causing stresses on water through changes in precipitation and rising temperatures, which are causing serious damage to the environment and society. This analysis of the current water management legislation and policies in the context of water scarcity and drought in the European Union shows the lack of a specific regulation addressing these issues. There is therefore a need to develop a Water Scarcity and Drought Directive. Moreover, the results and conclusions of this research reveal how aqueducts, such as the Aqueduct Tajo-Segura are an example of good practice in mitigating the effects of climate change while ensuring sustainable development.

Keywords: water scarcity, drought, Water Framework Directive, aqueduct

I. Introduction

The Water Framework Directive (WFD) adopted in 2000 has established an integrated approach for EU water policy, focused on river basin management with the objective of all EU waters achieving a good status by 2015 (European Commission Environment Water, 2015). The WFD has a number of objectives, such as promoting sustainable water usage, protecting the environment, and mitigating the effects of droughts (Directive 2000/60/EC). The European Commission emphasizes the need for a combination of adaptation measures in water policies to address the issues of water scarcity and drought (European Commission, 2012). In this line, an analysis of the Directive and the policies developed to manage each river basin can shed light on how to effectively achieve the goals proposed by the Directive.

The River Basin Management Plans and the Programmes of Measures are essential tools in implementing the Directive. In 2009, the first River Basin Management Plans and Programmes of Measures were adopted, although countries such as Spain were not able to do this. These instruments are currently being updated and were subject to public consultation at the 4th European Water Conference during the first half of 2015, with the aim of final adoption by the end of 2015 (European Commission, Water, 2015). The Aqueduct Tajo-Segura Irrigators Association (Sindicato Central de Regantes del Acueducto Tajo-Segura) participated in this conference and emphasized the need of a water scarcity and drought regulation able to ensure the provision of sufficient water to the dry European regions through adaptation mechanisms such as aqueducts. In fact, a Water Scarcity and Drought Directive was the main request of Mediterranean countries at the 4th European Water Conference.

This article focuses on the WFD and water policies about water scarcity and droughts. It also provides a study of the Aqueduct Tajo-Segura as an example of good practice according to the WFD. The Aqueduct Tajo-Segura applies the supplementary measures established in the WFD such as the promotion of adapted agricultural production through mechanisms such as drip irrigation technology and low water requiring crops (Directive 2000/60/EC), (Soto, 2014).

The Aqueduct Tajo-Segura transfers surplus water from the headwaters of the River Tajo to the River Segura, which suffers a structural deficit of water resources for use by the population and for irrigation. This is general interest in its purest form. The volumes transferred supply water to over 2.5 million people and over 40 million trees. When the water flow of the aqueduct is continuous and stable, it ensures sustainable development, promotes resilience to climate change, and mitigates the impact of drought conditions. The water transferred is drawn from the excess of the basin of origin. The basic rule of the aqueduct is to prioritize the demands of the Tajo Basin, including environmental needs. Spanish Law 21/2013 always preserves the preferences of the donor basin and respects the determinations of its water planning (Spanish Law 21/2013, BOE n. 296) . The ecological flow is protected, avoiding any harm to the Tajo Basin (Spanish Government, 2009). The level of agricultural productivity from water of the Aqueduct Tajo-Segura is very high because of the special climate and geological conditions in southeastern Spain. This factor is especially relevant to provide high levels of food production and shall be of special interest and consideration by the European Union because regions like this ensure food security in Europe and around the world (PricewaterhouseCoopers, 2013).

II. The Water Framework Directive

The Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 (Water Framework Directive, 2000/60/EC), establishes a framework for Community action in the field of water policy. The current climate change situation is expected to aggravate the existing stresses on water through issues such as changes in precipitation, and rising temperatures. (European Commission, 2012). Although, the WFD has provided guidelines to manage water scarcity and droughts, the present and forecasted effects of climate change demand additional measures at the legislative level to provide resilience and ensure water availability to dry areas such as southeastern Spain.

The purpose of the WFD is "to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:

[…]

(e) Contribute to mitigating the effects of floods and droughts" (Directive 2000/60/EC). The WFD specifically emphasizes the need to mitigate the effects of droughts and establishes as a mechanism to do so a framework for the protection of water. The WFD does not specifically address how to mitigate the effects of droughts in dry regions which are dependent on a water basin. It provides a non-exclusive list of supplementary measures which Member States within each river basin district may choose to adopt as part of the programme of measures required under Article 11(4). Supplementary measures may be designed and implemented in addition to the basic measures, in order to achieve the environmental objectives of Article 4. The supplementary measures list includes demand management measures, *inter alia*, promotion of adapted agricultural production such as low water requiring crops in areas affected by drought (Directive 2000/60/EC). An example of the implementation of this demand management measure is the Aqueduct Tajo-Segura in Spain, where the best available technology is applied to ensure low water use (Islestudio, 2008).

According to the WFD, the irrigation of dry land by the Aqueduct Tajo-Segura promotes adapted agricultural production through mechanisms such as drip irrigation technology and low water requiring crops. However, the way the WFD addresses drought is only to meet the environmental objectives. The social and economic impact of drought on society are not addressed in the WFD.

The WFD approaches drought as an unforeseen or exceptional circumstance, which must be solved to achieve good water status. In case of drought, all practicable steps must be taken "to mitigate the adverse impact on the status of the body of water" (Directive 2000/60/EC). Moreover, the WFD establishes that if droughts are the result of "circumstances of natural cause of force majeure, which are exceptional and could not reasonably have been foreseen, in particular prolonged droughts, the Member State may determine that additional measures are not practicable, subject to Article 4(6)" (Directive 2000/60/EC). The WFD addresses drought as a negative effect on the good water quality of the basin but does not address the negative impact on the society depending on a specific basin. There is no protection for arid or semi-arid regions such as the southeast of Spain, which suffer a structural deficit of water resources for use by the population and for irrigation.

Under the WFD "member States shall collect and maintain information on the type and magnitude of the significant anthropogenic pressures to which the surface water bodies in each river basin district are liable to be subject, in particular estimation and identification of the impact of significant water flow regulation, including water transfer and diversion, on overall flow characteristics and water balances" (Directive 2000/60/EC). At the regional level, this assessment is essential to guarantee the correct allocation of water according to its use, especially in drought regions such as southeastern Spain where the Aqueduct Tajo-Segura provides water to one of the most arid regions in the EU. In fact, "south-eastern Spain [the Murcia and Valencia regions and eastern Andalucía] has been experiencing drought over the last 25 years (European Commission, 2014).

Although the WFD incorporates the transfer and diversion of water as mechanisms to manage water flow, there is no specific provision addressing transfer of water in order to mitigate the effects of drought in society and more specifically in the agricultural sector. This situation is affecting southeastern Spain, which requires additional measures to protect society, the sustainable development of the region, and current agricultural practices and uses.

The European legislation lacks a specific regulation for establishing a framework that is able to mitigate the impact of drought on society and the economy. This is especially relevant in the agricultural sector, which is the largest water user in Europe. The WFD does not establish any protection for agriculture and the dignity of farmers to continue with their activity in case of drought. Under the Universal Declaration of Human Rights "everyone, as a member of society, has the right to social security and is entitled to realization, through national effort and international co-operation and in accordance with the organization and resources of each State, of the economic, social and cultural rights indispensable for his dignity and the free development of his personality" (U.N. 1948). Farmers as members of society, have the entitlement to cultural rights indispensable for their dignity. When water from the Aqueduct Tajo-Segura is not sufficient, additional sources of water must be guaranteed in order to protect agricultural activity and therefore farmers' dignity. The WFD lacks a regulation ensuring the supply of water for agricultural activities in case of drought. There is therefore no protection of the use of water for agricultural purposes, which means farmers' dignity as a fundamental human right is not protected.

III. Water Policy

The Commission emphasizes the need for a combination of adaptation measures in water policies to address water scarcity and drought (Directive 2000/60/EC). The EU has developed a desertification and drought related policy according to the implicit requirement of the WFD to properly manage water quantity in the EU. "The Environmental Council of 30 October 2007 supported the Commission's 2007 Communication and invited the Commission specifically to review and further develop the water scarcity and drought policy by 2012" (European Commission, 2012). The Report on the Review of the European Water Scarcity and Droughts Policy, 2012 specifically establishes that "the use of European Investment Bank (EIB) funds for Member States´ actions to address [water scarcity and drought] WS&D is still low" (European Commission, 2012). Moreover, there are still limitations in the integration of Drought Management Plans with river basin management plans (European Commission, 2012). In addition, "[l]imited progress has been made with the use of EU Solidarity Funds in the area of droughts" (European Commission, 2012). There are several gaps in the current Water Scarcity and Droughts policy, including conceptual gaps, information gaps, and policy, governance and implementation gaps (European Commission, 2012). While the assessment and management of flood risk are regulated under the Directive 2007/60/EC, there is no specific directive related to water scarcity and drought. The lack of legal instrument combined with inadequate policies to address these issues contributes to economic and social disequilibrium between regions in EU. Therefore, there is a clear need to regulate the assessment and management of water scarcity and drought. In addition, aqueducts should be recognized as a tool to promote integrity between Drought Management Plans and River Basin Management Plans.

Aqueducts are used in several countries such as the U.S.A. (especially in California, Texas and Arizona), Australia and South Africa (Hirji, 1998). Like southeastern Spain, these countries suffer continuous drought conditions and therefore a structural deficit of water resources for water use in population supply and irrigation. All of these countries share the common factor of arid and semi-arid regions and the accompanying need to establish adaptable measures able to support the demands of society while protecting the environment. In this context, aqueducts are instruments able to provide inter-basin water transfers contributing to the development of society through the water excess of the basin of origin. This guarantees the protection of the minimum stream flow meeting the requirements of both biological and physical habitats (Ghassemi and Ian, 2007) (Hirji, 1998).

In the European Union, several countries use aqueducts as an appropriate instrument to deliver and transfer water. Examples include the many Roman aqueducts, which are still in use today. These demonstrate both the relevant use of aqueducts throughout European history and the essential role of inter-basin transfers of water in current society. The source of the Aqueduct Aqua Virgo still feeds the famous Trevi fountain in Rome, Italy. Another example is in Frejus, France, where the current water supply system follows the same course as its ancient predecessor to a large extent, although its water is now used only for irrigation (Roman Aqueducts, 2015).

The United Kingdom has over 30 aqueducts, including the Devonport Leat, which was constructed in the 1790s to carry fresh drinking water from the high ground of Dartmoor to the expanding dockyards at Devonport, Devon, England (Hawkings, 1987). The New River, a man made waterway in England, opened in 1613 to supply London with fresh drinking water over a distance of 38 miles (62 km) (New World Encyclopedia, 2015). Another example in the United Kingdom is the Stratford-upon-Avon Canal, located in the South Midlands. The canal, which was built between 1793 and 1816, runs for 25.5 miles (41.0 km) in total (Cumberlidge, 2009).

In Greece in 1975, the World Bank contributed US$40 million to the East Vermion Irrigation Project, which consisted of the construction of 15 new concrete lined primary irrigation canals, with a combined length of about 140 km with water coming from the Aliakrmon and Edessa Rivers (The World Bank, 1975). Portugal also has a long tradition in irrigation canal aqueducts such as the Levadas canals in Madeira Island. The Levadas originated out of the necessity to bring large amounts of water from the west and northwest of the island to the drier southeast, where water is used by the population and for agriculture. Today the Levadas not only supply water to the southern parts of the island, they also provide hydroelectric power (Azores, 2015).

Aqueducts also have a large tradition in Spain. For example, in Merida an aqueduct starting at the antique Proserpina dam still supplies the local farmers in the area (Roman Aqueducts, 2015). Other relevant inter-basin transfers are the Guadiaro-Guadalete transferring 110 hm^3 per year; the Negratín-Almanzora aqueduct, which transfers 50 hm3 per year, the Zadorra-Arratia transferring 150 hm^3 per year from the Ebro River to the Gran Bilbao, and The Ter al Llobregat, which transfers 8 m^3/s to Cataluña. All of these aqueducts have the grantor region and the receiving region in the same autonomous community. This has helped to avoid potential conflict and has brought solidarity between people living in the same autonomous community. However, where the transfers are between different autonomous communities as in the Aqueduct Tajo-Segura, water conflict has been an issue, with the lack of solidarity between regions being the main problem (Claver, 2008).

IV. The Aqueduct Tajo-Segura Geographical Location and History

In Spain, water is poorly distributed, with the southeast being dry and the north wet. For example, regions along the Ebro Basin in the northeast suffer regular floods, causing serious damage to society and the environment. In fact, the autonomous community of Aragon alone has already lost €25 million due to flooding in 2015 (El Mundo, 2015). By contrast, the southeast of Spain suffers from serious water scarcity and drought. One potential solution to mitigate the effects of flooding and drought would be the development of additional infrastructure connected to the Aqueduct Tajo-Segura. This infrastructure would be able to store and transfer excess water from other basins to the Tajo Basin in order to be transferred to the southeast using the infrastructure of the Aqueduct Tajo-Segura.

Historically, people have diverted river waters to other areas which needed water, and that work has only been limited by the level of technological development of the time. The Aqueduct Tajo-Segura is probably the most important hydraulic work in Spain. The Aqueduct Tajo-Segura transfers surplus water from the headwaters of the Tajo River to the Segura River (Spanish Law 21/2013, BOE n. 296). Water from this aqueduct is essential for southeastern Spain including the regions of Almería, Alicante, and Murcia (Claver, 2008).

The planning project for the aqueduct occurred in 1993 and was included in the National Hydrological Plan with the aim of solving the problem of the shortage of water resources in southeast Spain. The Aqueduct Tajo-Segura is in current use, and started operations according to the Spanish Law 21/1971, June 19th, which in Article 1 set the maximum annual amount of 600 hm^3 of water surplus to be transferred from the Tajo Basin to the Segura Basin. Moreover, once the construction was complete, the law allowed the transfer of the maximum annual amount of 1.000 hm^3. The Tajo-Segura came into operation in 1979, to support irrigation and the domestic water supply for the population of the Júcar and Segura Basins (Spanish Government, 2015). See figure 1, which shows the geographical location of the aqueduct.

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Figure 1. Tajo River along the Iberian Peninsula and the Aqueduct Tajo-Segura.

The water transfer begins in the reservoirs of Entrepeñas and Buendia, which have a total capacity of 2,443 hm^3. The water is led through a channel that has a capacity of 33 m^3/s and stretches through tunnels and aqueduct sections. The Aqueduct Tajo-Segura links the Bolarque Reservoir on the Tajo River with the Talave Reservoir on the Segura River. It is 292 kilometers in length. This aqueduct can guarantee a transfer of 600 cubic hectometers (155 for domestic water supply and 445 for irrigation). While it was expected to transfer 1,000 cubic hectometers, the average annual volume transferred is 350 hm^3. This aqueduct is also used today to supply water to the Tablas de Daimiel National Park and to transport water from the Alarcón reservoir to Albacete for irrigation and drinking water (Spanish Government, 2015).

The post-transfer system is a complex structure of canals beginning at Talave Reservoir on the Segura River. This infrastructure enables the management, transport, and final distribution of water to the various recipient zones in southeastern Spain.The Ojos Dam distributes the water through different channels: the right bank channel, the Almería channel, the main left bank channel, the Crevillente channel, the La Pedrera reservoir and the Campo de Cartagena channel. This infrastructure allows efficient water distribution and the best available technology is applied to ensure low water use (Soto, 2014).

The average yearly water volume transferred into the Segura Basin from 1979-2014 was 328,000,000 m^3 per year (55% of the allowed maximum). Volumes transferred for public use have not varied greatly over time, unlike irrigation transfers, whose average yearly sum was 204,000,000 m^3, almost half of the allocated quantity (Soto, 2014).

V. Sustainable Water Allocation of the Aqueduct Tajo-Segura

An analysis of the Aqueduct Tajo-Segura shows that aqueducts are sustainable and appropriate tools for allocating water in Europe. The Aqueduct Tajo-Segura presents a solution to the current dry conditions in southeast Spain. This aqueduct has been providing drinking water to over 2,500,000 people, protecting natural parks, and irrigating 140,000 hectares of farmland since 1979 (SCRATS, 2015).

The concept of Sustainable Development was adopted by the European Commission in the 2009 Review of EU Sustainable Development Strategies (SDS) in July 2009 (European Commission, 2009). The European Council also confirmed that "Sustainable development remains a fundamental objective of the European Union under the Lisbon Treaty" in December 2009 (Council of European Union, 2009).

The concept of Sustainable Development "stands for meeting the needs of present generations without jeopardizing the ability of future generations to meet their own needs – in other words, a better quality of life for everyone, now and for generations to come" (European Commission, Environment, 2015). The concept includes the integration of different sectors of society from local to global, as well as social, economic, and environmental aspects, which are all interconnected in regional and global human progress. An analysis of some of these aspects, such as appropriate use of water in irrigation, economic impact of the Aqueduct Tajo-Segura, current water transfer regulation and management, as well as ecological flow show how this aqueduct guarantees the concept of sustainable development.

1. Appropriate use of Water in Irrigation

The Aqueduct Tajo-Segura contributes to guaranteeing the sustainable development of the region (European Commission, Environment, 2015). The Aqueduct Tajo-Segura applies the supplementary measures established in the WFD. The land irrigated by the Aqueduct Tajo-Segura promotes adapted agricultural production through mechanisms such as drip irrigation technology and the use of low water requiring crops (Soto, 2014). Among this technology, *localized irrigation systems* apply water directly where the plant is growing, thus minimizing water loss through evaporation from the soil. This ensures the most effective use of water. However, the problem of water scarcity and drought in southeastern Spain needs additional solutions to mitigate the effects of climate change in the context of the EU to ensure the sustainable development of the region.

The reuse of water is also applied in irrigation practices. In fact, the WFD addresses the reuse of water as an additional measure to mitigate water scarcity (WFD, 2000). Reuse of water has a high value for agriculture because it ensures the continuity of water use. The Spanish Royal Decree 1620/2007 (BOE, n. 294) establishes specific national regulation of the reuse of water. In the Murcia Region alone, the average annual volume of reused water was 103 hm^3 during the period 2002-2011 (Soto, 2014).

2. Economic Impact of the Aqueduct Tajo-Segura

Agriculture is essential for the Spanish economy and the progress of the country. Water transfer related to the agro-food industry contributes a total of €2,364 million to the GDP (PricewaterhouseCoopers, 2013). In addition, agriculture promotes the development of industries connected to the sector such as transport, engineering, and sanitation. Agricultural activities related to the Aqueduct Tajo-Segura generate more than 100.000 jobs. Moreover, water from the aqueduct creates over 320,000 indirect jobs, contributing to the development of the country. This is especially important in the current economic crisis in Spain. Water profitability per m^3 is very high at between €0.60/m^3 and €1.00/m^3. Moreover, profitability can be as high as €3/m^3 in greenhouses (Soto, 2014). There is a high level of exports from the southeast. In 2013, 69% of national vegetable exported were from southeast Spain; this represents a total of €1,016 million (FEPEX, 2013).

The development of the region is established according to the sustainable development concept, where the Aqueduct Tajo-Segura provides ecological value to society by protecting national parks and improving the environment (PricewaterhouseCoopers, 2013). An example of this environmental protection is the Spanish Law 13/1987, July 17th, enacted to provide water for environmental purposes through the Tajo-Segura aqueduct to the Tablas de Daimiel National Park (Ley 13/1987, BOE n. 171). This National Park receives water from the Aqueduct Tajo-Segura thus maintaining its ecological value. Moreover, the aqueduct irrigates 44.000.000 trees, which contribute to mitigate desertification and improve air quality by removing CO_2 from the atmosphere (SCRATS, 2015).

The Aqueduct Tajo-Segura is also a source of income for other autonomous communities in Spain through payments to donor regions. The total amount paid to the autonomous communities located in the Tajo Basin is €405,33 million. This implies an additional benefit from the aqueduct to other regions (SCRATS, 2015).

3. Water Transferred

Spanish Law 21/2013 approves management regulations for the Aqueduct Tajo-Segura. In February 20015, the Constitutional Court declared null some articles of this law due to a default form when a report from Aragon was not included. The Constitutional Court established that the nullification of this law "should be deferred for a period of one year" to run from the date of publication of the decision in the Official Gazette (BOE) (February 5th, 2015), this gives time to include the report from Aragon and correct the default form. This law establishes a transfer system on a monthly basis, depending on the total water supply available in the Entrepeñas and Buendia dams in the upper Tajo River at the beginning of every month. The law establishes that the maximum annual amount of surplus transferred is 650 hm^3 (600 hm^3 for the Segura Basin and 50 hm^3 for the Guadiana Basin). The Law defines the rules of exploitation for four different levels. The Royal Decree 773/2014 (BOE n. 223) regulates these levels.

Level 1 is established when the water level between both dams is equal to or above 1.300 hm^3, or when during the last 12 months the water level between both dams was equal to or above 1.200 hm^3. In this case, the relevant agency shall authorize a transfer of 60 hm^3 per month, not exceeding the yearly maximum.

Level 2 is established when the water level between both dams is lower than 1.300 hm^3 without reaching the volumes given in level 3, and when during the last 12 months the level between both dams was less than 1.200 hm^3. In this case, the relevant agency shall authorize a transfer of 38 hm^3 per month, not exceeding the yearly maximum.

Level 3 is established when the total water supply in Entrepeñas and Buendía does not exceed, at the beginning of the month, the values shown in the following table:

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
m^3 x 10^6	613	609	605	602	597	591	586	645	673	688	661	631

This is considered an irregular hydrological situation; the relevant agency shall authorize at its own discretion a transfer of up to 20 hm^3.

Level 4 establishes that if the water level between both dams is less than 400 hm^3 water transfers are not allowed (Royal Decree 773/2014, BOE n. 223).

The law also establishes a transitory period of 5 years to achieve the new reference level of 400 hm^3, which defines the level of water surplus. However, the law will be directly implemented in case of a total level of water supply in Entrepeñas and Buendía of 900 hm^3.

The current situation varies from level 2 to level 3, where the values are established according to the transitory period and the rules of exploitation set in the law (SCRATS, 2015). In fact, the level during hydrological year 2013-2014 was level 2 and the current hydrological year 2014-2015 has varied in level from one month to another. So far in 2014-2015, October, November, and April were at level 2, while December, January, February, and March were at level 3 (SCRATS, 2015). There is a need to ensure stable water transfers to southeast Spain. The demands of the Tajo Basin using the headwater, including environmental needs, are estimated at 350 hm^3 per year, plus evaporation of approximately 50 hm^3 per year (SCRATS, 2015) (Spanish Government, 2009). This implies that the water level left after meeting the demands of the Tajo Basin with water from the headwater should be transferred to southeast Spain. Moreover, additional transfers of excess water from other basins, such as the Ebro Basin to the Aqueduct Tajo-Segura would ensure water availability for this region.

4. **Ecological Flow**

According to the WFD the Aqueduct Tajo-Segura ensures the protection of the Tajo Basin. Under the Tajo Basin Hydrological Plan the ecological flow is guaranteed. In fact, the Tajo Basin Hydrological Plan establishes a minimum flow of 6 m^3/s is in Aranjuez and 10 m^3/s in Toledo and Talavera. These flow levels meet the requirements of both the biological and physical habitats of the species in those river sections (Spanish Government, 2009). The total water resources in the Tajo Basin are about 10,000 hm^3/year, and the maximum volume transferred is 600 hm^3, which is barely 5.5% (SCRATS, 2015).

The Aqueduct Tajo-Segura does not cause environmental harm to the Tajo Basin. In 2008, an environmental study developed by the Universidad Politécnica de Madrid addressed the minimum stream flows in the stretch of the River between Bolarque and Aranjuez. This study was developed according to the term 'good ecological status' established under the WFD and transposed into the Spanish Water Law (Royal Decree 21/2001, BOE n. 176). "Good surface water status" means the status achieved by a surface water body when both its ecological status and its chemical status are at least "good" (Directive 2000/60/EC). The results of this study show that the environmental demand established under the Law 52/1980 in 6 m^3/s was respected (Law 52/1980, BOE, 256). This study concluded that the Aqueduct Tajo-Segura is not causing harm to the ecological flow and therefore the good water status in the Tajo River is guaranteed (Universidad Politécnica de Madrid, 2008).

In 2013, the Company Ingeniería y Ciencia Ambiental, SL developed an additional study addressing ecological flow in the Tajo River through physical habitat modelling in the stretch between Bolarque Dam and Jarama River. This study was established according to ARM/2656/2008, which approves the Hydrological Plan. The results of the study established that the minimum stream flow 6 m^3/s under the law in the Bolarque-Aranjuez section is compatible with the methods set in the Hydrological Plan to calculate ecological flow through physical habitat modelling because the habitat result obtained is between 30%-80% according to the Hydrological Plan (Ingeniería y Ciencia Ambiental, S.L., 2013). The conclusions of these two studies prove that the Aqueduct Tajo-Segura is not causing harm to the environment or negative impact on the ecological flow in the Tajo River.

The main environmental problem in the Tajo Basin is bad water quality due to sewage coming from Madrid and the industries located around Madrid and Guadalajara. This is mainly a problem of water purifying, which has not been solved yet. It is not admissible to use more water from the Entrepeñas and Buendia dams upstream to dilute the pollution. This is against Spanish Law and the WFD. Moreover, this situation confuses the ecological flows with flow dilution of discharges, which is a legal fraud that could also have very negative effects on the Aqueduct Tajo-Segura water transfers (El Soto, 2008) (Iagua, 2015).

As we can see, the Aqueduct Tajo-Segura ensures the concept of Sustainable Development as it protects the environment for present and future generations while promoting the development of the region. The Aqueduct Tajo-Segura Irrigators Association (Sindicato Central de Regantes del Acueducto Tajo-Segura) upholds the interests of all the users of the Aqueduct Tajo-Segura (Claver Valderas, 2008). This association is a key factor in ensuring the sustainable development of the region and achieving adaptation measures that promote resilience to climate change.

VI. Desalination

Desalination has been considered as a potential solution to obtain more water for agricultural proposes. However, desalination cannot be an alternative to the Aqueduct Tajo-Segura due to the large number of issues involved. Among these issues the higher level of energy consumption is particularly important. While the consumption of energy for the aqueduct is 0,87 kWh/m^3, the consumption for desalination is between 3,5kWh/m^3 and 4kWh/m3. The substitution of the Aqueduct Tajo-Segura with desalination would therefore require four times the current energy consumption (Soto, 2014). Moreover, this increase would be unacceptable to the EU, which is committed to reducing the level of energy consumption by 20% by 2020. Another negative effect of desalination would be the increase of greenhouse gases, where the use of desalination would increase the emission of CO_2 by 400% (Soto, 2014).

An additional issue with desalination is the quality of the water, which is not appropriate for irrigation because of the high level of boron it contains. This would harm crops such as lemon trees, orange trees, peach trees, apricot trees and fig trees. Moreover, desalinized water is very low in nutrients and minerals. This leads to the need to add fertilizers, with the associated additional cost of production and energy consumption in manufacture. Finally, the cost of desalinizing water would be €1m^3, while the current cost of water from the Aqueduct Tajo-Segura is €0.10 euros/m^3 (Soto, 2014).

VII. Food Security

The Food Agriculture Organization of the United Nation has estimated that the demand for food is likely to grow by 70% by 2050 (European Commission, Joint Research Center, 2015). The Joint Research Center (JRC) is the European Commission's in-house science service and carries out research in order to provide independent scientific advice and support to EU policy. Among one of the challenges addressed by the JRC is to establish international trade from productive agricultural areas to deficit areas, through greater integration of regional agricultural polices (European Commission, Joint Research Center, 2015).

It is therefore highly relevant that regions with a combination of water, sun, soil and excellent climate conditions such as southeastern Spain can produce large amounts of food, which can be exported to other regions ensuring food security in EU. For example, exports from southeast Spain, which is irrigated with water transfers from the Aqueduct Tajo-Segura, included 3,199,626 tons of vegetables and 2,025,855 tons of fruit in 2013. An interesting aspect of this is that the EU is by far the largest consumer of these exports at 90% (FEPEX, 2013).

The European Union should protect semi-arid regions with privileged soil and climate conditions, which are able to produce large amount of food. The Joint Research Center (JRC) has also established that these regions in the EU can "contribute to global food security, being important suppliers of agricultural and food products in a growing world market" (Joint Research Center, 2014). In the context of climate change, it is essential to protect those productive regions, which ensure the production of food for present and future generations. In order to protect this source of food, the first step is to ensure the availability of water for the irrigation of semi-arid regions. Therefore, it is essential to develop a Water Scarcity and Drought Directive in order to protect semi-arid regions, such as southeastern Spain, which are able to ensure food security for Europe and other countries.

VIII. Conclusion

The primary conclusion is the need for a Water Scarcity and Drought Directive This Directive must ensure the concept of sustainable development where not only the environment is guaranteed, but also society and the different water uses It is particularly important to protect the continuity of agricultural activities. The agricultural sector is the largest consumer of water and ensures food security for the European Union and other countries. In order to achieve this goal, new European legislation must incorporate the regulation of inter-basin water transfers as a solution to mitigate the effects of drought. The Water Scarcity and Drought Direct should specially address the integration of Drought Management Plans with River Basin Management Plans. Water Management Plans must include inter-basin water transfer in regions such as southeastern Spain, which lack natural access to water. Moreover, according to the Universal Declaration of Human Rights, the dignity of farmers must be protected by enabling them to continue with their activity in the case of water scarcity and drought. The case of the Aqueduct Tajo-Segura shows how aqueducts are an appropriate tool to allocate water in a sustainable manner protecting the environment. However, semiarid regions like southeastern Spain need the guarantee of sufficient water to cover all their needs for present and future generations.

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