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Institutional Barriers to Efficient Water Management

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Abstract

Water resources are crucial for the sustainable development of the society, the economy and the environment; however those precious resources are often managed in very inefficient ways. The increasing water scarcity worldwide highlights already now the tremendous need for more efficient management. Agriculture is *the* major consumer of water resources around the world, thus efficient water management in agriculture is of paramount importance. There has been abundant research done about the economic, technological, social and environmental aspects of efficiency in the water sector. However, there is a lack of research about institutional barriers to efficient water management. The water sector experiences challenges in Southern Europe, thus we have identified the following research questions: ***To what extent do the identified institutional barriers hinder efficient water management in the agricultural irrigation sector in Bulgaria, Italy and Spain? Why do the identified institutional barriers differ in Bulgaria, Italy and Spain?*** We intended to measure two main parameters in our framework: ***(A)*** **The role of institutions** in terms of coordination, trust, active management, strategic planning, clear objectives, clear responsibilities and financing; and ***(B)*** **Rules and Regulations** in terms of water rights, pricing and metering, trade and water markets. The qualitative research program based on secondary sources was able to identify the answers to our research questions. *Water rights* constitute the biggest barriers in Bulgaria, lack of *metering and pricing* in Italy and absence of *clear objectives and responsibilities* in Spain. Based on our findings, we propose a pyramid framework that allows assessing the current development or maturity level in countries, and explains thereby why the institutional barriers are of different relative importance.

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I. Introduction

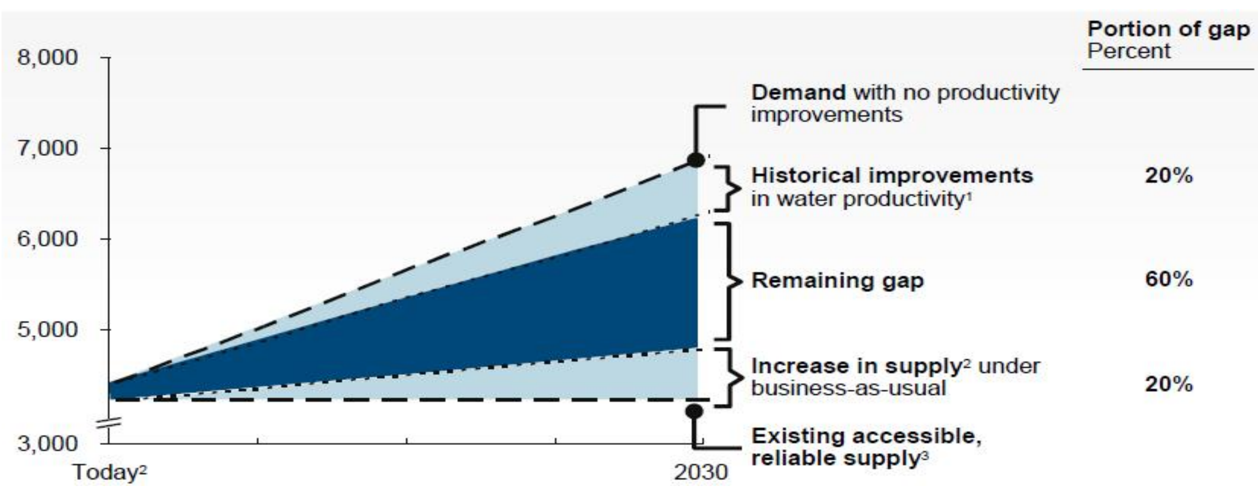
(1) Challenges and Problems for the Solution of the Water Problem

Water is increasingly becoming a scarce resource and its importance to the sustainable development of the humanity is crucial. An underlying problem is the bad management of the water resources. Due to the fact that agriculture accounts for the vast majority of water consumptions in many regions (Gemma and Tsur 2007), we focus on this particular area. The following introduction will discuss the potential measures to solve the water problems, the managerial implications and the challenges for the implementation of the solutions.

1.1 What Can Be Done?

A report written by McKinsey and several other big corporations (2009), based on various statistics and scientific works, has concluded that, if the management of the current water resources continues to be done in the same way in 20 years, there will be a 60 % gap between water supply and demand. The historical improvements in water productivity, which currently are 1 % per year, and the increase of supply through new infrastructure, will be able to close just 40 % of the gap.

Figure 1: Business-as-usual approaches will not meet demand for water (billion m^3)



1 – Based on historical agricultural yield growth rates from 1990-2004 from FAOSTAT, agricultural and industrial efficiency improvements from IFPRI.
2 – Total increased capture of water through infrastructure build out, excluding unsustainable extraction.
3 – Supply shown at 90 % reliability and includes infrastructure investments scheduled and funded through 2010. Current 90 %-reliable supply does not meet average demand.

Source: McKinsey & Company (2009)

The report claims that the solutions to these challenges are in principle possible and are not prohibitively expensive. There are in general three options available for closing the supply-demand gap:

1) The first one is simply to increase the amount of supply available for use. This is particularly relevant for those countries that have limited infrastructure but abundant water resources and therefore have the potential to convert that natural resource into available, accessible, and reliable water. This option has already been largely exhausted in developed countries since all economic ways of supplying additional water have been used. Furthermore, in many regions in the developing countries the water stress is already high, making this solution unfeasible.
2) The second one is to increase the water productivity of existing activities across the sectors of the economy. This entails either increasing the efficiency of water use (in other words, producing the same output with less water or increasing production for the same water).

For policymakers and other stakeholders, these two approaches represent a "*how*" question: *"How can the existing gap be solved technically—through supply levers, water productivity levers, or some combination of the two?"*

3) The third option revolves around a *"what"* question: *"What reductions in the water-using activities themselves can be encouraged?"* Rather than simply deploying technical measures to close a water gap, this approach entails shifting the country's economic activities toward less water-intensive ones. This option resembles the footprint of nation's concept, as will be discussed in the following. (McKinsey & Company 2009)

The three options can be combined in various ways yielding different cost structures. However, what could be said for sure is that the "business-as-usual" approach is no longer applicable. Water management needs to be radically improved.

The risks and challenges are not valid only on a national and international level; trends in availability and quality of water can have clear implications for businesses and their investors. A study done by JP Morgan (2008) distinguishes three varieties of water-related risks for the business:

Physical risks: Physical water risks mostly affect sectors in which water is consumed or evaporated in the production process. Agriculture processing is an obvious example.

Regulatory risks: Regulatory responses include permits, prices, or both to control consumption and discharge. Regulation has become dramatically more important in the water sector in recent years as water resources have been fully committed and engineering solutions no longer offer easy ways to increase supply. This not only raises costs, but may result in less predictable supply.

Reputation risks: The increasing competition for clean water among economic, social, and environmental interests has a large potential for damaging the reputation and even growth prospects of companies.

1.2 Problems and Challenges in Implementation

There are many technical solutions available for effective water management in agriculture. The first type of solution offers increased efficiency in water transportation, distribution and application (e.g. drip and sprinkler irrigation, closed, insulated irrigation distribution canals). The second type of solutions constitute of good agricultural practices, such as no-till farming and improved drainage, utilization of the best available germplasm or other seed development, optimizing fertilizer use, and application of crop stress management, including both improved practices (e.g. integrated pest management) and innovative crop protection technologies (McKinsey & Company 2009). Both types of solutions could lead to increased water use efficiency (Colombo 2007).

Given the fact that all those solutions are well-known and available today, one might wonder what is the reason that the water sector is among the least innovative sectors in the world economy (McKinsey & Company 2009). This fact is even more facinating, given the importance and the scale of the water problem.

We have to note, however, that not all solutions lie in the technological domain. In fact, Dickey (1981) claims that all types of irrigation systems could yield to more efficient water use, but they should be managed as effectively as possible. Each method of irrigation has advantages and disadvantages and "*most inefficiency is caused by selecting the wrong method of irrigation or by mismanaging the method selected*". The systems themselves are not to blame for low efficiencies.

The report conducted by McKinsey and Company (2009) observes that the implementation of water-saving solutions and measures faces significant challenges with rather political, managerial and social background with purely technological challenges being the easiest to overcome.

(2) Research Question

As we show in the following literature review, there has been a lot of research and attention on the general economic aspects of problems in the water sector. In addition, there has been a lot of research on the technological aspects of the good water management – ingenious technical solutions, innovative agricultural practices – this knowledge is all well-known and accessible! However, the aspiration for achieving more efficient water management has not been very successful so far. Moreover, the current trends are likely to magnify the importance of the current problems in the near future. The gap between what we are doing and what needs to be done is widening.

The water sector incorporates features that create a unique challenge for management (Holmes 2000):

- Water is a vital public good. Supplying and managing it is a social service, and almost always a natural monopoly.
- Water attracts very high political interest because of its importance to any community and the large capital investment needed to provide services.
- Water management in general lacks a profit motive or other market mechanism by which its effectiveness can be measured, with the expectation of commercial organizations that provide services under contract to a community. Therefore, diverse goals may divert the organization's resources.
- Additionally, water-sector organizations are dominated by technological professionals, who have a rather limited overview over the sector.

The main challenges to efficient water management seem to be institutional (Holmes 2000). We have been fascinated by the institutional barriers to the successful implementation and adaptation of newer and more efficient practices. Different models evidenced by the literature, are often mutually excluding each other with conflicting statements and recommendations. Moreover, there seems to be no practical and comprehensive framework mapping the different barriers to the efficiency in the sector. Thus we limit ourselves to the analysis of intervening institutional factors that constitute barriers to adoption of efficient water management within agriculture.

We have decided to overview some of the most popular models to create a framework and to test the validity of the framework in three countries in Southern Europe, member states of the EU - Bulgaria, Italy and Spain - due to the characteristics of these countries.

- First of all, irrigational agriculture is important for the economic activity in Southern Europe, as it uses the bulk of the abstracted water. At the same time the water stress in those countries is likely to increase in the next years.
- Second, the EU is among the most developed regions in the world – one could assume that both technologies and financing availability and knowledge are abundant.
- Third, the water sector in the three countries shows that they are using water in an unsustainable way. Huge gaps of efficiency are evidenced.
- Fourth, the three countries provide an interesting research background because of their diverse cultural, historical, institutional, and economic backgrounds.

Technology and knowledge are widely available in the EU; however there seem to be barriers to the adaptation of the efficient water management in the irrigation sector. These problems and challenges lead us to our research questions:

To what extent do the identified institutional barriers hinder efficient water management in the agricultural irrigation sector in Bulgaria, Italy and Spain? Why do the identified institutional barriers differ in Bulgaria, Italy and Spain?

In a nutshell, the dissertation has two objectives: the first, more descriptive objective is to provide the reader with an overview of the managerial and institutional barriers to adopt and implement efficient water management in the agricultural irrigation sector in Bulgaria, Italy and Spain. This is realized by the development by a framework based on recognized models that aims at answering the first, primary research question.

The secondary research question, more analytical, aims at identifying the reasons for dissimilar institutional barriers among the countries.

II. Literature Review

The aim of this section is to provide a literature review on the background of our thesis object and to outline the management theories that deal with water management. Furthermore, a critical assessment, analysis and comparison between the theories presented will be conducted.

(1) Background Information

1.1 Definition of the Phenomenon

The modern definition of water resource management provided by McKinsey & Company (2009) explains the complexity of the phenomenon:

"Water resource management can refer to a number of activities addressing the impact of water use on economic activity, people, and the environment. These could range from protection against the destructive elements of water (flood control), to ecosystem protection, to hydropower and navigation uses, to activities that divert water resources for consumptive use."

Good or efficient water management could mean many things to the different parties and levels of governance. To the farmer, good water management means getting the right amount of water to the crops at the right time with minimum labor and expense. Desirably this has to be accomplished without creating other problems, such as an accumulation of salt in the soil or losing water to leakages. To the irrigation district company, good water management means meeting the water needs of its customers as efficiently as possible, with minimum waste or loss. To society, good water management means having adequate supplies of good quality water for all municipal, industrial, agricultural, recreational, and environmental needs. (Bureau of Reclamation 2000)

Therefore, we define efficient water management as the one that ensures that the water resources are used in a way which is sustainable for the environment, the economy and the society. Inefficient water management on the other hand means use of the water resources that threaten the sustainable development of the environment, the economy and society.

The focus of our work is on the way institutions deal with water management within the field of agriculture (excluding water usage in livestock farming and focusing on water consumption in crop production farming). Thus we avoid the already much discussed field of urban water resource management or the engineering perspective.

1.2 The Scarcity of the Water Resources

Even though water is abundant on Earth, 97.5 % of it is saltwater, and just about 3 % of the total water resources consist of fresh water. Of this 3 %, over 2.5 % is frozen, locked up in Antarctica, the Arctic and glaciers, and not available to men. Thus humanity must rely on 0.5 % of the water resources for all of man's and ecosystem's fresh water needs. (Fry and Haden 2005)

There are several global trends that contribute to an increasing imbalance of supply and demand of fresh water resources: the changing climate, the increasing water pollution, the growing population, and urbanization/industrialization. These factors are making water already now a scarce resource around the world. Many countries face water scarcity as a fundamental challenge to their economic and social development. According to McKinsey & Company (2009), by 2030 over a third of the world population will be living in river basins that will have to cope with significant water stress, including many of the countries and regions that drive global economic growth (see Appendix Figure 1).

However, for the EU the greatest challenge is the changing climate, since the pollution is either under control or diminishing (European Environment Agency 2010), the natural population growth is negative (McKinsey & Company 2009), and the member countries in the Union are already quite industrialized, urbanized and have high incomes in comparison with the rest of the world (JP Morgan 2008). Therefore we will focus on the problem of the changing climate and the diminishing water resources.

(A) The Changing Climate

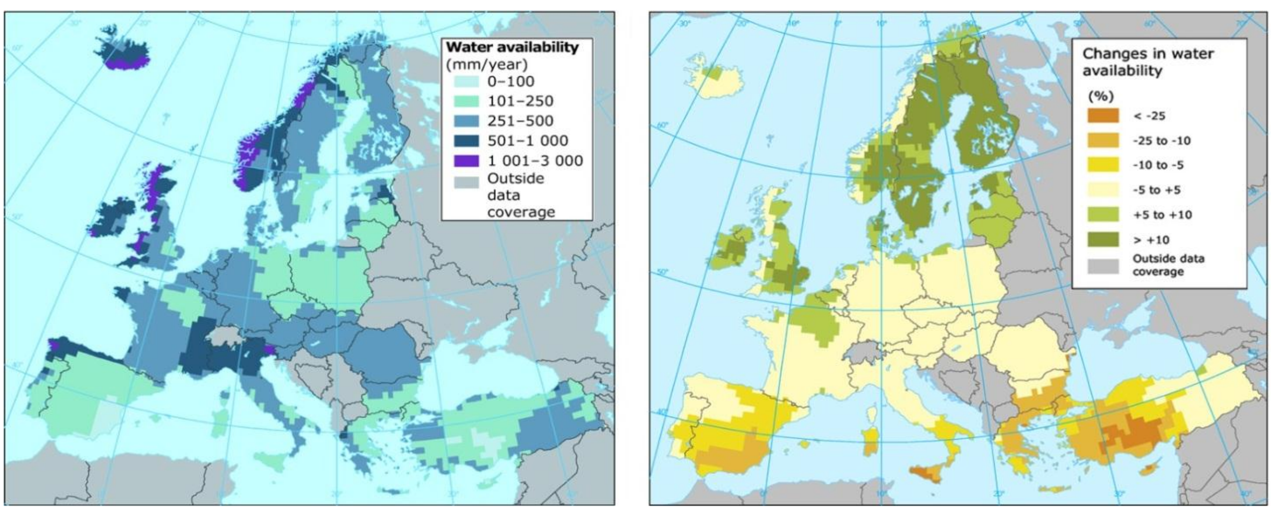
Most of the scientists today agree that there is a major shift in the global climate, largely caused by human activity. This process is labeled "*Global Warming*" (University of Copenhagen 2009). Global climate change projections suggest that the risk of prolonged droughts is the major future threat to several regions, with some of them already experiencing water shortages (Varis and Abu-Zeid 2009). Climate change is increasingly altering hydrologic cycles and leading to increased flooding in some areas and drought in others. Climate change influences freshwater systems in complex ways with respect to both long-term average availability as well as variability of water supplies. Climate change can also affect water quality, as higher water temperatures, increased rainfall intensity, and longer periods of low water levels exacerbate various forms of water pollution. (JP Morgan 2008)

Europe will not be an exception from those trends. The current climate change is expected to magnify regional differences in natural resources and assets. Southern Europe is already very vulnerable to climate variability, and the climate change will result in higher temperatures and drought, water scarcity, less hydropower potential and in general lower crop productivity (IPCC 2007). Since the EU is the focus of our research, we examine the current water resources and water use in the Union.

(B) Water Resources and Water Use in Europe

In general, water is relatively abundant with total freshwater resources across Europe of around 2.270 km^3/year (see Appendix Figure 2). Moreover, only 13 % of this resource is abstracted, suggesting that there is sufficient water available to meet demand. However, the resources are not uniformly distributed and problems of water scarcity arise in many regions, mainly in Southern Europe, due to an imbalance between abstraction and availability (see Figure 2) (EEA 2009).

Figure 2: Current water availability and changes expected by 2030

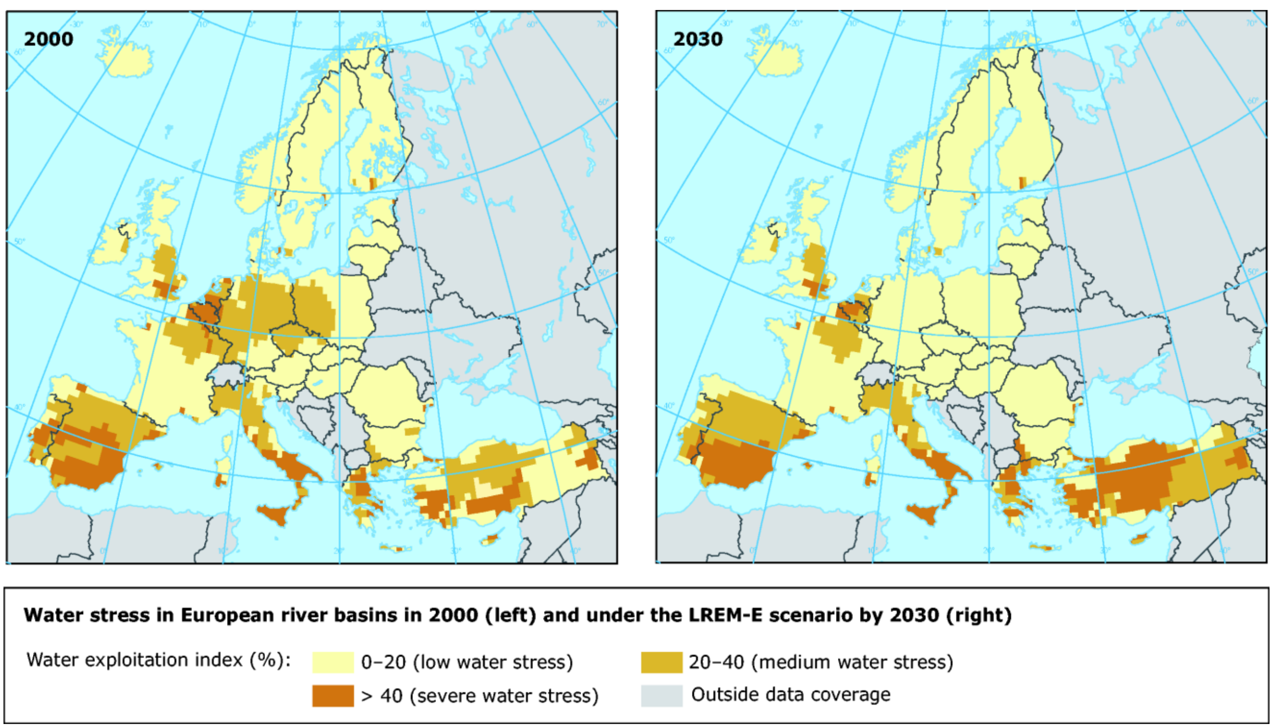


Source: Center for Environmental Systems Research (University of Kassel, Germany), 2003-2004. Dataset: WaterGAP model

Climate change is expected to reduce water availability and increase irrigation withdrawals in Mediterranean river basins. Under mid-range assumptions on temperature and precipitation changes, water availability is expected to decline in Southern and South-Eastern Europe (by 10 % or more in some river basins by 2030) (DG Environment - European Commission 2007). There will be pressure on both surface and underground water in the coastal areas in Southern Europe, where water demand is already high.

Water scarcity occurs where there are insufficient water resources to satisfy long-term average requirements and it refers to long-term water imbalances, where the water demand exceeds the supply capacity of the natural system (EEA 2010). Currently the main way of assessing water scarcity is by means of the Water Exploitation Index (WEI). The WEI is the average demand for freshwater divided by the long-term average freshwater resources. WEI is based on annual data and therefore cannot account for seasonal variations of water availability and abstraction. (Eurostat 2010)

Figure 3: Water Stress in the EU



Source: Center for Environmental Systems Research (University of Kassel, Germany), 2003-2004. Dataset: WaterGAP model

National estimates show that Cyprus (45 %) and Bulgaria (38 %) have the highest WEI scores in Europe, with high values also apparent for Italy and Spain. National estimates of this sort do not, however, reflect the extent and severity of water scarcity in sub-national regions. For example, while Spain's national WEI is approximately 34 %, the Southern river basins of Andalusia and Segura have extremely high WEIs of 164 % and 127 %, respectively. (EEA 2009)

In the EU as a whole, energy production accounts for 44 % of the total water abstraction, primarily serving as cooling water. 24 % of abstracted water is used in agriculture, 21 % for public water supply and 11 % for industrial purposes (EEA 2009). However, EU-wide figures for sectorial water use show strong regional differences (EEA 2009). In general the bulk of water abstraction for irrigation in Southern Europe is done by the agricultural sector, while in Northern Europe most of the abstracted water is used by the energy and the industrial sector.

Overview of the water resources availability and use in the three countries of interest:

Bulgaria: The long-term natural resources of fresh groundwater are estimated at 68.598 million m^3 (Eurostat 2010). Water resources are unevenly distributed in the Bulgarian territory, since there are areas very short of water alongside areas with relatively abundant of water resources. The abstraction of water in 2008 was 6.425 million m^3, or per capita per year 843 m^3. The main users of water are the industry and the domestic sector. The agricultural sector accounts for merely 15 % of the total water abstraction and 5.6 % of the actual water use (NSI 2010).

Italy: The long-term average fresh water resources are 296.000 million m^3 (Eurostat 2010). The availability of water is quite high, but its distribution along the Italian peninsula is very uneven: 65 % of the water is concentrated in the North of Italy, 15 % in the Center, 12 % in the South and 8 % on the big islands (OECD 2006). The abstraction of water in 1998 in Italy was 41.982 million m^3 (Eurostat 2010). Agriculture is the most important water-consuming sector accounting for 57 % of the total abstraction (Berbel, Calatrava and Garrido 2007).

Spain: The long-term average fresh water resources are 346.527 million m^3 (Eurostat 2010), however their geographical and seasonal distribution is non-uniform. The abstraction of water is 33.760 million m^3 in 2006, or 634 m^3 per inhabitant. Agriculture accounts for 68 % of the total abstraction of water (Berbel, Calatrava and Garrido 2007).

1.3 The Economic Importance of Water

(A) Water Foot Print and Virtual Water

The importance of the water resources for the economy is shown by the concept of water footprint. The water footprint of a country is defined as "*the volume of water needed for the production of goods and services consumed by the inhabitants of the country*". There are four important factors that explain the high water footprints: gross national income of a country, water-intensive consumption pattern, climate and water-inefficient agricultural practices (Chapagain and Hoekstra 2004). Appendix Figure 3 shows a world map with the average national footprint per capita, which highlights the significant economic importance of water. In addition, Appendix Table 1 shows the water footprint of the EU countries.

Closely linked to the water footprint concept is the virtual water concept. Virtual water is defined as the volume of water required to produce a commodity or service. The virtual water content of products strongly varies from place to place, depending upon the climate, technology adopted for farming and the corresponding yields. (Chapagain and Hoekstra 2004)

Chapagain and Hoekstra (2004) suggest that the reduction of water footprints can be achieved in various ways: A first way is to break the seemingly obvious link between economic growth and increased water use, for instance by adopting production techniques that require less water per unit of product. A second way of reducing water footprints is to shift to consumptions patterns that require less water, e.g. by reducing meat consumption. A third method is to shift production from areas with low water-productivity to areas with high water productivity, thus increasing global water use efficiency. However, the current pattern of world trade does not seem to be influenced by the virtual use of water, so this solution is hardly feasible without global political will and effort (Fraiture, et al. 2004).

(B) Irrigation Agriculture and Food Supply

Worldwide irrigation water consumes over 70% of the available renewable fresh water resources (Gemma and Tsur 2007) and the amount of abstracted water has been steadily increasing in the last several decades (see Appendix Figure 4). The importance of irrigation agriculture for the world food supply is significant (Crossan, Cummings and Frederick 1978). While it is practiced on only about 18 % of total cultivable land, it produces over 40 % of agricultural output. Therefore it is expected that the irrigated area will continue expanding to meet the food demand of a growing population. However, fresh water resources available for irrigation will at best remain fixed and most likely decline (Gemma and Tsur 2007). The extensive expansion of the irrigated areas might not bring the desired increase in food supply, because even today between 15 % and 35 % of the global irrigation withdrawals exceed supply rates and are therefore unsustainable (see Appendix Figure 5) (World Resources Institute 2005).

(C) Agriculture in EU

Agriculture, hunting, forestry and fishery accounted for just 1.8 % of the GDP in the EU-27 in 2008; however these industries are essential for the food supply and the health of the population. The agricultural industry of the EU-27 generated € 141 billion of gross value added at producer prices in 2008. The total farm labor force in the EU-27 was the equivalent of 11.7 million fulltime workers. (Eurostat 2010)

In 2007, agricultural output in the EU-27 was worth € 360 billion, measured in basic prices. 57.5 % of the value comes from crop products and 42.5 % from animal products (Olsen 2010). In around one quarter of all Europe the value of crop production exceeds 70 % of the total agricultural goods output. These regions are mainly found in Southern Europe. Moreover, most of the agricultural value created in Southern Europe comes from water-intensive and irrigation-dependent crops like vegetables and fruits, because the climatic conditions favor this production. Of the 35 regions with a share higher than 40 %, eight are in Italy. Other important regions are found in Greece and in Portugal. In Spain the vegetable and fruit production accounts for 36 % of the overall agricultural production in the country. (Olsen 2010)

1.4 Irrigation in the EU

(A) Irrigation Infrastructure

Agricultural water use across Europe has increased over the last decades. One of the main drivers of irrigation use is increased productivity. In Italy and Spain, for example, irrigated agriculture contributes more than 50 % to total agricultural production and more than 60 % to the total value of agricultural products (OECD 2006). The area irrigated, however, encompasses only 21 % and 14 % of total agricultural land in Italy and Spain respectively. (EEA 2009) Historically, another major drive for the use of irrigation is the subsidies to farmers that will be discussed in the analysis.

The southern EU Member States have the greatest absolute area equipped for irrigation (in 2005), with Italy (3.97 million hectares), Spain (3.77 million hectares), France (2.71 million hectares), Greece (1.59 million hectares), Romania (0.81 million hectares) and Portugal (0.62 million hectares) being the six largest. Combined, these six countries contribute to almost 84 % of the total irrigated area across the EU-27. The intensity is highest in Northern Italy, Spain and certain areas in Greece, Romania and Turkey (EEA 2009). Appendix Table 2 highlights the relative importance of irrigation in the EU countries.

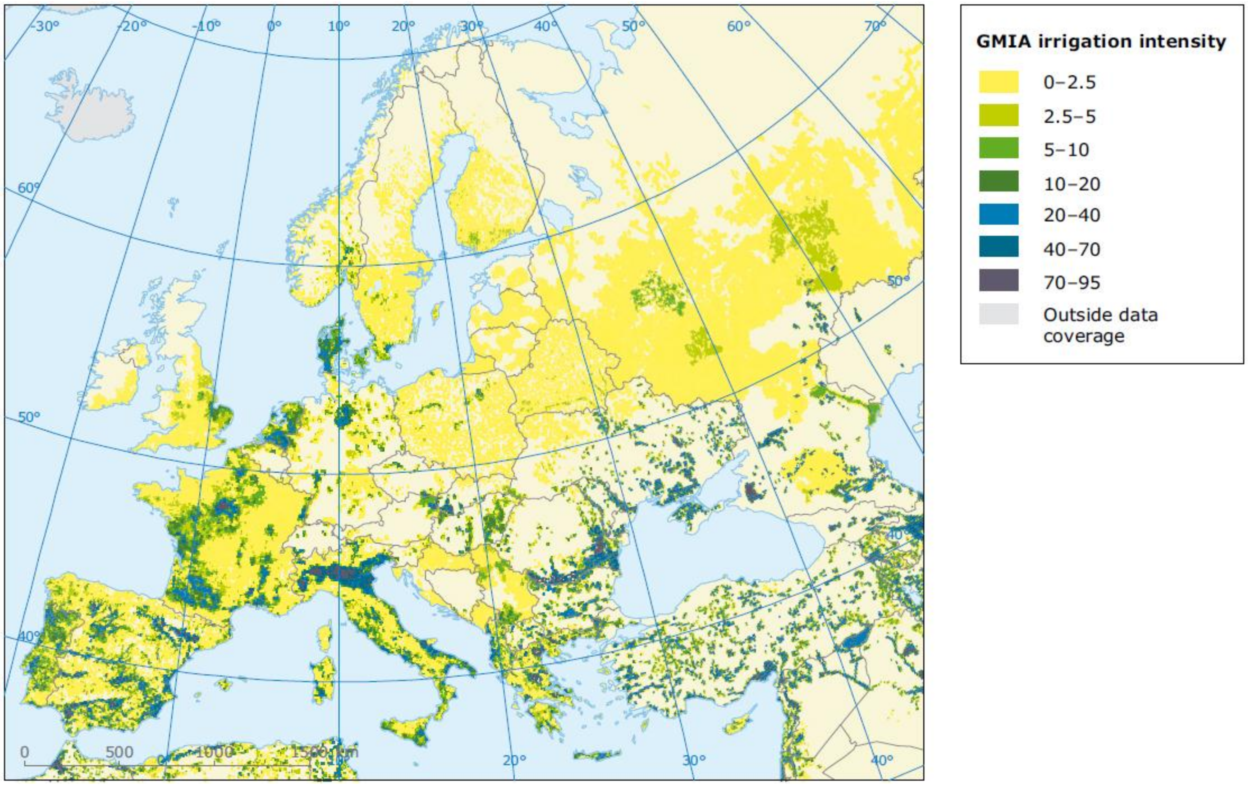
The area equipped for irrigation has been growing since the 1990s in most Southern-European countries, especially in Spain, Italy and Greece. At the same time there were very dramatic declines in Bulgaria and Romania (Siebert, et al. 2007) due to the political, economic and institutional changes of 1989-90, and the subsequent poorly managed and executed reforms (Öko Inc. Budapest 2001). The public capital grants were the main source of financing for the construction of the irrigation infrastructure across OEDC countries (Berbel, Calatrava and Garrido 2007).

Bulgaria: The restructuring of the irrigation sector makes it difficult to estimate the area equipped for irrigation, because the equipment at the former pumping stations is missing almost everywhere and significant part of the canals is destroyed (Chehlarova-Simeonova, et al. 2006). Thus it depends on the definitions used whether areas are still classified as equipped for irrigation or not and one can find different numbers for the extent of irrigated areas in the statistics. The official statistics claim that the area equipped for irrigation was 1.288.000 ha in 1990 (FAO 1991) but declined later 545.160 ha in 2003 (Ministry of Agriculture and Foresty 2004). Even stronger was the decline in the area actually used for irrigation. While in 1985 about 1.014.000 ha of cultivated land was irrigated the area actually irrigated declined to about 40.000 ha nowadays (Chehlarova-Simeonova, et al. 2006).

Italy: The irrigated surface has grown from 18 % of the total agricultural area in 1995 to 25 % in 2000 (Bazzani, et al. 2004). The share of irrigation is different among regions - 63.5% of the cultivated area in northern Italy is irrigated, 7.4 % in central Italy and 29.1 % in southern Italy (Istat 2010). For some crops (vegetables, fruits and flowers) the irrigated area is virtually 100 % (Bazzani, DI Pasquale and Gallerani 2002).

Spain: The area equipped for irrigation was 2.540.310 ha in 1990, and increased to 3.828.110 ha in 2003. A similar trend was observed for the area actually irrigated that was reported at 2.433.700 ha in 1990 and 3 437.370 ha in 2003 (Instituto Nacional de Estadística 2002).

Figure 4: Irrigation intensity across Europe, by percentage of area equipped for irrigation



Source: Siebert et al. (2007)

The Eurostat's Farm Structure Survey (2003), has reported the area covered by specific irrigation methods: surface irrigation, sprinkler irrigation, drip irrigation and mixed methods that vary in efficiency (for indicative values see Appendix Table 3). In some cases the farmers use several methods, thus the sum of the percentage presented in the following is above 100% (for detailed information see Appendix Table 4).

Surface irrigation is the most common type of irrigation used throughout the EU. The percentage is as high as 94 % in Bulgaria, 83 % for Portugal, 59 % in Greece, 55 % in Spain and 42 % in Italy. Among the countries with substantial areas of irrigation France has the lowest percent – only 12 %.

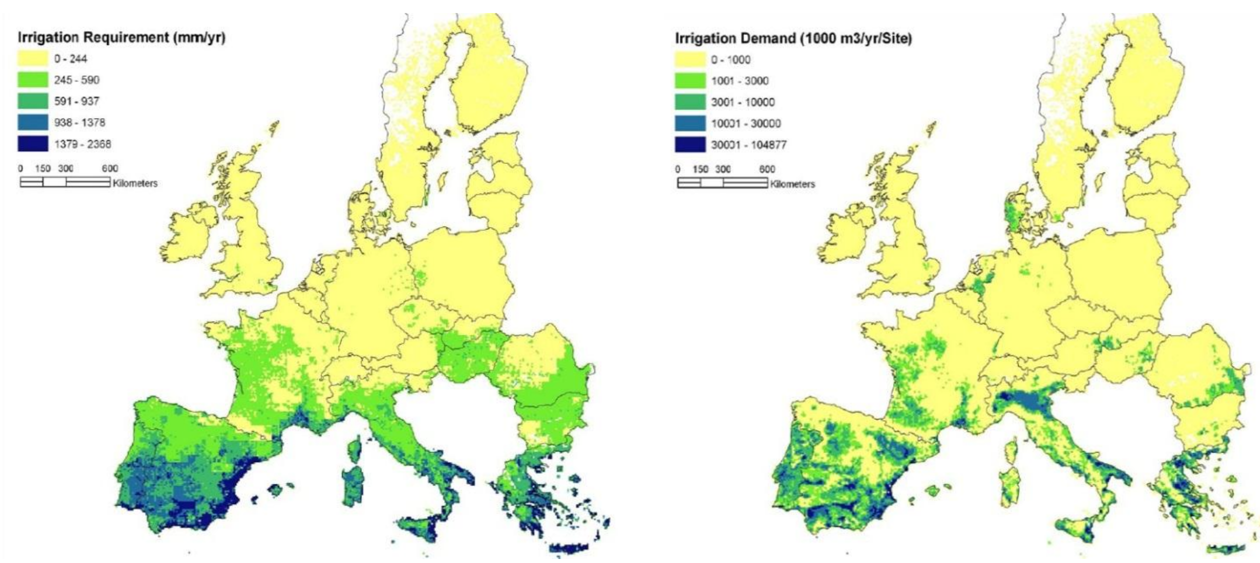
The sprinkler irrigation is the second most common type. It is the dominating type of irrigation in Northern Europe. In southern Europe it is less common – Italy has 40 %, Spain 12 %, Greece 31 % and Bulgaria just 5 %. The notable exception is France, where this type of irrigation accounts to 80 % of the total methods used.

The drop irrigation is the dominating type in some southern island countries that have severe water problems, like Cypress and Malta. In Greece it is 32 %, Spain 32 %, Italy 24 %, France 19 % and Bulgaria just 1 %. There seems to be a correlation between the type of irrigation, economic development and the water scarcity problem. Surface irrigation is common in the less developed countries and the ones in the South. Sprinkle irrigation seems to be common in countries where the water efficiency use has become a bigger concern. Drop irrigation, on the other hand is common in areas which have severe water problems, and thus have to invest in the most efficient type of infrastructure.

(B) Irrigation Water Use and Efficiency

Water use: Since there are huge statistical gaps in our knowledge on actual water used by irrigation (EEA 2009), Wriedt, Van der Velde, Aloe, & Bouraoui (2008) have developed a modeling approach to estimate irrigation water requirements (IWR), and regional irrigation water demands in the EU. The IWR is *"the amount of water that has to be applied in addition to rainfall to serve crop water requirements"*. It is results from the interplay of climate, soil properties and crop composition at each site. The irrigation water demand is *"the volume of water required in a certain region to satisfy irrigation requirements"*. It is calculated by multiplying IWR with irrigated area.

Figure 5: Average irrigation requirement and demand per site (10km^2 cell) in the EU and Switzerland



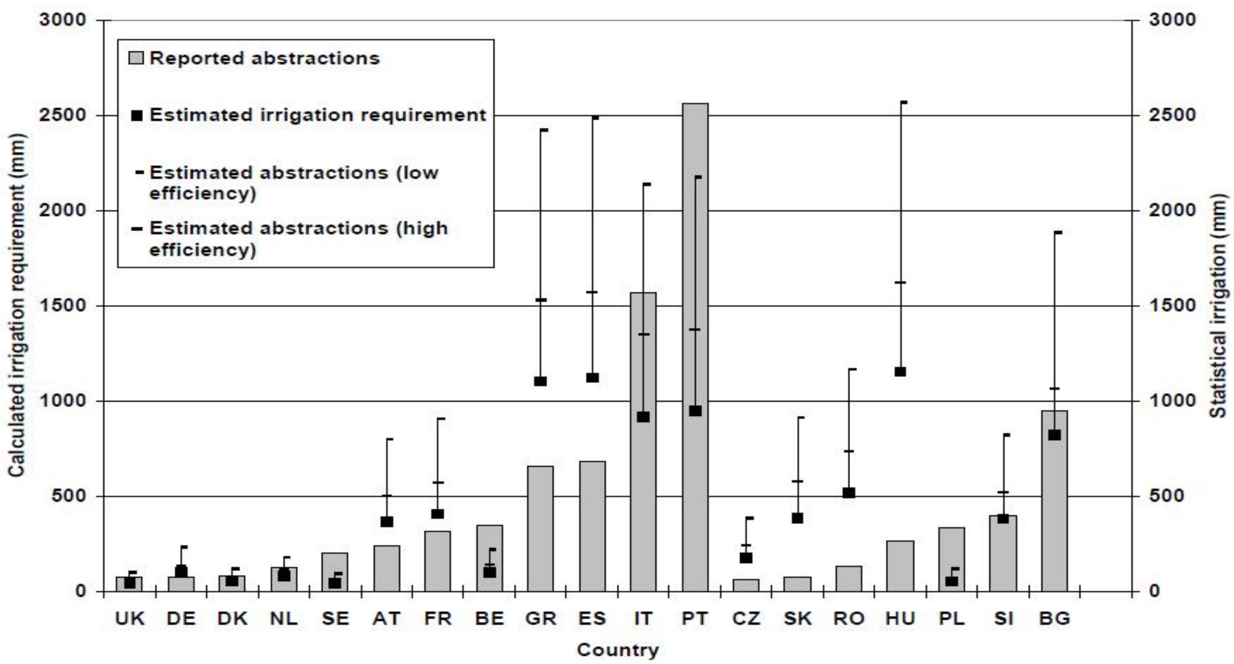
Source: Wriedt et al. (2008)

The findings reflect the importance of irrigated agriculture especially in southern Europe and illustrate the approximate volume of irrigation water demand within a defined spatial unit (a 10 km x 10 km cell).

Actual abstraction rates will be higher than the demand indicated in Figure 6 due to inefficiency (losses) in the systems supplying crops with water (EEA 2009). The additional water abstraction results from the need to compensate for losses during transport, the need to apply water in excess to prevent salinization and the water use efficiency of the irrigation method. Statistical information on irrigation refers to water abstractions for irrigation or agriculture rather than irrigation water use at field level. (Wriedt, et al. 2008)

Irrigation efficiency (water use efficiency) expresses the ratio of irrigation water used efficiently by plants to the amount of water supplied or abstracted. Irrigation efficiency is composed of conveyance efficiency and field application efficiency. Field application efficiency mainly depends on the irrigation method and the level of farmer discipline. Conveyance efficiency mainly depends on the length of the canals, the soil type or permeability of the canal banks and the condition of the canals (for indicative values see Appendix Table 5).

Figure 6: Comparison of reported national water abstractions for irrigation with calculated irrigation requirements and resulting abstractions assuming low and high efficiency of irrigation practices



Source: Wriedt et al. (2008)

Improved irrigated agriculture efficiency could be achieved by reducing conveyance losses, improved application efficiency, changes in irrigation practices, change of crop types and reuse of treated sewage. According to a recent study on EU water saving potential, the saving potential of irrigated agriculture is about 43 % (Ecologic 2007). However, various studies indicate that irrigation management and maintenance of irrigation systems are key factors determining actual water use, counterbalancing potential water savings of irrigation technology.

(2) Theoretical Background

The managerial approaches to water management have been changing over the time in correspondence to the economic and social development of the societies. According to Allan (2000), five water management paradigms could be historically identified:

The **first paradigm** is associated with *pre-modern communities* with limited technical or organizational capacity.

The **second paradigm** is that of *industrial modernity*. The paradigm dominated at the time of the industrial revolution. The development of technology and science led to the basic assumption that the nature could be controlled for the benefit of the one controlling it. In the water sector the ideas of Enlightenment, engineering capacity, science and investment initiatives of the state and the private sector characterized the period of this paradigm.

The **third paradigm** is tightly connected to the environmental awareness created by the green movement since the 1960s. In its essence this paradigm is reflexive to the second one and it puts an emphasis on the fact that water is essential for the balance of the ecosystems.

The **fourth paradigm** was inspired by economists who began to draw the attention of water users to the *economic value of water* and its importance as a scarce economic input. These ideas gained support in the early 1990s. Privatization, regulation and competition have been advocated as cornerstones in this paradigm by some major international institutions such as the World Bank (Kessides 2005).

Some of the rationale of private participation in infrastructure and restructuring has been driven by the seemingly high costs and poor performance of state-owned network utilities. Under state ownership, services were usually underpriced, and countries often could not afford the substantial investments, which led to poor quality and scope of the service and was a barrier to economic growth. (Kessides 2005)

The **fifth paradigm** is based on the notion that water allocation and management are political processes. Environmental fundamentals such as the hydrological logic of the river basin and economic fundamentals relating to the value of water are central to the concept of *integrated water resource management - IWRM*. But IWRM demands much more than the mere recognition of the environmental and economic value of water and planning, engineering and economic interventions. IWRM is an intensely political process because water users have interests and they do not want them to be diminished by such interventions. This paradigm argues that prioritizing water allocation with an eye on the economy and prioritizing investment to reduce environmental impacts will conflict with the interests of current water using practices. The fifth paradigm is emphasizing participation, consultation and inclusive political institutions to enable the mediation of the conflicting interests of water users and the agencies which manage water (Allan 2000). The fifth paradigm also states that the investments in irrigation must become more strategic. Irrigation has to be seen in the context of other development investments, taking into consideration the big picture and including social, cultural, economic, and environmental aspects. Also to be considered is the full spectrum of irrigation options—from large-scale systems providing water for all or most of a crop's needs to small-scale technologies supplying water to bridge dry spells in rain-fed areas. (Colombo 2007)

Summing up the chronological development of the paradigms, it can be stated that the second paradigm has lost its influence in the developed countries, because the major water infrastructure projects like dams, canals, dikes have been completed by the 1970s. It is still, however, the leading paradigm in the developing countries (Allan 2000). The last three paradigms currently co-exist in the developed countries. According to Colombo (2007) the different paradigms co-exist, because the different people place different values on water use. He identified as a major reason for the diverging views the divergent understanding of some basic premises: *"How much water is used in agriculture? How much irrigation is there? What is the contribution of groundwater? And what is the present use and future potential of rain-fed agriculture?"*

In contrast to the previously mentioned theories and paradigms, Biswas (2004) takes a different stance: He examines the broader issue of the implementation of a sustainable development concept, and its potential application to make water management more efficient and equitable than at present. He raises questions about whether *"a single paradigm of sustainable water resource management can encompass all countries of a very heterogeneous world, with very different cultures, social norms,* *climatic conditions, physical attributes, management and technical capacities, institutional and legal frameworks, and systems of governance."*

Biswas (2004) has made a good point in stressing that there is indeed great diversity among the different countries and one and the same approach might not work everywhere with the same efficiency. However, as Lenton and Muller (2009) have found from studying different cases from around the globe, there are certain similarities and patterns of implementation problems that pops-up everywhere rather consistently.

(3) Barriers to Efficient Water Management

In the following, we focus on the barriers to efficient water management, taking in account some of the main points of the fourth and the fifth paradigms, which are among the leading ones in the developed countries. The literature recognizes many different barriers, which we assemble in two major barriers: The first one is formed by the institutions that have a leading role in the governance of the sector. The second barrier is constituted by the effects that some specific rules and regulations, such as pricing and water use rights, have on water management.

3.1 The Role of Institutions

There have been many studies on the role of institutions in water management. We interpret and define institutions in our thesis as governmental bodies that are directly involved in (agricultural) water management or related issues. One of the most recent and comprehensive studies is done by Blomquist, Schlager, and Heikkila (2004). In order to discover how institutional issues form barriers to effective management and how innovation can produce solutions, the authors have focused on conjunctive water management, which *"involves the coordinated use of surface water supplies and storage with groundwater supplies and storage"*. Conjunctive management, due to its inherent qualities and its relative advantages compared with other water supply alternatives, has been one of the more popular recommendations for improving the water resource situation. Therefore one could conclude that conjunctive management should be widely adopted and used. However, through a comparative analysis between three US states in the South-West, the authors found that this is not the case. In fact, the discovered differences between the states are significant. Also Pujol, Raggi, & Viaggi (2006) call for a more in-depth analysis of the connections between market performances and institutional settings, as related to the issue of water-agriculture policy design and coordination. They also sustain that existing experiences around the world show that water markets are more acceptable in a mature legal system, with well-defined property rights on water use, and in communities with a high degree of trust. In the following, major obstacles and key capabilities involving institutions are discussed:

Coordination: What explains then why some communities choose to implement more progressive water management programs, while others have not? In the case of conjunctive water management, the technical aspects are quite straightforward, so they are not a barrier for the implementation. Therefore, the authors have concluded and argue that coordination between the principal institutions that govern water resources and their clients is the key to the production of effective management solutions for water scarcity problems.

Colombo (2007) also identifies the lack of coordination as a reason for the failure of reforms. Focusing on formal irrigation or water management policies and organizations, most reforms have ignored the many other factors that affect water use in agriculture—policies and government agencies in other sectors, informal user institutions, and the macroeconomic environment and broader social institutions. As Biswas (2004) notes, it is unrealistic to assume that one single organization in the water sector could dictate rules and policies to all sectors that are important for the water use, such as land use, agriculture and energy. Therefore coordination between the policies in the different sectors is essential.

Moreover, political or social problems are among the main reasons for the failure of otherwise beneficial and good initiatives within the water sector (McKinsey & Company 2009) that could be overcome through increased and better managed cooperation. Colombo (2007) labels the state as the primary, although not the only, driver for reform in the water sector - capacity building, information sharing, and public debate are essential. Lenton and Muller (2009) suggest that managing water effectively requires the sustained collective effort and engagement of people in all sectors of society if it is to be successful in achieving the society's goals. "*However, successful outcomes are not necessarily those where there is general consensus or everyone's needs are met."* A pragmatic, sensibly sequenced institutional approach that responds to contextual realities has the greatest chance of working in practice.

Trust: In order one institution to be able to coordinate the efforts of the different stakeholders in the sector, above all it has to be trusted. Lenton and Muller (2009) for example see in robust, competent and trusted institutions a prerequisite for better water management. The pluralism and social embeddedness of institutions affect water development, management, and use and can constitute barriers or otherwise facilitate effective management.

Active management: The active management and participation of the institutions in the governance of the water sector is essential for its efficiency. Bromley (1986), as well as Lenton and Muller (2009), suggest that it can be distinguished between projects that are *managed* as opposed to those that are merely *administered*. Mere administration cannot be defined as management. Bromley (1986) reasons that the "*myth of management persists in bloated bureaucracies, where status accrues to those who build rather than those who operate and manage*". The water sector offers different models of governance, because it is a complex domain to govern and manage, resistant to the simplistic administrative divisions that serve in other areas of human activity. Colombo (2007) also identifies in institutions a major reason for failure of efficient water management; because they do not take in account the history, culture, environment and self-interests that shape the scope for institutional change. Their solutions are often based on "blueprint" solutions that follow a model that may have been successful elsewhere, but are not really applicable in the local conditions.

Strategic Planning: Traditionally the governments of the individual countries have been responsible for the planning, development, withdrawal, uses and disposal of waters. Irrigation of farms by means of water drawn through dams, canals and wells or drainage of waterlogged lands grew with active involvement of institutions and legal procedures set up on drainage by the governments. Water disputes were heard by government or institution functionaries and resolved as per law of the land (Water For Food 2009). Thus the institutions occupy a leading role in the planning in the water sector.

Clear Objectives: The lack of a clear set of objectives is a common problem in ineffective urban water management organizations. Uncertain or changing stakeholder demands and priorities are a common problem. On the contrary, institutions with very well-specified tasks typically reported few problems (Holmes 2000).

An example of bad water resource management comes from China: China's water resource management system reflects the country's approach of having policies and laws set centrally, but administered locally. The associated management arrangements are costly due to their complexity, the need for a high level of consistency and the involvement of multiple government agencies, each with their own priorities. (Cosier and Dajun 2009)

Differences in effectiveness of water management are attributable according to Lenton and Muller (2009) to different support of a sound policy framework at regional and national levels. They suggest that a basin perspective must be supplemented by overarching national policies if water management is to be effective. In following this macroeconomic approach, the authors suggest that water resource planning and management must be linked to a county's overall sustainable development strategy and incorporated in a public administration framework.

Clear responsibilities: Cosier & Dajun (2009) contend that the lack of clear responsibilities of the different institutions is a major problem in the water sector, because they create either tension or lack of initiative. Moreover, as Kessides (2005) claims, the state is quite often directly involved in water management, not just by setting regulations, but also by being the main owner and distributor in the system. It is most common in the water sector to find vertically integrated (state) monopolists responsible for supply, distribution and retail services. Consequently, most initiatives in the water sector demand initiation by governments.

Financing the Water Sector: The state of the infrastructure in the water sector determines to a great extent the degree of efficiency (Kessides 2005). Irrigation technology, land management, operation and maintenance, drainage systems, systems of monitoring etc. are all essential for efficient water management system (Water For Food 2009). The need for a higher level of funding for the irrigation, drainage and flood protection sector is apparent (Water For Food 2009). One global estimate calls for enhancement of present level of funding for irrigation by at least 40 %, not only for new infrastructure but also for replacement, modernization of ageing systems and imparting sustainability to them (Water For Food 2009). However, getting financing is among the main challenges that the sector is facing (McKinsey & Company 2009).

It is unrealistic to expect that such financing will come from state and local government budgets, which are lean even in good economic times and are devoted to other high-priority governmental services and commitments. Securing financing from the private sector and the water users in many cases is the only sustainable solution (Blomquist, Schlager and Heikkila 2004).

3.2 Rules and Regulations

Blomquist, Schlager, & Heikkila (2004) recongnize the crucial role of the institutions when setting the rules in the sector. Also Pujol, Raggi, & Viaggi, (2006) suggest that water markets are working better in mature legal system, with well-defined property rights on water use, and in communities with a high degree of trust. This is important, because the fact that the sale of water rights may be associated with a fear of losing those rights. In addition, water exchanges need to be supported by trustworthy contract enforcement systems. The details about (initial) distribution of property rights and the bargaining mechanism adopted may also strongly affect the outcome of water markets. The willingness to participate in a market may vary according to the length of the right being exchanged. For example, one-time, seasonal or annual exchanges may be viewed as a temporary transfer without major implications. Pricing, water usage right, distribution and regulation in general are the most important elements of good water management. In this section we will focus on pricing and water usage rights.

Pricing: Pricing regulations are crucial for efficiency in the water sector. A research done by Pitafi and Roumasset (2009) on the benefits of possible new pricing mechanism in Honolulu confirms the importance of pricing regulations, by demonstrating that significant improvements in water use efficiency could be achieved through rather bureaucratic, reforms as a new pricing mechanism.

Kessides (2005) underpins the importance of efficient pricing policies as well. However, those policies usually are quite controversial, because of the conflicting objectives of such policies and because of the severe problems in measuring elasticity of demand. That is how price changes affect the amount of water consumed by different groups of customers and their decisions to connect or remain connected to the water system.

Table 1: Objectives of Water Tariff Design

Objective	**Description**
Cost recovery	Tariffs must be consistent with revenue adequacy - that is, they should generate revenue that covers the financial cost of water supply.
Economic efficiency	Prices should provide signals for efficient actions by consumers, suppliers, and investors. In particular, prices should indicate to consumers the financial and environmental costs that their consumption decisions impose on the economy.
Equity	Consumers with similar characteristics should be treated similarly.
Affordability	Given its importance for well-being, water should be provided at minimal cost to poor people, through well-targeted subsidies if needed.

Source: Whittington, Boland and Foster (2002)

An interesting question regarding the measures in water pricing sought by the EU is the efficiency and efficacy. As suspected by Rieu (2006), when the water bill accounts for only a small proportion of farmer's total production costs or income; or also when alternative crops or irrigation practices are not available due to technical, social or economic constraints; or when the bulk of the total water charge consists of fixed costs, influences the mentioned efficiency and efficacy goals.

The charges for irrigation in the EU countries, as in most other countries, have been inadequate to recover capital and operating costs (Whittington, Boland and Foster 2002). The impact of EU's regulation on the European countries is examined more in detail in the analysis section.

Water rights: Kessides (2005) explains that one of the reasons for the lack of private investment in water sector is the lack of clear water use rights. Roberson (2008) confirms this statement and gives an example with the dilemma that farmers have when deciding whether to add irrigation to their operations or not. The irrigation equipment and the corresponding operation are expensive, and on the other hand there is no certainty that water will be legally available to the grower. The World Bank (2003) argues as well that a credible regulation with concrete water rights is essential for managing effectively water within agriculture. Anderson (1983) states that the key to market allocation is a well-defined, enforceable system of transferable property rights. Water rights specify how water will be divided between industrial, domestic, and agricultural consumption sectors and also within the sectors, such as among individual farmers (Thobani 1997).

Trade and water markets: The transfer of water from one region to another is of essential importance in many countries (Manuel 2003), especially in Bulgaria, Italy and Spain, where some areas have abundant water resources whereas others not. Thus the transfer, but in addition also working, standardized water markets are crucial to facilitate efficient water management (World Bank 2004). Trade is an important part that secures efficiency at the institutional level.

As Pujol, Raggi, & Viaggi (2006) confirm, water markets could potentially improve the economic efficiency of water use, in terms of higher profit per hectare, given limited water availability. The potential improvements are associated with a more intense specialization of farms that are strongly differentiated among farmers. We identify water markets as the competitive ones.

III. Research Methodology

(1) Research Question

The goal of our research program that we have designed is to answer our research questions:

To what extent do the identified institutional barriers hinder efficient water management in the agricultural irrigation sector in Bulgaria, Italy and Spain? Why do the identified institutional barriers differ in Bulgaria, Italy and Spain?

(2) Theoretical Framework

Our research question has two major parts. The first one is descriptive – we describe and analyze the barriers that we identified in the literature review in the selected countries. The second part is in essence theory testing. We want to assess the validity of the theoretical framework we have created using the research theory done in the field. The dissertation is based on qualitative research. The epistemological view that we follow is the Functionalist Paradigm, more in specific one of Functionalist Sociology that seeks Objectivism (Burrell and Morgan 1979). Thus we pursue the ontological position that implies that the social phenomena that confront us as external facts are beyond our reach or influence (Bryman and Bell 2007).

Following the mentioned logical positivist approach (Alevesson and Skölberg 2009), we consider the systematization of data as central. Thus, to address the first question we basically follow a benchmarking approach. Benchmarking is a valuable tool that has been found to be of considerable use in enhancing performance in both public and private sector organizations, also in the irrigation and drainage sector. Benchmarking in the public sector in general and the irrigation sector in particular is a more complex task than in many other sectors. Irrigation and drainage is always subject to site-specific characteristics, and key to the success of benchmarking is the identification of the main drivers that apply in each situation (Water For Food 2009). Due to this critical importance of benchmarking in water management and more specifically in irrigation and drainage projects, we seek to define a new framework that incorporates leading water management theories. Following Bromley's approach (Bromley, Irrigation Water Management 1986), we realize that for efficient benchmarking it is important to (1) study the pattern of water allocation and use; (2) examine the impact of water availability on cropping patterns, input use, and crop yield; (3) identify the organization and management weaknesses; and (4) suggest measures to improve the performance of water distribution.

In the introduction we already made an overview of the water allocations, use and productivity. The main point of our thesis is point number (3). In the literature review we have suggested some theoretical models that deal with the institutional barriers to more efficient water management. Based upon them, we have built a framework that seeks to capture the whole complexity of the sector by taking a managerial, organizational and institutional stance. The categories and our motivation for choosing them are described in detail in Table 2. Building a conceptual framework is advantageous, because it forces the research to proceed carefully and selectively about the constructs and variables to be included in the study (Voss, Tsikriktsis and Frohlich 2002). Also Eisenhardt (1989) argues that an a priori specification of constructs is valuable because *"it permits researchers to measure constructs more accurately"*.

Table 2: Framework for Analysis

	Benchmarking category	Description / Objects of investigation	Source
(A) The Role of Institutions			
What is the control imposed by the involved institutions and the overall setting they define?			
(1)	**Coordination**	What is the coordination between the principal institutions and their clients? The coordination between the institutions and the customers?	Blomquist, Schlager and Heikkila (2004); Colombo (2007); Biwas (2004); EEA (2009); (McKinsey & Company 2009); (EEA 2009)
(2)	**Trust**	Do the stakeholders in the water sector trust the institution?	Lenton and Muller (2009)
(3)	**Active Management**	Do the institutions actively manage or just administrate?	Lenton and Muller (2009); Colombo (2007)
(4)	**Strategic Planning**	Do the institutions have strategic plans for the sector?	Water For Food (2009)
(5)	**Clear Objectives**	Do the institutions have clear objectives?	Holmes (2000); Lenton and Muller (2009); Cosier and Dajun (2009)
(6)	**Clear Responsibilities**	Are the responsibilities of the stakeholders clear?	Cosier and Dajun (2009); (Kessides 2005)
(7)	**Financing**	How is the financing of infrastructure projects done? Who is financing it?	McKinsey & Company (2009); Water For Food (2009); Blomquist, Schlager and Heikkila (2004); Kessides (2005)
(B) Rules and Regulation			
What are the rules and regulations - in terms of water rights and pricing and metering? Is there market for water and how is it traded?			
(8)	**Water Rights (Ownership Rights)**	Are there existing water rights or ownership rights? What kind of water rights are these?	World Bank (2003); Kessides (2005); Blomquist, Schlager and Heikkila (2004); (Roberson 2008)
(9)	**Pricing and Metering**	Pricing regulations are crucial for efficiency in the water sector. Since water pricing is dependent on metering, both areas are validated.	
	Metering	How is water consumption measured? Is there even a measurement of water consumption in agriculture?	World Bank (2003); Pujol, Raggi and Viaggi (2006)
	Pricing	How is water consumption prized? How does the price influence irrigation efficiency in agriculture?	World Bank (2003); Pitafi and Roumasset (2009); Blomquist, Schlager and Heikkila (2004); (Kessides 2005); (Whittington, Boland and Foster 2002)
(10)	**Trade and Water Markets**	How is water traded? Is there an existing and well-functioning water market? How does trade within the water markets impact on the efficiency of water management in the target countries?	World Bank (2003)

(3) Investigation Methodology

Our findings derive from a variety of secondary sources. We have selected those sources that fulfill the following quality requirements identified by Scott (1990):

- Authenticity: Is the evidence genuine and of unquestionable origin?
- Credibility: Is the evidence free from error and distortion?
- Representativeness: Is the evidence typical of its kind, and if not, is the extent of its untypical known?
- Meaning: Is the evidence clear and comprehensive?

Additionally, we assessed the relevant literature with each other and asked what is similar, what is different and why (Eisenhardt 1989). In this way we have tried to *"validate"* our findings by using several sources, therefore minimizing the possible errors. We argue that the research program best suited for our particular research question is one based on secondary sources. The main reason is the aim of our research to be as objective and unbiased as possible.

There are several other reasons for focusing only on secondary sources: Firstly, there is already a vast amount of information available, both from a macro and micro-economical perspective. For example, Eurostat has been an important source for us. Eurostat publishes every two years the results of a study called "Farm Structure Survey" that is based on primary research. In addition, a more comprehensive "Farm structure survey", is carried out by Member States every 10 years. Secondly, the scope of our analysis takes the perspective from an institutional viewpoint. The available research done has not been interpreted from this viewpoint, but nevertheless there is little need to conduct primary research. Thirdly, due to the strategic importance of agriculture for the EU (connected with huge amount of agricultural subsidies), alone this secondary source offers much information that has not been studied from an institutional perspective. Last but not least, another implicit reason was the goal of our work to keep it as neutral as possible, thereby avoiding biased contacts with global agribusinesses.

The case study approach did not seem appropriate as well, because it can result in narrow and idiosyncratic theories and thus it may be difficult to raise the level of generality of the theory (Eisenhardt 1989). What we aim for is stronger validity, wider generalizability and a higher conceptual level (Voss, Tsikriktsis and Frohlich 2002).

In this section we aim to outline how are we going to access the categories presented in the framework. It is important to mention that in the analysis different weight and emphasizes is allocated to the different categories, based on the relative importance they occupy in each country.

3.1 Method for Investigating (A) "The Role of Institutions"

Coordination*, *trust and ***active management*** are naturally difficult to assess, since they are subject to personal opinion and thus the evaluation could vary considerably among the various stakeholders. The aim of our research is to get insights in the public opinion or the opinion of the stakeholders involved in water management. The research will give us qualitative data which we will interpret using the theories discussed before. As a rule of thumb more *Cooperation*, higher *Trust* and more *Active Management* are desirable.

We have decided to use secondary sources, prepared by the EU and national institutions or by other independent parties. However, we will also use anecdote data provided by the mass-media – newspapers, magazines, television and radio. Although this data could be biased, it is good enough for the discussed subjective criteria.

Strategic planning, clear objectives, clear responsibilities are criteria that are document-based and as such are easy to assess. What we are interested is whether the institutions have developed plans for the water sector, whether they have set clear objectives and whether the responsibility among the institutions in the water sector is clear. We are not going to assess whether the planning, objectives and the responsibilities assigned are good or bad. All we care is whether they exist or not and whether the planning, the objectives and the responsibilities are also *implemented* and *used* in practice, since this is even more important than the fact that they are stated in some official document. The reason for that is that the theories that we have outlined before are concerned mainly with the fact whether those elements exist as part of the institutional policy or not. Because the best water management solutions are location-specific, the researchers usually do not pay so much attention to what exactly those elements are.

In order to find information we will use official documents issued by the corresponding institutions in the sector. In order to access the actual implementation we will use other secondary data concerned with the topic.

For the ***financing*** we examine the current pattern of financing of the infrastructure projects in the irrigation system and the source of the investments. In our assessment the private investments are prized higher than the public ones, because it is triggered by real economic interest and is more sustainable than the public financing. We assess secondary data from various sources – both research and reports about the sector.

3.2 Method for Investigating (B) “Rules and Regulation”

Water rights, pricing and ***water trading*** are part of the regulatory framework, and as such information on them can be found in the official documents issued by the regulatory institutions. Beside the official documents, we will rely on data from other secondary sources that are concerned with the functionality and the efficiency of the three criteria. The existence of functional *water markets* and *water trade* is a sign of well-functioning water sector.

Water Rights have positive influence on the efficiency of water use when they are clear, and when they assure that the water is legally available to the customers. Unclear or disputable water rights decrease or eliminate the interests of the owner in investing in better infrastructure and solutions.

The researchers agree that the ***pricing*** regulation is crucial for the efficiency in the market. Good pricing has to balance between the four main goals of pricing: cost recovery, economic efficiency, equity and affordability. The best possible outcome is pricing that ensures sustainability of the economy, the society and the nature and at the same time ensures high efficiency of the water use.

Metering needs to fulfill several criteria. The first one is to provide reliable data that ensures that the amount of water abstracted and used is correct. The second one is that it needs to be legally recognized by the institutions and the private sector. However, researching and assessing this barrier is very hard, because, as Arregui et al (2006) point out, there “*the absence of specific literature about water meters is quite striking, both from a technical and from a managerial point of view*”.

IV. Analysis

(1) Europe

1.1 General Regulatory Objectives

The current water management practices in the EU have been influenced to a considerable extent by several European directives that are progressively being adopted by the Member States. Therefore, we find added value in discussing their general influence over the water management in the agriculture.

The major goal of the EU in the agricultural water sector is to achieve "*sustainable use of water*". The EU policymakers see the traditional supply-oriented approaches as unsustainable, because they simply exacerbate the adverse impacts of water use. Therefore they have proposed a number of demand-side measures together with some potentially sustainable supply approaches. These include the re-using of treated waste water; improving irrigation systems; modifying agricultural practices; implementing specific policy measures such as water pricing; and establishing farmer advisory schemes (EEA 2009). Moreover, the recent reforms in the Common Agricultural Policy (CAP) aim to completely decouple agricultural subsidies from production levels by 2012, which historically was one of the main drivers for the increasing use of irrigation (EEA 2009). Consequently, the economics of irrigation will be more guided by the relative productivity of crops and water accessibility than by relative farm subsidies granted to the crops (Berbel, Calatrava and Garrido 2007), thus potentially reducing the use of water in agriculture. Additionally, by adopting several specific directives enforcing better environmental protection of the water, the EU has reinforced its environmental protection policy. Moreover, the EU introduced *"cross-compliance mechanism"* which requires all farmers receiving direct payments under various schemes to comply with a set of *"statutory management requirements"*, such as a requirement to keep all farmland in good agricultural and environmental condition (EEA 2009).

The aim of the EU is to implement those changes by using both bottom-up and top-down approach. The bottom-up approach consists of acts aimed at setting the institutional framework and encouraging ***active management*** from the local state actors. The top-down approach consists of acts aimed at encouraging or forcing different managerial (state/farmer) behavior by introducing ***strategic planning*** on the European level.

All these measures adopted make clear that the EU is actively trying to improve the water efficiency, especially in the core consumption sector of agriculture. According to Lallana (2003), particularly the Directive 2000/60/EC will influence the evolution of European agriculture and therefore the water used for irrigation.

1.2 Directive 2000/60/EC – The Water Framework Directive

Directive 2000/60/EC is commonly known as the Water Framework Directive (WFD). It is central element of the whole European water policy that all Member States are obliged to implement (Garrido and Llamas 2007). The directive aims at establishing a framework for Community action in the field of water policy and more specific it aims at establishing "*good ecological status of European waters by 2015*" (Eurostat 2007).

Environmental objectives and institutional changes

One of the environmental objectives of the directive is to ensure a balance between abstraction and recharge of groundwater, with the aim to achieve *"good groundwater status"* (Lallana 2003). In order to achieve this, it focuses on water management at the level of hydrological units, the river basin units. An important step in the course of its implementation was the establishment of River Basin Management Plans in 2010 (Eurostat 2007). The WFD states that once identified, river basins have to be assigned to a river basin district. This is, under the terms of the directive, an administrative region covering a geographical area defined as the river basin, and the main organizations charged with water management issues for that area needs to have the ability to take decisions regarding the area as a distinct unit. Each river basin district must have appointed to it a competent authority to take the responsibility for implementing the directive (Chave 2001).

The WFD's Article 5 establishes that each Member State should carry out for all its river basins (1) an analysis of its characteristics; (2) a review of the impact of human activity on the status of surface waters and groundwater, and (3) and economic analysis of water use. This represents a massive study for whole countries, and a completely new approach to the inherited criteria with which water statistics were collected and recorded (Garrido and Llamas 2007). There is a considerable risk that several Member States will fail to meet the targets set in the WFD. There have been problems with meeting the deadline for incorporating the Framework Directive into national law and shortcomings in the actual transposition process in some cases (European Union 2010).

However, most European countries have already adopted the River Basin Management Plan, with few exceptions among which is *Spain* (see Appendix Figure 6). Under many aspects the *Italian* decree has already applied the principles and aims of the WFD, in particular regarding the approach on a river basin scale and the integrated quali-quantitative protection. (OECD 2006). Bulgaria is also among the countries that have already applied the principles and aims of the WFD, however there still problems with the actual implementation (Bachev, Agricultural Water Management in Bulgaria 2010).

Water pricing and metering

The WFD promotes the use of pricing and taxation as an incentive for consumers to use water resources in a more sustainable manner and to recover the cost of water services per sector of the economy (Arbues and Villanua 2006). Therefore *"prices must be directly linked to the amount of water consumed and/or pollution produced*" (European Union 2010) and it should reflect the "water user pays' principle (EEA 2009)

The directive states that water-pricing policies should provide adequate incentives for the users to use water resources efficiently and the water beneficiaries should contribute adequately *"to the recovery of the costs of water services, based on economic analyses"* (Arbues and Villanua 2006). The transfer of the costs to the beneficiaries of water services, including environmental costs places the intellectual principles of the question on completely new ground (Embid-Irujo 2005).

The WFD defines the *"water price"* as being *"the unit or overall amount paid by users for all of the services that they receive in terms of water, including the environment"* (European Union 2010). There are three installments of the price: *environmental costs*, *financial costs and resource costs.* The *environmental costs* are associated with damage or negative impact on the aquatic environment that have to be taken into account, which includes for example the polluter-pays principle. The *financial costs* embrace the costs of supply and administration, operation and maintenance, and capital costs. The *resource costs* represent the costs of resource depletion leading to the disappearance of certain options for other users (European Union 2010). These introductions constitute a novelty for many European Markets, which includes Bulgaria, Italy and Spain.

However, this pricing philisophy has several weaknesses. Experts argue that it is going to take some time to define precisely what these *environmental costs* are (Embid-Irujo 2005). Moreover, Berbel, Calatrava, & Garrido (2007) argue that differences between *environmental cost* and *resource cost* are difficult to implement in the real world. Moreover, the generic expressions such as environmental, financial and resource costs give the Member States a lot of arbitrariness in applying the principles. Moreover, there are already major differences between the water pricing systems in the Member States. For example, the irrigation water price in southern European countries is subsidized (European Union 2010).

There are number of possible farmer responses in behavior and attitude triggered by the proposed water pricing. This may include improving irrigation efficiency, reducing the area of irrigated land, deceasing irrigation and modifying agricultural practices such as cropping patterns and timing of irrigation (EEA 2009). Nevertheless, in irrigation systems where water efficiency is already high or where high value crops are grown, the price 'elasticity' is likely to be low (Dworak, Berglund, et al. 2007). Therefore, we assume that pricing mechanism proposed by the WFD will have different impacts in various countries.

Water ***metering*** plays an important role and must be implemented widely across all sectors. Conversion from flat to volumetric rates requires the installation of water meters. There is currently a general lack of such devices (EEA 2009). Therefore, to date, the pricing mechanism described in WFD has been applied only on a limited scale in European irrigation districts and often coupled with other instruments such as quotas. Consequently, little information is available to assess the success and limitations of water pricing in agriculture and to identify optimal implementation practices.

It can be summarized that the European regulation aims at achieving a change in intuitional and farmer behavior trough the top-down water pricing policies and initiatives, combined with bottom up initiatives. Whether this approach has proved to be successful in Bulgaria, Italy and Spain will be assessed in the country specific sections.

(2) Country Analysis - Bulgaria, Italy and Spain

2.1 Bulgaria

The transition in Bulgaria that started in 1989 brought many changes. The reform in the agricultural sector started with privatization of agrarian resources (Bachev, Study on Agrarian Contracts in Bulgaria 2010). The entire farming activity was transferred into newly evolving unregistered farms, cooperatives and firms. However, the privatization process took 10 years to complete and for a long-period of time the rights on major recourses, like farmland and irrigation facilities, moreover it lead to severe land fragmentation (Bachev, Agricultural Water Management in Bulgaria 2010). As a result large portion of agricultural lands have been left abandoned for a long period of time and the average yields for all major products shrunk to 40-80 % of the pre-reform level.

The irrigation sector was also affected by changes - the irrigation water usage declined by nearly 85 % during the period. In addition, many parts of the existing canal systems were abandoned. Moreover, the irrigation systems in Bulgaria that were built during the sixties and intended to supply water to large production units, now are supposed to provide water to many small agricultural producers, often with different economic interests, which creates a barrier for the development of the irrigation sector (I. Penov 2004).

(A) The Role of Institutions

In order one to understand the process that happen in the irrigation sector; one has to understand who the actors involved are and what their interests and abilities are. There are five types of actors involved in irrigation in Bulgaria: small producers, large producers, Irrigation Systems EAD (the state-owned irrigation service provider), local municipalities and water users associations (WUA).

Small agricultural producers: The small producers have knowledge of the local irrigation systems, but not sufficient organizational skills. In addition, many of them are subsistence, semi-market and small-scale commercial holdings with many of the farmers either in or close to retirement age (Bachev, Study on Agrarian Contracts in Bulgaria 2010). They invest modest resources in agricultural activities and thus their benefits and losses from irrigation are not significant. Agriculture, however, is an important income-generating activity for many of them. The small farmers co-operate to organize the irrigation process. Nevertheless, co-operation is done at a level that is too low to run the existing complex irrigation infrastructure. Furthermore, since they cultivate small plots, the revenue that the water supplier receives from an individual producer is negligible. In their opinion the Irrigation Company does not care sufficiently about their interests. Therefore, the main features of this group of actors are short planning horizon, insufficient trust, lack of organizational capacity, and poor bargaining position. (I. Penov 2004)

The *large producers* have organizational skills. Many of them also have knowledge about the local irrigation systems. Most of them have been set up as a family and partnership organization during first years of transition by younger generation entrepreneurs. The majority of these farms are formally registered as Sole Traders. They are strongly market and profit-oriented organizations. Those business farms effectively explore economies of scale and scope on production and management. Thus they have strong incentives and potential for innovation (Bachev, Study on Agrarian Contracts in Bulgaria 2010). They invest considerable recourses in agricultural activities and, as a result, their eventual losses and benefits from irrigation are also substantial. Since they cultivate large plots, the revenue that the Irrigation Company receives from an individual large farmer is considerable. Often large farmers complain that the small ones divert the water flow and thus disturb the water supply to their fields. The main characteristics of the large farmers are organizational capacity and strong bargaining position. (I. Penov 2004)

The *Irrigation Systems EAD* is the state monopoly company owned by Ministry of Agriculture and Foods (MAF) and responsible for the management of state irrigation assets, provision of irrigation and drinking water, drainage and flood protection. The specialists working in the firm have organizational skills and also global information for irrigation systems. The knowledge of the firm's specialists concerning irrigation infrastructure is indispensable. Often, the only way the water can reach the fields is through canals controlled by the company. The company tries to provide reliable water supply to the large farmers, but believes that the small farmers, if left without their control, will steal water. Therefore, the main characteristics of this actor are organizational capacity, strong bargaining position, lack of trust, and strategic outlook. (I. Penov 2004)

Associations of water users are voluntary organizations created by the water users and involved in irrigation and drainage activities in a certain area. The process of their formation started in 2001 and has been advancing at a slow speed. The aim of the reform is to transfer for free to the end water users and owners of the secondary irrigation infrastructure, which is the most dilapidated piece of the irrigation infrastructure and needs significant investments, as well as some smaller water sources. However, this reform did not change fundamentally the irrigation sector, since the Irrigation Systems EAD has kept its monopolistic position. The water user associations (WUA) got ownership just on the irrigation infrastructure within the final distribution; otherwise they still depend on the state monopolist on the delivery of water. Only on places where the water associations got ownership on the water source the situation has changed dramatically. Nevertheless, the water associations have proven their efficiency, by the fact that they could offer to their users prices that are 3 to 4 times lower than the state monopoly. Also, the associations are very stable financially and the rate of water fee-collection is 80-100 %, way higher than the one of the Irrigation Systems EAD. Therefore the main characteristics of these actors are organizational capacity, strong bargaining power and trust. (Hadjieva 2007)

The *local municipalities* have knowledge about the local irrigation systems and also possess due organizational skills. They are not directly but indirectly affected by the irrigation problems. Currently, they manage the small water dams and receive revenue fishermen rents. The local mayors are respected by the villagers and often act as mediators in irrigation conflicts. The local municipalities are important actors for the implementation of any strategy for building participative water institutions. Therefore, the main characteristics of these actors are organizational capacity and reputation. (I. Penov 2004)

Coordination and Trust: The coordination between the different stakeholders has been weak or lacking. There are several reasons for this state. The first one lies in the main actor in the field – the Irrigation Systems EAD. So far they have not made any real effort to coordinate their activities with the water users. First of all, they have not developed long-term relationship with their clients. Instead, the conditions of their service are negotiated each year, which prevents their own long-term planning and the one of their clients. Second, the farmers are not incorporated into the decision making process about pricing, therefore the monopolist sets its own prices, with little or no control from the MAF. The pricing uncertainty and the growth of the prices beyond any logical explanations have repulsed many of the farmers. So they have either stopped using irrigation, or they switched to the legal or illegal use of underground water or have started stealing water. Research conducted by Panov (2004) has found that if the communication and coordination between farmers, Irrigation Company, and state institutions is improved this could make the parties more aware of the problems and reduce both rent seeking and corruption.

Another major obstacle for the better coordination is the poorly developed social mechanisms for conflict resolution. The local water guards and local mayors are expected to solve such conflicts. There are rarely farmers sanctioned through the formal court procedure for violating the rules of water usage. The Irrigation Systems EAD refuses to supply water to farmers who have obligations left from the previous year. In order to isolate the offenders, the company often delays or does not release water in the branches of canals around which their plots are located, which further increases the mistrust between the irrigation company and its clients. (I. Penov 2004)

Third, there is great disparity between the interests, water use and planning patterns between the small and the big agricultural producers. The Irrigation Systems EAD therefore has difficulties coordinating and servicing its clients, thus it gives preference to the big clients and has great mistrust towards the smaller producers. Moreover, the unclear ownership of the secondary irrigation system and its bad condition makes the service to the water users that are situated far from the main channels almost impossible. The heterogeneity and uncertainty cause a coordination problem. (Theesfeld 2001)

Fourth, there are cases of conflicts between the newly established water association and the municipalities. The reason for this is that, if water user associations are created, the municipalities have to transfer the ownership of the small dams to them without any compensation. Therefore, from a financial point of view, the municipalities do not have incentives for the establishment of WUA's, because they will lose revenues from the rent. (I. Penov 2004)

Fifth, coordination challenges between the small and big agricultural producers hamper the creation of new WUA's. The reason for that is that they have different motives for involvement in agriculture and therefore different attitudes toward their participation in water management (Theesfeld 2001). On the one hand, the participation in WUA's by the small owners will increase their responsibilities – both in terms of financing the operation costs and participating in the management and organization of the WUA that could outweigh the benefits from the efficiency improvement. In fact, the organizational and financial capacity of the small farmers is so low that they need somebody else to initiate the process of establishing the association. On the other hand, many of the big farmers prefer to deal alone with Irrigation Systems EAD, rather than coordinate with and consider the interests of numerous smaller actors. In fact, due to their bargaining power and economies of scale, the big farmers have managed to create decent coordination with Irrigation Systems EAD and organize efficient irrigation process. However, many large and small producers coexist in areas where the network of canals cannot be maintained effectively without including both types of farmers. Therefore, the cooperation between the large and small farmers can be beneficial for both parties. In addition, the WUA is more likely to attract capital and investments from which not only the small, but also the large farmers will benefit (I. Penov 2004). Although coordination and diverging interests of small and big agricultural producers could have a negative impact on the creation of WUA's, those problems are in general resolved easier than the problems created by the regulatory rules themselves. (Hadjieva 2007)

We could conclude, from the above stated reasons for the weak coordination in the sector, that although this has caused problems, they usually are much easier to overcome than the problems caused by legal regulations. In our view the problem of weak coordination has been complementary to other, deeper problems.

Responsibilities, planning and objectives: During transition, public policies, regulations, monitoring, and support in the water sector were inefficient, inconsistent, reactive and sectorial with different agencies responsible for various aspects of water management. The Water Law, passed in 1999, and the accession to the EU have led to improvements in this aspect and are results of the current governance structure of the water sector that was set by the Water Law that passed in 1999. The adaptation of the Water Law has granted clear responsibilities among the different institutions. Bulgaria has already adopted development plans for its four basins, according to the EU regulations. However, there is no plan for the strategic development of the irrigation sector; neither is there any clear objectives guiding the development of this sector (Bachev, Agricultural Water Management in Bulgaria 2010).

The governance of the water resources is executed on a national and basin level. On the national level, a major organ of the water sector is the Ministry of Environment and Waters (MEW). The technological and regional governance is done by the Basin Departments. The MAF is responsible for the state policies in the irrigation sector. Moreover, the MAF is owner of the state-owned monopolist – the Irrigation Systems EAD, thus bearing the responsibility for its actions. However, bad coordination, mismanagement, ineffective enforcement, and corruption are still quite typical for public institutions. This has a significant negative impact on the water management (Bachev, Agricultural Water Management in Bulgaria 2010).

Financing: The support to agriculture in general has been very low during the transition in Bulgaria, and the state investments in irrigation systems are practically non-existing. However, the accession to the EU in 2007 provided huge EU and national funds in support to farmers, farming modernization, infrastructural development, and eco-measures. However, investments in new irrigation infrastructure and modernization are still limited (Bachev, Study on Agrarian Contracts in Bulgaria 2010).

The use of irrigation incentivizes the farmers to grow water-intensive cultures that have higher net income per unit of land - in some cases it is ten times the income from non-irrigated areas (Zagorova 2009). Therefore the farmers are in general motivated to use irrigation and to invest in irrigation infrastructure. However, only the big, commercial farms are willing and have the means to invest in irrigational infrastructure. Another constraint is the unclear ownership on the secondary irrigation infrastructure and the mistrust towards the water provider - Irrigation System EAD. Third constraint is the inability of the police to protect the water-intensive crops, such as vegetables and fruits, against theft, that forces the farmers to choose other types of crops (Brazdi 2010).

(B) Rules and Regulation

Water rights (ownership rights): The Water Law granted state, municipal, and private ownership to water resources. Private ownership, however, is very restricted and can be considered an exception rather than a rule. It must be mentioned that landowners can use water from wells free of charge up to a certain limit above which they must apply for permission and pay a tax. Therefore, the formal property rights on water are held by the state, but there are some limited private property rights on underground water resources. (I. Penov 2004)

The MAF controls the infrastructure for water usage through the Irrigation System EAD. The secondary canal systems are intended to be transferred to water user associations. The local municipalities are responsible for the small water dams. Hence, there is state ownership of the water resources and main canal systems, and unclear property rights on the secondary canal systems, and temporary rights and duties granted to the local municipalities regarding the small water dams. (I. Penov 2004)

There is discrepancy between the property rights, as prescribed by the law and the property rights in practice. This implies crucial implications on the overall water management. The irrigation systems in Bulgaria were designed to transport water from large water reservoirs located in mountains. The main canals are long and difficult to guard. Stealing water and irrigation equipment is not a rare event and, hence losses in the system are considerable. The secondary canal systems are in a bad condition in most places. These systems are maintained occasionally by the local municipalities or small groups of water users. Therefore, in practice, there is limited effectiveness of the formal property rights to water and the main canal systems, and a process of privatization on the secondary canal systems (I. Penov 2004). However, there is a 5 years period in which the state could take back the assets it has transferred to the water associations, if they do not manage them efficiently. Although, this mechanism was designed to prevent mismanagement by the new private owners it has created a great degree of uncertainty that prevents the water associations from investing in their infrastructure. Moreover, the transaction of the ownership should be done within 2 months according to the law, but the real process is extremely slow (Hadjieva 2007). Furthermore, the WUA's are not allowed to distribute profit among its members, which further reduces their personal motivation in investing in infrastructure.

According to the Water Law, the ***pricing*** policy should aim at providing appropriate stimulus for the users to use water efficiently, with an emphasis on ecosystem conservation. It has to take in account the social and economic effect; the effect on the environment by recovering the costs; as well as with the geographic and climatic conditions in the corresponding regions. The prices are formed according to the irrigated area, its location, the amount of water delivered and by the means of delivery (through pump or gravity). When the total losses of water are above 25 % they are not calculated in the price. (Hadjieva 2007)

The Ministry of Agriculture and Foods (MAF) each year sets prices and general terms of delivery for the service done by Irrigation Systems EAD, by a proposal made by the latter. In essence this has created a situation in which the monopolist is setting his prices almost without any control. As a result the prices have been steadily growing and are far above the means of most small farmers, therefore they have stopped irrigating.

The pricing has also been used for political purposes. For example for the election campaign in 2009 the MAF ordered the Irrigation Systems EAD to provide its services for free to the agricultural producers, without allocating budget funds to finance this operation. As a result, at the moment the Irrigation Systems EAD is practically in the state of bankruptcy (Popova 2010).

The farmers have the freedom to decide on the quantity of water that they want to purchase. On a local level, the Irrigation Systems EAD signs contracts, mainly with large producers. The local water guards, together with the local mayors, prepare water usage timetables. The contracts, however, are not binding and the water usage timetables are violated, which makes the organization harder. (I. Penov 2002)

Metering: The water is monitored on the main canals, but not on the secondary ones. Likewise, the water pumped from wells by the small farmers is not monitored. Big part of the metering infrastructure has been stolen. Therefore, small producers are charged per hectare, which lowers their incentives to participate in the monitoring process or to improve efficiency (I. Penov 2002).

Trade and water markets have been characterized by water transactions that happen on a local market monopoly. It is regulated by the state and distributed on a local level by weakly enforceable contracts and water usage timetables. The monitoring is restricted to the main canal system. There are incomplete conflict resolution and sanctioning mechanisms, especially in the case of the small water users. (I. Penov 2004)

In the following, the main findings of our framework structure are briefly summarized:

(A) The Role of Institutions

(1) ***Coordination***: The coordination in the sector has been rather poor; however its importance as a barrier to efficient water management has been rather complementary.

(2) ***Trust***: There is low trust between the institutions and the water users, as well as among the water users. The farmers participating in the Water User Associations are an exception.

(3) ***Active management***: The management of the sector is reactive, bureaucratic and poor.

(4) ***Strategic Planning***: There is no strategic plan for the development of irrigation infrastructure.

(5) ***Clear Objectives***: There are no clear policy objectives in the irrigation sector.

(6) ***Clear Responsibilities***: The responsibilities are in general well defined by the Water Law; however deficiencies in the institutions prevent the practical implementation.

(7) ***Financing***: The financing is limited. The only viable solution is the use of the EU funds by the WUA's. No financing for the primary irrigation infrastructure is available.

(B) Rules and Regulation:

(8) ***Water Rights (Ownership Rights)***: Clearly defined water laws (in theory) are unapplied in practice. There is no clear ownership on the secondary irrigation infrastructure.

(9) ***Pricing and Metering***: The pricing is set by the state monopolist, without being regulated.

(10) ***Trade and Water Markets***: Water is traded on a local monopolistic market. No trade of water exits beyond it.

2.2 Italy

(A) The Role of Institutions

The viability of irrigated systems in Italy depends highly on a working and efficient institutional setting and water-allocation mechanisms (Pujol, Raggi and Viaggi 2006). However, ***coordination*** is quite difficult among the Italian institutions due to a high degree of fragmentation. There are many public agencies operating in the water system with different, often overlapping competencies that are not well integrated and therefore create coordination problems in the management of water use. Thus, a weak point of the Italian irrigation system is the complexity and unclear roles of the several institutions and agencies involved. (OECD 2006)

Keystone for the Italian water sector is the Land Reclamation Act (1933), that converted all water bodies to the public domain and set forth the principles which have guided the management of water resources in Italy ever since (Berbel, Calatrava and Garrido 2007). The Italian legislation evolution led to the definition of the so-called "*Integrated Water Cycle*", characterized by three levels (OECD 2006):

1. "Planning" of water resources allocation on a river basin scale. At this level, both environmental and productive aims are defined. Planning is entrusted to all Italian regions and the Basin Authorities (OECD 2006). Basin Authorities constitute the core of the Italian water sector "Planning". They have the two tasks: (1) setting up "Integrated Water Service" across the water district by granting the concession to public, private, or mixed organizations; (2) governing water policy by means of typical regulatory instruments, by planning and monitoring the performance of service providers. Moreover, they draw up the Water Basin Plans and define the investments that the service provider company must make.

Basin Authorities politically represent the interests and preferences of the actors present in the water district, thus formally constitute the political arena for water policy and governing structure. However, most decisions are negotiated and made outside Basin Authorities assemblies, which are only called upon to ratify them. Actual decisions are made rather outside Basin Authorities assemblies in other arenas for decisions, such as local party secretariats, bilateral agreements between mayors, regional and provincial administrations, and pre-existing public enterprises (Lippi, et al. 2008).

2. “Programming”, concerns the definition of the political strategies and the economic instruments to achieve the aims fixed at the planning level. At this level, Action Programs and financial resources are defined. This level acts through several investment programs, entrusted to competent authorities. (OECD 2006)

3. The “Management” of water resources is entrusted to several agencies in the territory. The management is delegated to several agencies for irrigation. (OECD 2006)

Institutions and agencies can have competencies in one or more of the three described levels. The large part of competencies has been assigned to the Ministry of Environment Protection, while the Ministry of Agricultural and Forestry Policies is competent for the primary irrigation networks and for programming of national funds. Regions have the remaining competencies. (OECD 2006)

The industry structure is to a great extent a collection of geographically-defined and publicly dominated monopolies and oligopolies, where customers rarely have the ability to choose their water supplier (OECD 2006). Deteriorating water infrastructure is a key driver forcing a trend toward privatization and consolidation of water utilities in Italy (Datamonitor 2010).

So from a legal point of view, the Italian water system is very complex and characterized by a high level of fragmentation. The fragmentation is characterized by a high number of agencies (several hundreds) which are very small (OECD 2006). Coordination of principal institutions depends also on the geographic location. In the *Northern part of Italy*[1] research shows that institutions are well organized and coordinated (Datamonitor 2010). Interestingly, in this area, the process of implementation of the water reforms has been the slowest though, both in terms of formal procedures (establishment of Authorities, carrying out of surveys, approval of investment plans) and in terms of concrete transformation of the service provision model. This can be explained by the fact that, historically, in Northern Italy – the richest area of the country – there has been the highest concentration of municipal companies. With each municipality owning its own municipal company, this area has focused on localism and fragmentation of local utility management. Thus the reforms have encountered resistance from an industry that had developed over many decades on the principles of localism, strong autonomy of

[1] Northern Italy consists by definition of the following regions: Aosta Valley, Liguria, Lombardy, Piedmont, Emilia-Romania, Friuli-Venezia Giulia, Trentino-Alto/Adige

municipal enterprises from the controlling municipalities. All of these factors make it particularly difficult to implement the inter-municipal regulation and management of water services. (Lippi, et al. 2008)

Differently, in *Central Italy*[2] the presence of municipal enterprises of this kind is rather less significant. Water service provision was mostly undertaken by municipal Authorities directly. Thus the process of horizontal integration has been more straightforward due to the absence of the strong localistic corporate structures, such as the one typical of Northern Italy, and also owing to the notably authoritative attitude of regional administrations. Thus, in Central Italy full implementation of formal procedures and a large number of actual concessions came earlier than in other areas of Italy. (Lippi, et al. 2008)

Finally, in *Southern Italy*[3] a culture of "mere conformance" is evident. The formal reform steps had all been accomplished - while substantial implementation was totally lacking. For example, all investment plans had been approved, but no concessions had been awarded. The reason for this contradictory outcome lies in the lack of decision-making autonomy of Southern institutions. The role of the central administration has been decisive in implementation of the reform, but the decentralized decision-making model proposed by the reforms has not worked. (Lippi, et al. 2008)

Explaining these different outcomes in the geographical areas from a institutional viewpoint, it must be noted that where pre-existing authorities had already started the industrialization and modernization process and were structurally better off, the reform processes have been significantly faster and smoother. These factors are made clear by the fact that the Northern regions which boast a higher fragmentation of municipalities, as well as the Southern regions witnessing the heaviest governmental involvement and subsidization, have had much more difficulty in implementing the reforms than have the Central-Italian Authorities. (Lippi, et al. 2008)

Another important actor involved as customers in the coordination process are the farmers. They are very fragmented in size, with no strong majority of one size class dominating the others (Martins 2007). Appendix Table 6 shows that there is positive correlation between the farm size and the use of irrigation. This is due to their financial strength and the ability to take benefit from the economies of scale. . More interesting is the relationship between age of farmers and their tendency to equip the

[2] Central Italy consists by definition of the following regions: Lazio, Marches, Tuscany, Umbria

[3] Southern Italy consists by definition of the following regions: Abruzzo, Apulia, Basilicata, Calabria, Campania, Molise, Sicily, Sardinia

surface with irrigation technology. In contrast to Bulgaria, in Italy the older farmers are more likely to be interested to invest in irrigation. This may be due to the fact of the previously described relationship between surface area and irrigated area. It seems to be the case that bigger areas are owned by older farmers, who at the same time have more resources and interest to invest in irrigation technology. Appendix Table 6 shows the relationship of geographical location and degree of adopted irrigation practices. The regions located in the North - which already naturally receive a considerable bigger amount of rain – have denser irrigation infrastructure coverage and more efficient irrigation.

The lacking ***trust*** hinders efficient water management as well. Regulatory agencies are supposed to be autonomous from the executive branch of government, but they have often struggled to remain so in Italy (Pujol, Raggi and Viaggi 2006). This partiality led to institutions that are not fully considered trustworthy by the different stakeholders. In terms of ***active management***, policymakers and public institutions seem to be more administrating than actively managing the water landscape. It looks like they are rather reacting than proactively shaping the conditions. Big parts of the reactions are merely adaptions from the European directives.

A critical factor concerning water use efficiency for irrigation is the absence of exhaustive knowledge about water use for agriculture. There is a strong need for support instruments at the national level in order to elaborate strategies on integrated water management (OECD 2006). The efficiency level of water use management shows some points of backwardness, with the exception of some specialized areas. In a world where efficiency represents the most important aim, a critical factor is the low incidence of ***strategic planning***. In many cases, Italian agencies do not have a deep knowledge of water requirements and consumption in the areas that they manage (OECD 2006). However, strategic planning of the institutions should be based on good knowledge and take into consideration a long term perspective. Thereby it should be conscious about the issues whether a central, legislative decision concerning the relationship between state and market can be implemented across local governments through the introduction of formal policy instruments, without taking into account the complex and varied structures of power relationships and existing public–private arrangements. Evidence of the implementation process of the Galli reform in 1994 (Lippi, et al. 2008) shows that local factors were decisive in shaping the features, timing, and outcomes of the reform. In particular, some characteristics of the pre-existing context on one hand and the structure of local power on the other have significantly influenced or reoriented the process (Lippi, et al. 2008). While the form has not changed, local dynamics have filled the reform with very different contents. Panozzo (2000) argues that *"Governance as* *instruments"* cannot simply be created *"by decree"* without taking into account the existence of a local political context: *"governance as power dynamics"*. The hypocrisy of central government (Brunsson 1989) lies in the use of a mere labels for the reform which only shifts actual conflict resolution downwards to regional and local arenas.

Italy's leading institutions are not always operating towards ***clear objectives*,** due to sometimes not very ***clear responsibilities***. The current practices of integrated management of water resources are not working perfectly. Although the general principles of the Italian water management legislation leans towards the integration of water bodies on a basin scale, their effective application is still poor. One major problem is that water management responsibilities are fragmented into a number of administrative levels which are not coordinated (WWF 2003). Water supply policies and regulation are usually defined by one or several ministries, in consultation with the legislative branch. Often several ministries share responsibilities for water supply (Lippi, et al. 2008): National, river basin, regional, province, municipality authorities (WWF 2003) – all of them have certain responsibilities and it appears not always clear who has which responsibilities in which areas (Lippi, et al. 2008).

In conclusion, in Italy the prevailing instruments in water policies are (OECD 2006): (1) Policy instruments for reducing fragmentation at the institutional level with regard to planning and management water use; (2) Economic instruments for improving the efficiency of the water systems and irrigation networks; (3) Voluntary instruments within CAP measures and rural development programs, for reducing negative environmental effects of agriculture on water.

Financing the water sector has also changed. In the last years, different national instruments funded irrigation and financed investments for almost 3.6 million €: recuperating dams' efficiency, completing irrigation networks, renovating distribution networks, control and measure instruments, and wastewater reuse for irrigation. Even though the economic investments have been considerable, the performance of some of these projects has not been high. (OECD 2006)

Italian irrigated agriculture has been heavily subsidized in the past (Garrido and Llamas 2007). Also present water policies for irrigated agriculture in Italy are mostly based on a subsidization of agriculture and aimed at providing opportunities to as many farmers as possible (Pujol, Raggi and Viaggi 2006). But it is important to specify that programmed investments funded by national resources do not address farms directly. In fact they are oriented to efficiency improvements of public networks, while programming for water management improvement and modernization of farm irrigation systems are financed by the operational programs and the rural development programs of the EU. Regarding these programs, the financial resources (for the period 2000-2006, almost 750 million €) have been used for management improvement, irrigation methods modifications in order to reduce water consumption, research and technical innovation. (OECD 2006)

(B) Rules and Regulation

Water Markets: In Italy, the irrigation water is delivered by the "Reclamation and Irrigation Boards" (RIBs) that are public bodies managed as associations of landowners with public status (meaning that they are regulated by law and subject to government supervision), which control land reclamation and the distribution of water over a certain area (Pujol, Raggi and Viaggi 2006). RIBs distribute about 90 % of the water used for irrigation. The poorly maintained water distribution system in Italy relies mainly on the RIBs, since they have self-financing capacity to foster rural development, as well as to build irrigation projects. The government provides funds to cover all project capital costs, while the RIBs are responsible for managing and maintaining these systems, and collecting charges from farmers (Berbel, Calatrava and Garrido 2007). The aim of the RIB's is not to reduce water use, but to best allocate the available water. Shortages of water are a frequent problem in the area that affects even human consumption. Water is normally distributed in proportion to farmland, with the objective of avoiding conflicts and guaranteeing equal opportunities across farms. (Pujol, Raggi and Viaggi 2006). In terms of efficiency this may not always be the best solution.

Financing does not include directly the trade of water, which constitutes another barrier to efficient water management. The study concluded by Pujol, Raggi, & Viaggi (2006) came to the conclusion that ***trade and water markets*** are practically absent in Italy. The reason for this is due to the lack of a suitable legal framework and to the fact that water exchanges are possibly viewed as a way of eluding the current increasing block tariff system. However, there is evidence of formal or informal water markets in Southern Italy and to a lesser extent in the Northern part, although their size is almost impossible to assess. The possibility that water may concentrate into the hands of few farmers is viewed as conflicting with the basic rationale of the RIB's based on the equity-driven idea of irrigation as a support to the development of small farms. (Pujol, Raggi and Viaggi 2006)

One of the expected outcomes of water markets in agriculture is to produce a concentration of water use on the more efficient Italian farms. Pujol, Raggi, & Viaggi (2006) suggest that this is likely to produce a stronger specialization in high added-value crops by water buyers, whereas the others would retain less-intensive crops, therefore the economic efficiency of water use will increase. However, they highlight that the level of benefits depends crucially on the level of transaction costs, which are all the costs involved in carrying out a transaction (Williamson 1985). The institutional setting may have a key role in guaranteeing low transaction costs, through a proper regulation of water transactions. Given transaction costs at realistic levels, the level of economic gains from introduction of a market are likely to be modest, at best. If this is added to the likely amount of "unreportable" transaction costs and to the lack of an adequate legal framework for the years to come, the development of water markets is not to be expected in the near future. This underpins the importance of the institutional setting, since it has a key role in guaranteeing low transaction costs, through a proper regulation of water transactions.

Water rights are quite clear and already established in Italy, and they assure that the water is legally available to the customers (Pujol, Raggi and Viaggi 2006). However, water use regulation is based on the existing complex system of rights, often developed since ancient time (Bazzani, DI Pasquale and Gallerani 2002).

Pricing and metering constitute more important barriers. There is a lack of systematic water metering in Italy that also prevents accurate figures of water use (WWF 2003). Metering practices are recognized by institutions and the private sector on a national level. Therefore, in the irrigation sector it is not easy to apply water pricing based on water consumption. Beside the technical and regulation challenges connected with metering, the pricing policy has to consider numerous other aspects, such as the economic importance of irrigation for the Italian agricultural sector and the negative and positive environmental aspect of water use (OECD 2006).

Although there is no standardized pricing policy in Italy at the moment, this might change with the adaptation of the European directives (Datamonitor 2010). The WFD does not explicitly promote water markets and trading, but proposes more generically economic instruments, usually identified with volumetric pricing. Nevertheless even the approach based on volumetric pricing, or proxies such as irrigated area pricing, were not considered as acceptable by most Italian farmers (Pujol, Raggi and Viaggi 2006). Instead there is an irrigated area pricing system, often based only on the extension of the area that farmers intent to irrigate, without consideration of the water requirements of different crops or water consumption. This system does not assure efficient water use. The existing contributive system is not economically efficient and is not oriented to water saving (OECD 2006). In Italy, water pricing works usually works through surface based charges with only a few examples of volumetric pricing (Bazzani, et al. 2004). The aim is to cover RIB's costs, without clear incentives in terms of water savings. However, the charges cover only part of O&M costs and nothing of investment or depreciation costs (Chohin, Rieu and Montiginoul 2003).

The water prices that exist in the various regions are set in Italy by Public agencies. The fee does not include any environmental water tax or pollution tax. Part of the capital costs is subsidized. (Berbel, Calatrava and Garrido 2007) The average water cost at the farm level is about €36.00/ha, but actual tariffs range from €2.00 to €355.00/ha. The tariff system is usually based on the running costs of servicing an area. As mentioned, it is only in a small part of the total irrigated area that water is measured and volumetrically priced. Italian farmers pay much less than other users.

In the following, the main findings of our framework structure are briefly summarized:

(A) The Role of Institutions

(1) ***Coordination***: Coordination among the responsible institutions constitutes a barrier to efficient water management especially due to the fragmentation of the sector.

(2) ***Trust***: The relationships between institutions and customers are not fully based on trust. This is mainly due to the fragmentation and impartial law makers that are not enhancing trustful relationships.

(3) ***Active management***: Instead of following a proactive approach that enhances efficient water management practices, institutions seem to be rather reactive administrators.

(4) ***Strategic Planning***: Incompetent institutions are unable to set up long term strategic plans that enable better coordination and the achievement of expected goals.

(5) ***Clear Objectives***: The unorganized institutions have partially different and conflicting goals among themselves.

(6) ***Clear Responsibilities***: Water management responsibilities are fragmented into a number of administrative levels which are not coordinated.

(7) ***Financing***: Both national and EU subsidies are given either directly or indirectly to farmers. The public sector is leading the investments in infrastructure.

(B) Rules and Regulation:

(8) ***Water Rights (Ownership Rights)***: Water rights are established and clear.

(9) ***Pricing and Metering***: Due to the fact that metering is not regulated on a national scale, also pricing practices are different among Italy. Prices are set by public agencies that do not apply any volumetric pricing yet. Part of the capital cost is subsidized.

(10) ***Trade and Water Markets***: Regulated water markets do currently not exist in Italy.

2.3 Spain

Spain's irrigation practices go back to the 8th century when the Muslims occupied the Iberian Peninsula and further developed Roman irrigation techniques. The rich historical heritage explains the great diversity in practices and institutional settings across regions and even between neighboring irrigation areas (Berbel, Calatrava and Garrido 2007).

In many respects, the 1985 Water Law (WL) forms the core of water legislation in present day in Spain. The law opened a new era for water policy for number of reasons: (1) water resources were considered public domain, saving a few exceptions of ground use; (2) it laid down the water planning principles that eventually were materialized in three failed attempts of national hydrological plans; (3) it consolidated a financial regime for water users which delivered them important benefits, the irrigators being the most favored; (4) it consolidated the institutional role of the Basin Agencies, granting them autonomy, financial resources and personnel to become the actual decision makers in all water issues within the basin boundaries; (5) lastly, it defined a model of co-decision making in which direct water users and interested administrations have had an active role in all water planning and management at basin level. (Garrido and Llamas 2007)

(A) The Role of Institutions

In terms of ***coordination*** of the institutions the current challenge is that water policy is increasingly a regional policy, and regions, with the eventual support of their autonomy statutes, are developing their own legislative initiatives (Garrido and Llamas 2007). Spain has 17 Autonomous Regions or regional administrations. The Constitution and the Water Law (WL) from 1985, assign to the central administration the function of hydrological planning and direct management for interregional basins. The Basin Agencies (Hydrographical Confederations), depending on the Ministry of Environment, are the ultimate responsible entities for each of the 10 great basins. The areas of the Basin Agencies depend on the water sheds and their boarders are different than those of the Autonomous Regions. For intercommunity basins, the Autonomous Regions can organize their own water services and planning (Manuel 2003). However, the progress of adaptation of the European Regulations in the sector, in specific WFD, is slow and at present Spain is far from complying with the WFD (Berbel, Calatrava and Garrido 2007).

In terms of ***clear responsibilities***, the Spanish legislation states that the provision of water services is a legal monopoly (Arbues and Villanua 2006) with the responsibility lying in the hands of the Autonomous Regions and their Basin Agencies. Basin Agencies are in charge of planning, constructing and operating major water infrastructure such as dams; elaborating basin plans; setting water quality targets, as well as monitoring and enforcing them; granting permits to use water, as well as inspecting water facilities; undertaking hydrological studies; and to provide advisory services to other entities (Manuel 2003). As mentioned before, the water policy is increasingly a regional policy since regions are developing their own legislative initiatives (Garrido and Llamas 2007).

The 1999 reform complies with the WFD and creates the local entities for water management, user associations to manage locally the water cycle. User associations are mostly collective organizations. Farmers, the main consumers of water, group in two types of users associations. They gather in Irrigation Communities and groundwater users in Users Communities. Irrigation Communities are under the control of the Agriculture Ministry, in charge of transferring the infrastructure for irrigation to the Confederations. Now, these functions of the Ministry of Agriculture have been mainly transferred to the Autonomous Regions, which are acting in different ways, depending on the amount of transferred functions from the Central Administration (Manuel 2003). About 70 % of all Spanish irrigated area is serviced by Irrigation Communities. In addition to administering the resources and infrastructures they share water among irrigators, and have a major role in the water management both at the River Basin Authority and at district levels (Berbel, Calatrava and Garrido 2007).

Farmers, as the users, are important stakeholders as well. There has been one recurring farmer's problem, which is the one of illegal constructions: Tens of thousands users in virtually all basins had no legal rights or concessions to the groundwater resources they have been tapping for years. Any effort to reduce total extractions in the over drafted hydrogeological units had to be accompanied by the closure of the illegal users. So far all attempts have failed, and any reduction of total extractions has come from the efforts made by both legal and illegal users. (Garrido and Llamas 2007)

The described interplay of institutions suggests that in institution have started to follow and increasingly more ***active management*** approach. This is also due to three main drivers of change (Garrido and Llamas 2007) that were giving momentum to the most recent policy initiatives. Firstly, there is a widespread recognition that the ecological status of many water bodies has severely deteriorated. It is beyond dispute now that restoring water quality requires large investments, a better administration, and a great deal of participation and education. Moreover, the economic development and growth, the construction boom, the tourist sector and a competitive agricultural sector jointly contribute to worsen the already polluted water environments. Secondly, there is recognition that farm water demands still grow insatiably, especially where resources are already scarce. Moreover, the CAP of the EU has shifted the support measures from production incentives and specific sectorial programs to completely decoupled support. Farmers are now completely free to grow the crops they want. Thirdly, another driver of change towards a more active approach is the prevailing “urban” views of water problems. Irrigation is no longer seen as a benign water user (Garrido and Llamas 2007).

The Ministry of Environment is responsible for ***strategic planning*** and delegates to the irrigation districts that are assigned the role of water policy implementation and planning (Berbel, Calatrava and Garrido 2007). Strategic planning has been characterized by the breakdown of century-long consensus (Moral 2008). Up until 1994, civil engineers had provided the leadership and technical capacity to design and execute water plans. In the last decade, many other professional and scientific fields have become very influential in the most controversial discussions. Geologists, chemists, ecologists, and other social scientists now have more prevalence than civil engineers, and are increasingly filling the vacants in Basin Agencies and top management positions in the Environmental departments of both regional and national governments, thus giving wider perspective on the problems and the challenges of the sector (Garrido and Llamas 2007).

An important strategic plan constitutes the *National Irrigation Plan* (PHN) that evaluated the real water needs for irrigation, the potential saving in consumption in farming, the expected growth of irrigated land, and the future sustainability of areas rich of cultivation. However, no economic analysis, such as cost benefit, is lacking in the PHN in 1998. The PHN included the introduction of free market mechanism, like the transfer of water rights at opportunity costs, or marketing mechanisms, like sending signals of scarcity, should help to equilibrate and control the demand, and to avoid such questioned and high investment transfer systems as the one proposed in the PHN. The goals of the PHN were to satisfy the water demand by increasing mainly surface water resources, to improve water quality, to prevent damage by floods, to recover the hydraulic environment to improve irrigation and hydroelectricity, to sustain and replace hydraulic infrastructure and to promote research and development. The Budget of the PHN foresaw different investments: 20 % and therefore the majority were directed towards the transfer of water, 19 % towards the improvement of resources in basins. 10 % were invested in new irrigation and 5 % in the improvement of existing irrigation systems. (Manuel 2003)

The already mentioned Water Law (WL) of 1985 represents another important historical stage in terms of strategic development, with its aim to rationally use and protect the water resources, by transferring all continental waters, public or private, to the public domain, and putting the emphasis on protecting water quality (Manuel 2003). The WL made hydrological planning one of its central elements (Embid 2002). In addition, it consolidated the institutional role of the Basin Agencies, granting them autonomy, financial resources and personnel to become the actual decision makers in all water issues within the basin boundaries. However, this fragmentation of the decision making process led to a failure to set ***clear objectives***. The lack of common objectives had a negative impact on the ***trust*** between these players. Finally, the WL defined a model of co-decision making in which direct water users and interested administrations have had an active role in all water planning and management at basin level. (Garrido and Llamas 2007)

The 1985 WL consolidated the financial regime for ***financing the water sector***, which delivered important benefits to the water users, with the irrigators being the most favored. Financing alone, however, it is not enough to ensure efficient water management by investing huge amounts of money. Garrido and Llamas (2007) point out that "in terms of financing and designing groundwater works, the Ebro project[4] still represents a landmark in wrongdoing and poor design".

The European regulations, especially the CAP, also influenced the pattern of investments in irrigation. Up until 2003, support granted to the farm industry by the CAP was based on price support mechanisms or per hectare direct payments. This policy resulted in an increase in the irrigated area of certain crops. From 2003 on, farmers are free to grow the crops they wish. As a result, farmers are more opened to market signals and less reluctant to exchange water rights than 10 years ago. Secondly, in many areas farm water demand is now more flexible to accommodate to the actual hydrological conditions (Garrido and Llamas 2007).

(B) Rules and Regulation

Water Rights: With the aim to introduce a water market, the 1999 reform overhauled the former water rights system (Manuel 2003). The reform changed fundamentally the regulation of the exchange of water rights, permitting right-holders to engage in voluntary water transfers and the Basin Authorities to

[4] The Ebro project was part of the National Hydrological Plan

setup water banks or trading centers in cases of droughts or of severe scarcity problems. It allows contracts for the assignment of water use rights between the concessionaires or holders of use rights. . Nevertheless, it is not the actual concession that are transferred but rather the total or partial content of the rights to usage contained in those concessions, with the concessions surviving in all cases. To this end, the 1985 WL was modified in order to allow for the traditional principle of specialized water use for irrigation to be excluded, allowing the irrigation of land other than that which appears in the concession with the water whose right is transferred. This is a key legal provision, since it hypothetically allows a large volume of water to come into circulation (Embid 2002), given that agricultural irrigation makes up 80 % of the water used in Spain. The regulation imposes an upper limit which is the amount really used by the concessionaire or holder of the right being transferred. This means that such a regulation makes only sense if irrigation water can be used to irrigate land other than that for which it was originally destined. (Embid 2002)

It also changed the consideration of desalinized and reused water as belonging to the public domain, on equal foot to other water sources, and the issuance of special water rights granted to its users (Garrido and Llamas 2007).

Basin Authorities and irrigation districts set the ***pricing*** for irrigated water in Spain. In different areas, fixed, volumetric or both pricing principles are applied and the costs are supposed to cover supply and district costs. There is no environmental nor pollution tax included – in contrast to what the WFD suggests. Operation and maintenance costs and part of capital are subsidized. In specific, farmers pay a “regulation levy” and a “water use tariff” to the Basin Authorities through the irrigation district, and an additional tariff to cover the costs of the irrigation district itself. Irrigation districts that abstract their water directly and that do not use publicly developed infrastructures only pay the regulation levy plus their own pumping, transport and application costs. (Berbel, Calatrava and Garrido 2007)

Basin Agencies and irrigation districts have set very low water prices, so that the water bill represents a small percentage of the family income. Thus, the incentive that the current water rate schedule transmits to farmers about the desirability of conserving water is weak. Low prices foster the attitude that water is free and abundant and that there is little need for conservation and they also eliminate the cost-effective incentive to adopt more efficient technologies (Arbues and Villanua 2006).

Water prices however differ considerably not only among the different Autonomous Regions in Spain, but also within them. For instance, in the province of Andalucía the minimum price per m^3 was 0.23 €, the maximum price 0.76 € and the average tariff 0.56 € in 2003. At the same time, in the province around Madrid the minimum, maximum and therefore average price all corresponded to 0.73 € per m^3. The most expense province was Cataluña with 1.20 € per m^3 (Manuel 2003).

In Spain a fixed per-hectare tariff is applied in 82 % of the Spanish irrigated area, while volumetric tariffs are applied in 13 % of the irrigated area, mostly in those districts that are served with groundwater and/or that incur energy costs (MAPA 2001). Binomial tariffs, which combine both a volumetric component, to cover variable costs such as energy or labor, with a fixed per hectare charge, are applied in 5 % of the irrigated area. In Spain, districts with pricing based on the volume of water used consume, on average, 10–20 % less than those districts with flat rate pricing, regardless of the level of the flat rate. (EEA 2009)

Concerning the price elasticity there is no agreement between the researchers. A case study conducted by Arbues and Villanua (2006), analyzing the effect of water price, has shown that although the tariff structure established by the Zaragoza City Council leads users to reduce their consumption when prices increase, such a response is low given that the price elasticity. Also Gómez-Limón et al. (2007) report that Spanish farmer incomes need to decrease by 25 % to 40 % before price increases have an impact on water use. Moreover, the EEA has found that in irrigation systems where water efficiency is already high, the price “elasticity” is likely to be low (EEA 2009). Interestingly Eurostat (2007) came to another conclusion in the area of irrigation, which is by far the largest water consumer in Spain and perhaps the most vulnerable sector to higher water prices: Based on numerous case studies around the world, it is concluded that the role of water pricing in the agricultural sector should be downgraded. In Spain, most studies coincide in identifying a severe income effect and little reductions in water use resulting from water charge increases within the range of political feasibility. (Eurostat 2007). On the other hand, another example of irrigation districts in the Guadalquivir basin constitutes a rare exception (Manuel 2003): A new water charging structure was implemented to replace the old area-based charge. The new approach included both a fixed and variable charge linked to water use, with farmers paying, on average, significantly more than under the original area-based approach. This has resulted in a 30 % reduction in water consumption for the same crop types equating to approximately 2.000 m^3/ha of water saved per year.

Although the existence of such positive examples, Embid-Irujo (2005) still sustains that there is a general lack of stimuli for proper water management, especially for irrigation. He argues that especially for the Spanish market, very low water prices are not conducive to saving, and besides, such saving would be in many cases extremely difficult to achieve in view of the poor state of the supply lines which generate losses. The result of this inefficiency is often the constant desire to build new hydro schemes to offset already existing management problems. (Embid-Irujo 2005) This is made possible through ***metering*** systems that are quite spread among the Peninsula. The existence of more than 500 companies that produce water meters in Spain (List of Companies 2010) illustrates the widespread demand for metering instruments in Spain.

Trade and Water Markets: Pujol, Raggi, & Viaggi (2006) found out that real water markets are absent in Spain. However, Spain is interestingly the first country in the world where there have been serious attempts to provide for water right exchanges, which required the mentioned amendment to the water law in 1999, but which has so far been used very sparsely (Berbel, Calatrava and Garrido 2007).

This amendment of the Water Law opened an era of water markets in 1999; however it took 7 years for the first experiences to occur. The Law opened two routes to enable right-holders to lease out their rights either to the Basin Authorities or to another user. The simplest way just takes an agreement between two right-holders and their decision to file a petition to formally exchange the right. The Ministry of Environment and on a regional level the Basin Agency grants the permissions (Garrido and Llamas 2007). There is an underlying need for a water market or at least water transfer, since a general problem in Spain is that the most populated urban areas are in the Southern coast, where water is scarce and needs to be transferred there (Manuel 2003). In general these large-scale transfers serve the purpose of moving water from the South central plateau to the Southeast. For the moment the Basin Authorities and the Ministry of the Environment have been generous in granting these transfer requests (Garrido and Llamas 2007).

A second possibility to enable water exchange is provided by the so-called water banks or exchange centers. The option to use buyouts of water rights, permanent or temporal, gave rationale to the setup of these exchanges centers. Not strictly an office or agency, these centers are run and located in the Basin Agencies themselves. Centers are much more efficient means to promote water exchanges, for many reasons, including transparency, control, avoidance of third-party effects and market activity and scope (Garrido and Llamas 2007). The new legislation enables farmers also to sell their concessions to other farmers, thus facilitating the development of a local water market. (Arriaza and Upton 2002)

In the following, the main findings of our framework structure are briefly summarized:

(A) The Role of Institutions

(1) ***Coordination***: Although the EU pushes towards standardization, Spain is still increasingly characterized by almost full decentralization to (autonomous) regions, which makes coordination difficult.

(2) ***Trust***: The WL was granting the Basin Agencies autonomy, financial resources and personnel to become the actual decision makers in all water issues within the basin boundaries. Thereby it was able to establish trust to a certain extent between these players, although the high fragmentation could not establish a fully trustworthy environment.

(3) ***Active management***: More active management has been enhanced by the widespread recognition of the water scarcity problem, the recognition that water consumption is still increasing and that the agricultural sector is a major contributor.

(4) ***Strategic Planning***: Strategic planning is increasingly executed by more diverse groups of experts that however do not seek an integrated national approach, due to regional autonomies. The National Irrigation Plan was an attempt to realize strategic planning, however it failed.

(5) ***Clear Objectives***: Objectives are not totally clear from a top down perspective and neither at a local basin agency level.

(6) ***Clear Responsibilities***: Responsibilities for policy settings are quite clearly defined among the Autonomous Regions and Basin Agencies; however they are not coordinated and integrated among them.

(7) ***Financing***: The decoupling of financing related to crops has changed and will increasingly change crop selection and thus water consumption in Spanish agriculture.

(B) Rules and Regulation:

(8) ***Water Rights (Ownership Rights)***: Water rights are established and clear.

(9) ***Pricing and Metering***: Basin Authorities and irrigation districts set the prices. Water supply is regulated by districts/users. Fixed, volumetric or both pricing principles are applied among Spain. Costs are supposed to cover supply and district costs. There is no environmental nor pollution tax included. O&M costs and part of capital are subsidized.

(10) ***Trade and Water Markets***: Trade is very common, due to unevenly distributed water resources. However, standardized water markets are currently only existing on a very limited scale in Spain.

V. Discussion

(1) Relative Importance of the Institutional Barriers to Efficient Water Management

A first general important finding from our analysis is that the institutional frameworks, compositions and dynamics in the three countries are highly complex and also show great diversity. This complexity and diversity is a result of the different historical evolution and economic background of water management in the three countries, however there also many similarities caused chiefly by the strong recent influence of the common European regulatory framework. Still, from a legal perspective, Bulgaria, Italy and Spain play on different playgrounds. Although the European integration process has aligned to a certain extent the institutions, i.e. by pushing the countries towards a volumetric pricing approach, it has not been applied at the same pace and continuity in the three countries. The institutional setting - which we consider as the role of the institutions and the rules and regulations that they make and enforce - is one of the causes of the differences in efficiency of water management. However, the institutional barriers created by the settings in the three countries in question have shown to be of different importance. Our findings do not state that a certain barrier is not important or valid in general. In fact, all of them are important, but their relevance differs in the three countries. The underlying reasons and the importance of the outcomes will be discussed in the following section. By this we address both the primary and secondary research questions.

(A) The role of the institutions:

Although the *coordination* in the water sector is important, the relative importance of this barrier in the three countries varies. In Bulgaria, our research reveals that the poor coordination between the stakeholders in the sector has always caused problems, especially the weak inter-institutional and often conflicting and unclear laws and regulations. Still, this fact is rarely emphasized as a main challenge to achieve water sector efficiency. The importance of coordination has always been seen as complementary to the other problems in the sector. In Italy, our findings show that the institutional order is very complex and unorganized. Although there are regional differences, the general institutional fragmentation, the lack of clear objectives and the conflict between the existing one, as well as the problematic responsibilities have made coordination between the different stakeholders quite difficult. Thus a common national approach to the problems in the water sector is almost unfeasible. We expected that Northern Italy, which is the most developed and wealthy region of the country, with its long traditions in irrigation, would also be the leader in terms of coordination. Surprisingly, however, that was not the case. Due to the high fragmentation and degree of localism of institutions in the North, the area has had difficulties in adapting centralized and common goals and thus achieving coordination is very challenging. At the same time, the very South has had the opposite problem of being too dependent on the central government and actually just following its policies, however without bothering to implement them in practice. In the middle part of Italy , where there is a balance between the strength of the central government and the local institutions, the coordination in terms of allocation of clear responsibilities and objectives, has been easiest to achieve and has shown the best results. Thus, among all the elements, *coordination* seems to be one important barrier to more efficiency.

This is a very interesting finding, since it is counterfactual in that it shows that generally better institutional frameworks do not necessarily lead to more efficient water management. Rather, the findings about regional differences in Italy, paired with the ones from Spain suggest that more national and supranational similar rules and institutional frameworks are important.

The coordination of the institutional objectives and actions in Spain seems to be of paramount importance for the efficient water management. The three failed attempts to the creation of the common National Hydrological Plans clearly show the magnitude of the coordination problem. Moreover, the coordination problems associated with the National Hydrological Plan spilled over to political arena and has created a lot of tension and controversies in in the Spanish public live. In particular, the biggest current threat for Spain is the lack of clear objectives and responsibilities.

We have found out that there are strong connections between the analyzed barriers. The element of *coordination* is dependent on a top-down *strategic planning* that establishes through an *active management* approach of *clear responsibilities* and *clear objectives*. *Financing* appears to take a secondary status in terms of a barrier in Italy and Spain, whereas in Bulgaria it is still of major concern due to the dilapidated irrigation infrastructure in the country. The aspect of financing is a very interesting and complex one and has its due impact on efficiency. Financing has the potential to reduce the impact of all the identified barriers and much of the initiatives aimed at increasing the water use efficiency need strong financial resources if they are to materialize. Financing practices are constantly developing. They are influenced by the EU regulations and initiatives, the national and regional policies and funds as well as private investments and initiatives. Nevertheless we conclude - considering financing in the institutional light– that its importance as an institutional barrier is only limited, since the private sector could be the one providing financing.

The dimension of *trust* has been difficult to assess as an independent dimension, since it is part of each step in the water management process. It plays an important role in all the three Southern European countries. The trust in the institutions seems to be low in the three countries, even though the reasons for this might differ.

(B) Rules and regulation: Rules and regulations are being continuously aligned across Europe, although Garrido & Llamas (2007) argue for example that in Spain regional differences will even increase, due to the development of own legislative by the Autonomous Regions.

Rules and regulations have a relatively different influence in Bulgaria, Italy and Spain. *Water rights* are of paramount importance in Bulgaria and constitute a major threat to efficient irrigation practices. However, the problem relies chiefly in the fact that there is a great discrepancy between the written water rights, such as how they are published in the National legislation, and the water rights, such as they are exerted in practice. In the previous sections we found that the water resources in Bulgaria are formally state owned, and that the state also controls the main canal systems; however the property rights on the secondary canal systems are unclear, which is one of the main barriers to investment and maintenance of these assets. Conflict resolution mechanisms are unclear and the formal sanctioning mechanisms are inefficient. For example, the cases of stealing of water or not paying for the used water are not penalized by the authorities, which has significant negative impact on the coordination and most of all the trust among the stakeholders in the sector. Water rights seem to be of less importance in Italy and Spain. In most cases, water rights are already established and not an issue any more. However, in Spain there is a problem with the unclear underground water rights that through the years have led to massive illegal use of water. Illegal water abstractions account for around 45% of the total water abstractions, as estimated by WWF (2006). These abstractions are constantly undermining many of the good practices and policies that Spain has implemented. In fact, illegal water abstractions are an underestimated factor influencing the efficiency of the water management, not just because they incentivize unsustainable practices, but also because they produce unreliable statistical data, which is a prerequisite for well-informed and considerate decision making in the water sector.

Pricing has been a much discussed issue in connection to achieve better efficiency, thus we speculate why this wide recognition – starting from the WFD - has not resulted in a regulation that imposes the countries to adapt metering and pricing standards. It seems necessary to simplify competencies and to consider the problem of water costs in order to increase efficiency and effectiveness of water policies. In Italy, the lack of established standardized *pricing and metering* practices – at least not on a national scale – seem to be a big problem. In Spain, both metering and pricing practices exist and are exerted to a great extent.

Pricing of water is very challenging, because it is not a standard good. In a perfect competitive market, the prices are defined through the interaction of buyers and sellers. But water pricing, specifically in relation with environmental uses, has to be *"invented"* (Berbel, Calatrava and Garrido 2007). The problem is to establish a set of prices that result in achieving the optimum allocation of water. The charges for irrigation in the EU countries, as in most other countries, have been inadequate to recover capital and operating costs. Other levels of recovery have been introduced largely in regard to the issue of allocating the water between competing uses, in particular, between human and environmental uses.

Water pricing has been a much discussed topic among leading scholars around the world with different outcomes. We suggest applying volumetric rates and replacing the flat rates. Literature sees some obstacles in applying this type of pricing: Tsur and Dinar (1997) illustrate how the efficiency gains may not justify the costs of restructuring tariffs. Also Chakravorty and Roumasset (1991) show that volumetric charges imply wealth re-distributional effects in large districts with network losses. Another relevant obstacle is the lack of appropriate water-metering devices in many European irrigation districts. – Independently from this relevant critique, we sustain that volumetric measurements are one key step to achieve more efficiency in agricultural water management. The main reason for that is that such an institutional measure aims at a direct influence on the farmer behavior. But in order to change this behavior, we argue that the price must be higher than certain threshold values that are still to be discovered. These values will most probably vary among different countries, depending on the actual living costs.

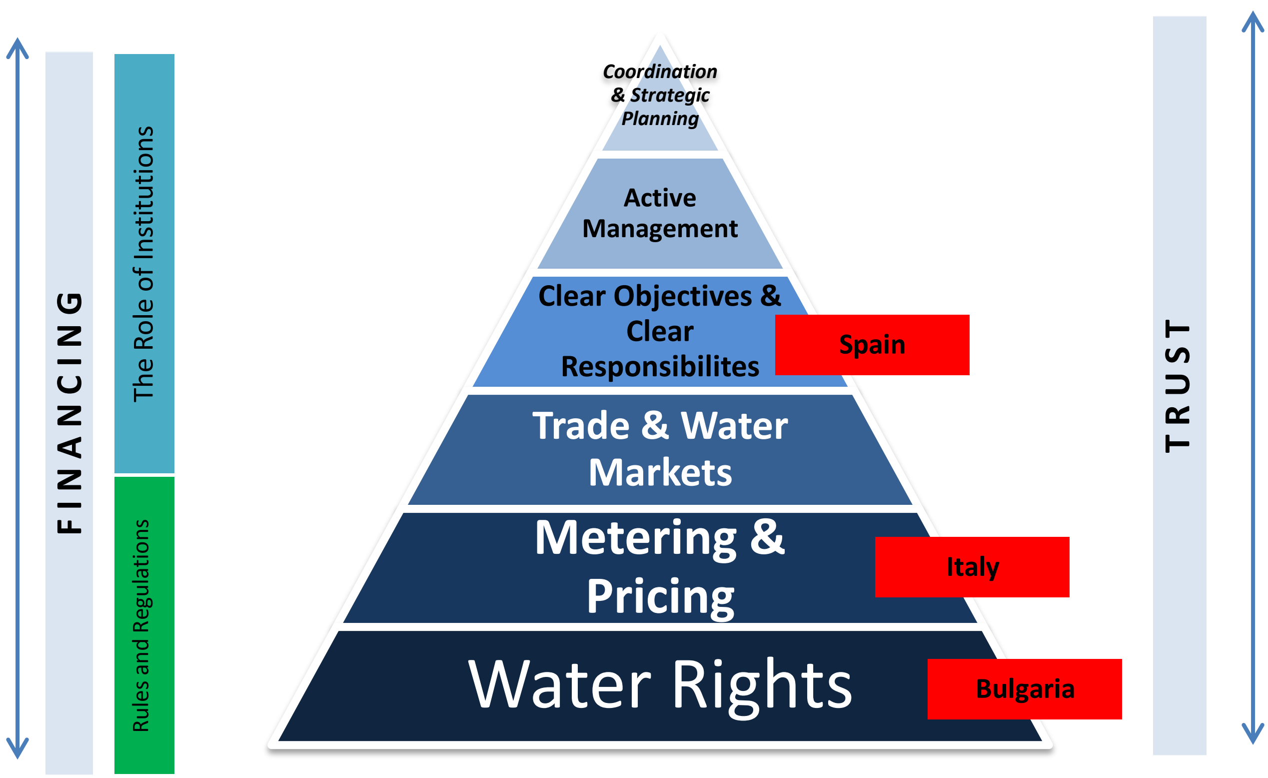
Water rights, metering and pricing should in the best case enable the functioning of *trade and water markets*. In Bulgaria, given the basic problems with the water rights, water markets do not exists. In Italy, water rights are established, however metering and pricing practices only on a small scale. Currently the water markets are pretty undeveloped, although there are signs that it might change in the near future. The water market in Spain is already functioning. However, its scale so far has been quite limited, therefore there are still no significant improvements in the water use efficiency observed. Our expectations are that this will happen in the mid and long-term.

From the above discussion it is obvious that all the mentioned barriers are in fact hindering efficient water management. However, we have also observed that their importance and relevance is different in the different countries. In Bulgaria, which has by far the most inefficient irrigation sector among the three countries, the establishment of the water rights is the biggest challenge. The main challenge in Italy is the lack of common pricing policies and the difficult coordination in most parts of the country. The main challenge for Spain is the poor coordination between the Autonomous Regions and the inability to create and implement nation-wide water policy with clear objectives and responsibilities.

(2) Hierarchy of Institutional Barriers– Pyramid Framework

The relative importance of the different barriers in Bulgaria, Italy and Spain are clearly dissimilar. However, we think it is possible to read out of these barriers some common patterns and thus we propose a new concept to analyze and remove barriers to efficient water management.

Figure 7: Institutional barriers to efficiency in agricultural water management – Pyramid



The presented pyramid represents our understanding of the institutional influence in a graphical way: Generally, we regard rules and regulations – consisting of water rights, metering and pricing - as the fundamental prerequisite to establish the rules of the game and the role of institutions as the practical implications and connotations of the institutional acting.

Thus we consider *water rights* at the bottom of the pyramid, because lacking those results in inefficient practices ex-ante. Also *pricing* depends first of all on the existence of established water rights and secondly it can only coexist with instituted *metering* practices. There are no intelligent pricing solutions without the existence of metering. From a sustainability point of view, metering is even more important, because flat-rate approaches have been considered as highly unsustainable. Consequently we argue that the bottom of the pyramid consists of the most important barriers to overcome. Once hurdled those barriers, the country steps up and moves on to the next developmental level.

The next step of the proposed pyramid is *trade and water markets*: These are dependent on water rights, because trading of water is only possible if water rights are established; and on functioning metering and pricing, since if water is to be traded on a market, its volume needs to be measured and priced. We agree with Bromley (1986), who criticizes that "*letting markets work, overlooks the very real problem of establishing the preconditions that define arenas of exchange. The problem is order."*

The upper part of the pyramid constitutes of the direct institutional acting. *Coordination and strategic planning* are at the top of the pyramid. We consider the two elements interconnected as strategic planning has to be coordinated and vice versa. The importance of coordination and strategic planning became evident especially in Italy and Spain, but also in Bulgaria. A country needs to focus on these upper elements, once the fundamental barriers are overcome.

Active management as a proactive approach to handle water management can be seen as the next logical step after coordination and strategic planning. Active management implies thenceforth *clear objectives* and *clear responsibilities*.

Outside the pyramidal framework -however interconnected with all the different steps – are the elements of *trust* and *financing*: Trust between the institutions is a key element needs to be present at all stages. We want to emphasize the importance of trust with all other stakeholders as well, foremost the farmers. Trust is difficult and establish and easy to lose, since it is connected whether previously fulfilled promises will be fulfilled. The means to establish trust are to first of all stick to the agreements that have been established with the different stakeholders during the coordination phase. In all the three analyzed countries there has been an observed discrepancy between talk and action. Any kind of decoupling should be avoided by the institutions.

Efficiency depends to a certain extent also on financing. Necessary financial resources can enable a better functioning of all elements of the pyramid. For countries such as Bulgaria, where some basic infrastructure is still missing or characterized by backwardness, the proposed pyramid can be amplified at its bottom to an additional level, the physical infrastructure.

The presented pyramid is characterized by the different levels that are highly dependent on each other. If elements at the bottom end of it are unstable and shaky, then the whole pyramid results loose and unsustainable. In addition, also if the top elements *coordination and strategic planning* are lacking, then efficiency cannot be reached. Whether developing countries or developed ones, we argue that the institutions have to master the balance between order and ability to change.

The pyramid can be understood as increasing maturity levels: Spain and Italy with clear water rights have already achieved a higher maturity level than Bulgaria. However, also these two countries need to improve in many areas, foremost the overall coordination and strategic planning from the top down. Italy needs to primarily overcome the barrier of lacking metering and pricing. Spain instead has mostly succeeded in the bottom part of the pyramid and needs to define clear objectives and responsibilities in its water management policies.

However, the pyramid does not indicate that countries need to work solely from the bottom upwards in order to remove the barriers. Elements are still quite interconnected and thus one needs to keep in mind all the discussed dimensions.

In line with the World Bank (2004) that states that - "*...infrastructure restructuring, privatization, and regulatory reform offer substantial potential benefits for governments, operators, and consumers. And there is sufficient experience to guide these institutional reforms. Still, they should not be pursued blindly in a specific country or industry without carefully assessing the institutional and structural prerequisites and without explicit attention to the concerns they raise*."- we provide with the pyramid framework, that represents a hierarchy of institutional barriers, an instrument to assess the institutional and structural prerequisites to efficient water management in irrigated agriculture.

VI. Conclusion

The research program was able to produce the final results that we aimed to achieve related to the objectives of the dissertation. It allowed us to answer the primary and secondary research questions and identify our main findings:

- Primary research question -

To what extent do the identified institutional barriers hinder efficient water management in the agricultural irrigation sector in Bulgaria, Italy and Spain?

The identified managerial and institutional barriers were of diverse importance in the three countries. Whereas fundamental water rights are weak in Bulgaria, those have already been established in Italy and Spain. *Financing* appears to take a secondary status in Italy and Spain, whereas in Bulgaria it is still a major concern due to its dilapidated irrigation infrastructure. The dimension of *trust* plays an interesting role in all the three Southern European countries. Due to the sometimes partial institutions and lack of transparency, stakeholders have lost trust to a certain extent in the institutions.

1) **Bulgaria** has been influenced by all the barriers that inhibit efficiency. But the most important barrier in Bulgaria is the weakly implemented *water rights*. Metering is available on a very limited scale, the pricing mechanism encourage neither efficiency of water use nor trust between the service provider and the users. Water markets are not present at all. Additional barriers are the lack of strategic planning, the division of clear objectives and responsibilities and active management. However, all the latter ones currently constitute less important barriers than the lack of water rights.

2) **Italy** foremost struggles with setting up standardized approaches to firstly, metering and secondly, pricing practices. Thus *pricing and metering* currently constitute the biggest barrier in Italy. The Peninsula is characterized by the presence of different barriers in different geographic locations. In the Northern part there are many local Basin Agencies and other decision makers on this institutional level that result in a highly institutional fragmentation that is difficult to manage. At the same time the very South has had the opposite problem of being too centralized. The middle part, where a working balance between the central and local institutions has been achieved, has demonstrated to be the most efficient in terms of coordination and allocation of clear responsibilities and objectives. We think that this may be also thanks to the fact that the North has the most water resources, the most irrigation in both terms

of areas irrigated and advancement of technology. All this, combined with very fragmented municipalities and basin agencies makes coordination naturally more challenging.

3) **Spain** seems to have the most efficient water management of the three countries researched. The country has introduced metering and pricing mechanisms in the majority of the area. Moreover, it is one of the few countries that have already established water markets, although at a limited scale. In the complex institutional field in Spain, coordinated action seems very important and at the same time difficult to achieve due to the diverging interests of the national, regional and local institutions. Thus the greatest institutional barriers in Spain are the lack of clear *objectives and clear responsibilities*.

An important finding we made was that generally better institutional frameworks do not necessarily lead to more efficient water management. Thus, we argue that more national or supranational similar rules and institutional frameworks are more important. Therefore we want to emphasize the importance of the EU to step in and proactively shape the institutional frameworks.

- Secondary research question -

Why do the identified institutional barriers differ in Bulgaria, Italy and Spain?

We have been able to answer this question by setting up a pyramid framework. As described above, Bulgaria, Italy and Spain are all on a different development level. Based on our study findings, we propose a framework based on a pyramid that allows assessing the current status or maturity level of countries and thereby explains *why* the importance of the identified institutional barriers differ in Bulgaria, Italy and Spain:

1) **Bulgaria**: We rank Bulgaria at the bottom of the pyramid, due to the fact that not even water rights are well established, not to mention the big distance from functioning metering or pricing, that are the main prerequisites for the existence of water trade. Thus the biggest institutional barrier in the Bulgarian agricultural irrigation sector is the absence of water rights. However, organizational deficiencies in terms of lack of strategic planning and coordination, unclear responsibilities and objective, in addition to passive administration rather than active management contribute as barriers to efficiency, although at the time being their importance is secondary.

2) **Italy**: We consider this country as positioned one step higher than Bulgaria in our pyramid. Italian institutions have mostly overcome the barrier of water rights, mostly as a result of a century long history in water and irrigation management. The biggest barriers to efficient water management from our

institutional viewpoint constitute the lacking metering and the divergent pricing methods across the Peninsula. Therefore it is difficult to make use of the existing water rights. Additionally, fragmentation and geographical differences and a lack of centralized strategic planning and coordination constitute secondary barriers.

3) **Spain**: We consider the Spanish institutional framework and setting as the most developed among the three countries. Spain can look back as well to a century long history of water and irrigation management and it has overcome some of the basic barriers that Bulgaria and Italy are still struggling with. It has been able to establish transferable water rights and metering. It is even considered the first country in the world with serious attempts to establish a water market. Thus the biggest barriers for Spain are the completion of water markets around the whole country and more importantly, the overall coordination and strategic planning that imply the division of clear responsibilities and clear objectives, thereby actively managing the system and establishing trust among all the players.

Limitations in methodology and framework

We are aware of constraints and weaknesses that our research methodology faces. We see a major problem in the implicit limitation of sources: Although based on a variety of sources and statistics, we sometimes faced difficulties in interpreting the information, due to the often unreliable information that is available – including also official statistics delivered by Eurostat or the National statistic institutions. This is in line with the findings of Wriedt et al. (2008), who have discovered great discrepancies between the statistically reported water abstractions for irrigation and the amount of calculated irrigation requirements based on their model. The reason for those discrepancies could be also found in the deficiencies in the statistical data, and uncertainties about the actual size of the irrigated areas. For example, data about irrigation water use is rarely measured, even though monitoring could theoretically provide reliable data (Wriedt, et al. 2008). Contributing to unreliable statistics are also illegal abstractions (exceeding legal abstraction rights or undeclared and unauthorized abstractions), that severely bias the abstraction assessments. For example, the Spanish water authorities estimate that about 510.000 illegal wells exist in Spain, extracting at least 3.600 hm^3 of water as opposed to legal abstractions of 4.500 hm^3 (WWF/Adena 2006). Thus about 45 % of all water abstracted from aquifers is abstracted without legal constraints, providing a clear example of the so called "tragedy of the commons" (Hardin 1968) – We encountered the same problem, since we dealt also with external, secondary data. As mentioned before, we dealt with this problem by trying to "validate" the information by using multiple sources of information; however a small degree of uncertainty remains and this fact should be taken into account.

Furthermore, the mere focus on managerial, institutional and organizational theory provides only a limited picture of the overall situation, by neglecting and under stressing the importance of technical and engineering theories.

Additionally, by going more in specific of our framework, one might also criticize the choice of the benchmarking categories. Firstly, they appear rather vague and undefined. In addition to their ambiguous definition, they are also to a certain extent overlapping: For example, within *(A) Rules and Regulations*, the various subcategories may be seen as overlapping. *Coordination* for example, depends on *strategic planning*, *clear responsibilities* and *clear objectives*.

Recommendations for future studies

Holmes (2000) underlines the lack of attention to the cultural background as a significant barrier to the development in the water sector. According to him, the problem is that water management theories and concepts are based largely on research work conducted in English-speaking countries cannot be applied in another country without further proof. Also the presented framework has been developed and tested in Bulgaria, Italy and Spain – non-English speaking countries however. The framework was not tailored ex ante to these countries, but rather developed as a European or even global framework. Henceforth we suggest future studies to apply the proposed framework to different countries in order to identify institutional barriers to efficient water management. Since the topic is supposed to be even more discussed in the future, we hope, in addition, that the framework will find also some practical effects and results in a better functioning institutional agenda that recognizes the crucial importance of the scarce resource of water as outlined in the first chapters.

Although not included in the framework, we would like to draw the attention to the farmers as the end consumers. Farmers are among the most important stakeholders in agricultural irrigation, because they are the one taking first and foremost the decision whether to use irrigation or not and then what kind of agricultural practices to use. Also, there is clear link between the agricultural practices of farmers and the use of water (EEA 2009). Therefore, if an institutional reform aims at increasing water use efficiency, it should also consider how to modify the current inefficient agricultural practices. This is however, easy to say and hard to implement. A change in one agricultural practice involves millions of farmers, which are also within Bulgaria, Italy and Spain rather heterogeneous groups with a lot of differences. The attitude of the farmers towards new techniques and technologies is therefore crucial. If the farmers are more willing to innovate, then the adaptation of new practices will be faster and cheaper.

Therefore, the farm structure and farmers' behavior, attitudes, their willingness to innovate, and decision making processes have significant influence on the efficiency on the water use (McKinsey & Company 2009). This could be an interesting field of research that could expand the proposed framework even further.

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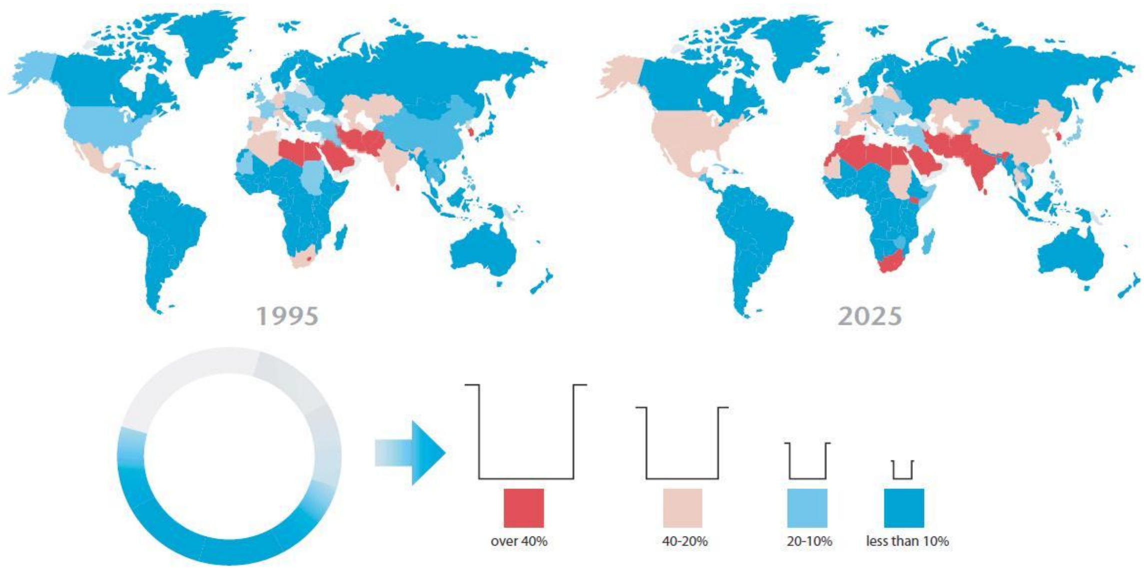
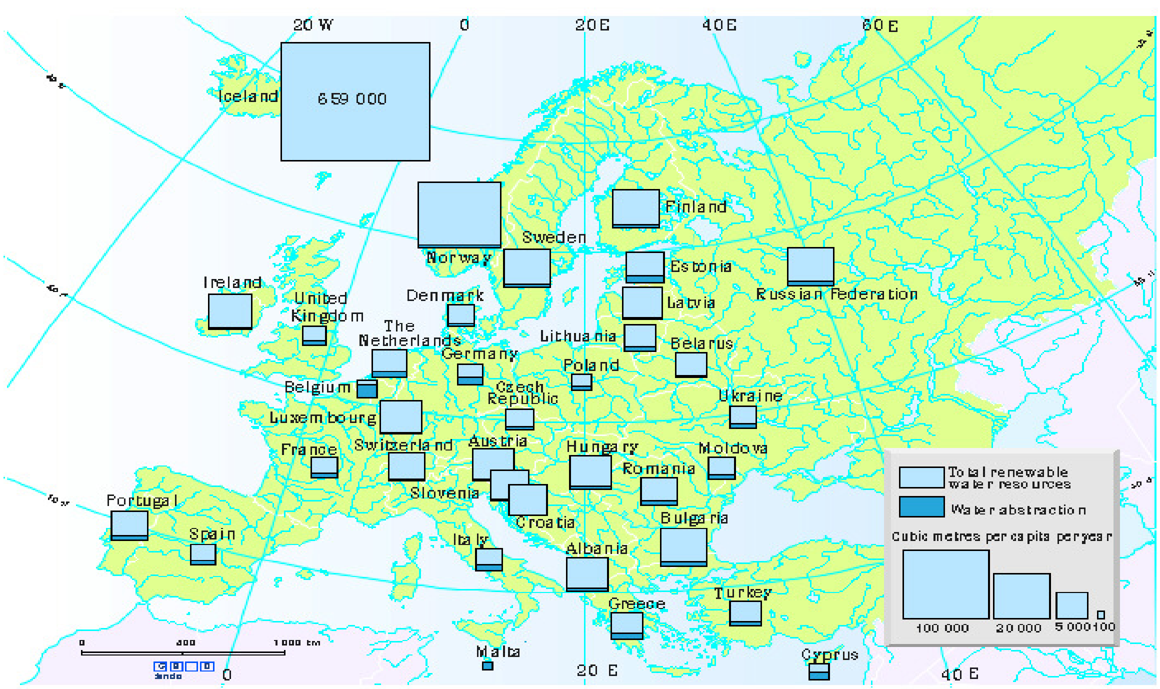
VIII. Appendices

Appendix Figure 1: Water Stress – Projection of how much water will be withdrawn with respect to the amount that is naturally available.



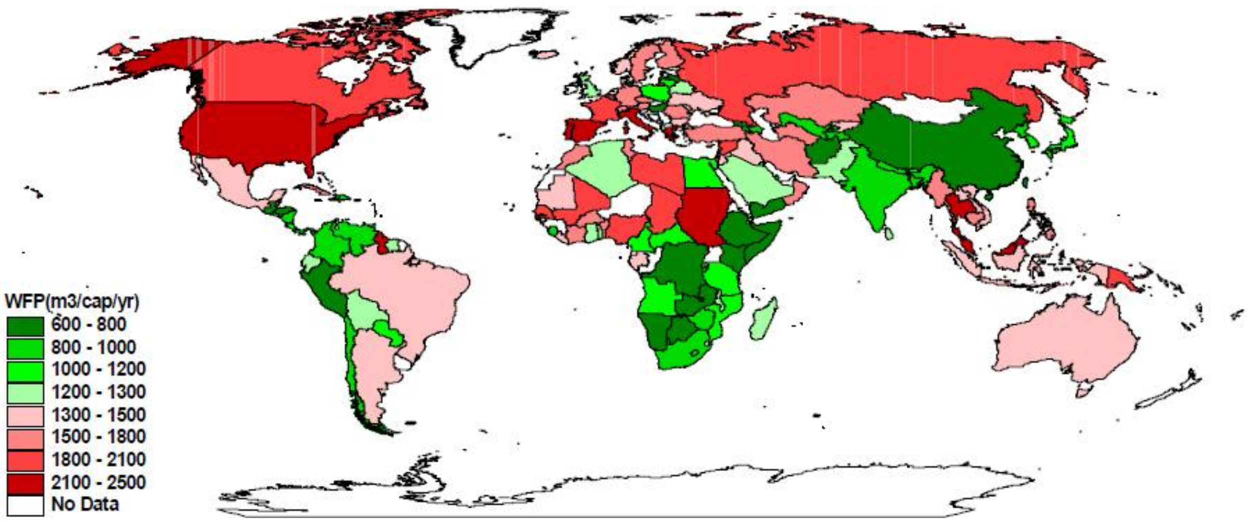
Source: Fry and Haden (2005)

Appendix Figure 2: Water resources in Europe per capita



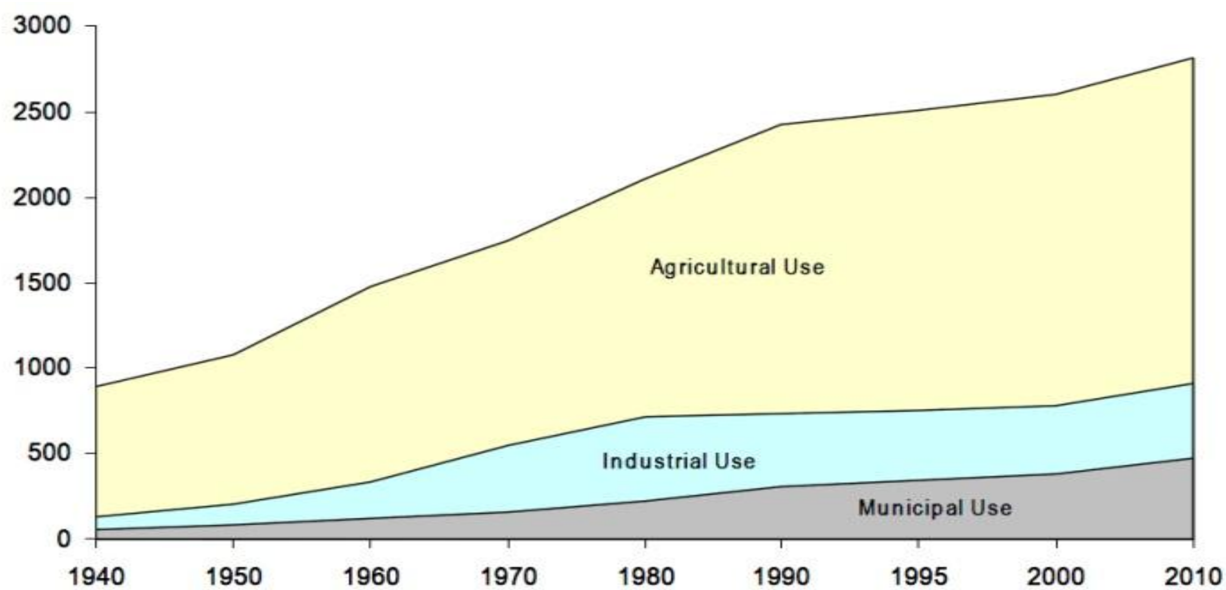
Source: European Environment Agency (2005)

Appendix Figure 3: Average national footprint per capita (m^3/capita/yr)



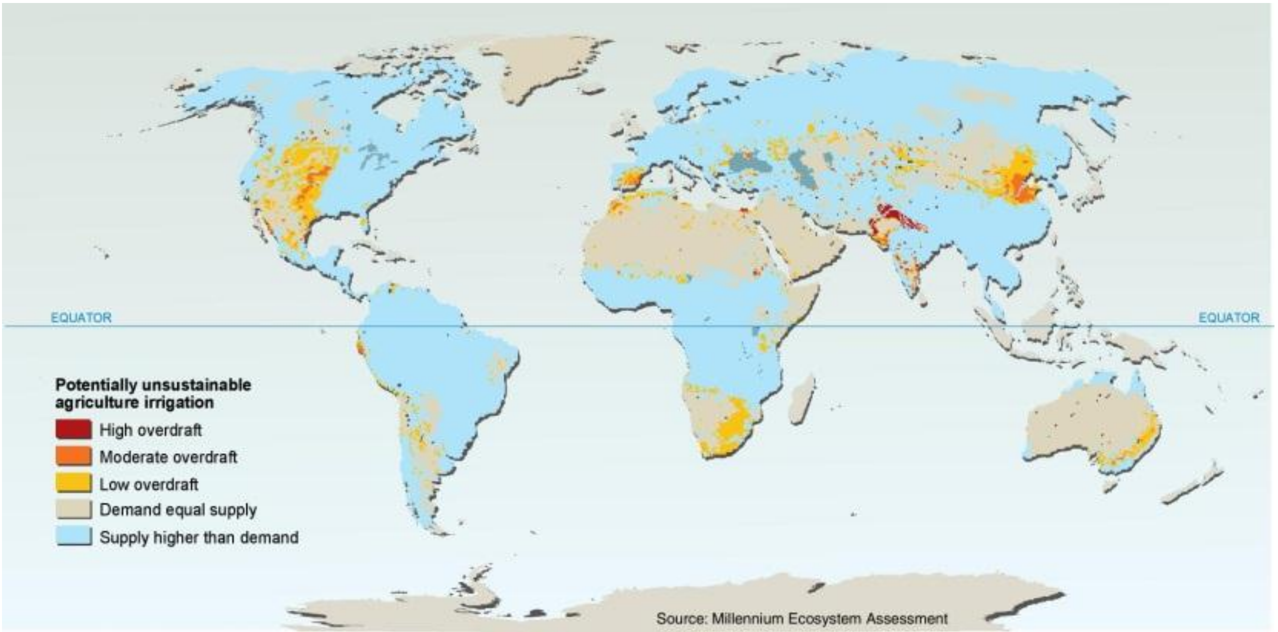
Source: Chapagain and Hoekstra (2004)

Appendix Figure 4: Water withdrawals by use (km^3 per year)



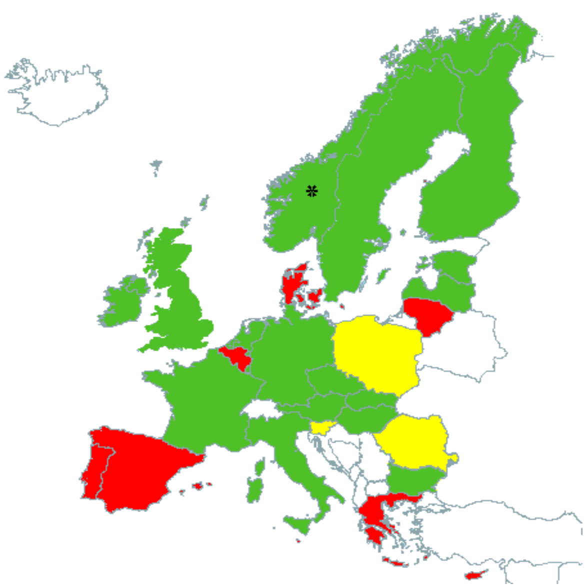
Source: JP Morgan (2008)

Appendix Figure 5: Unsustainable water withdrawals for irrigation



Source: World Resources Institute (2005)

Appendix Figure 6: Status of adoption of River Basin Management Plan in Europe



The three colors represent:

Green: River Basin Management Plans adopted.

Yellow: consultations finalized, but awaiting adoption.

Red: consultation have not started or ongoing.

Source: European Commission (2010)

Appendix Table 1: Water scarcity and water import dependency for selected countries (1997-2001)

Country	Total renewable water resources (Gm^3/year)	Total water footprint (Gm^3/year)	Water scarcity (%)	National water self-sufficiency (%)	Water import dependency (%)
Austria	77.7	13	17	37	63
Belgium-Lux.	21.4	19.2	90	20	80
Bulgaria	**21.3**	**11.3**	**53**	**87**	**13**
Czech Republic	13.2	16.1	123	71	29
Denmark	6	7.7	128	40	60
Finland	110	8.9	8	59	41
France	203.7	110.2	54	63	37
Germany	154	126.9	82	47	53
Greece	74.3	25.2	34	65	35
Italy	**191.3**	**134.6**	**70**	**49**	**51**
Malta	0.1	0.7	1478	13	87
Netherlands	91	19.4	21	18	82
Poland	61.6	42.6	69	71	29
Portugal	68.7	22.6	33	46	54
Romania	211.9	38.9	18	89	11
Spain	**111.5**	**94**	**84**	**64**	**36**
Sweden	174	14.4	8	47	53
United Kingdom	147	73.1	50	30	70

Source: Acquastat (2006)

Appendix Table 2: Agricultural irrigation in the EU (arranged in descending order of irrigated area)

Country	**Total Geographic Area** (Mha)	**Irrigated Area (2009)** (Mha)	**Drained Area (2000)** (Mha)	**Arable & Perm. Crop Area (APC) ('03, '07,'09)** (Mha)	% of APC to Geog. Area	% Irrigated Area to APC	**Food Production (Cereals) (2004)** (MT)	**Productivity for Cereals (Av.2003-05)** (Kg/ha)
Spain	**50.60**	**3.80**	**NA**	**26.30**	**51.98**	**14.45**	**24.5**	**3350**
Romania	23.84	1.50	1.83	9.85	41.32	15.23	7.8	1541
Italy	**30.13**	**2.75**	**5.30**	**10.70**	**57.00**	**25.70**	**23.3**	**5043**
France	55.15	2.60	2.50	19.57	35.49	13.29	70.5	6893
Greece	13.20	1.45	0.52	3.83	29.02	37.94	5.0	3905
Portugal	9.19	0.65	0.04	2.31	25.14	28.14	1.4	2533
Bulgaria	**11.10**	**0.59**	**0.08**	**3.53**	**31.80**	**16.66**	**7.5**	**3279**
Holland	4.15	0.56	3.00	0.94	22.63	59.57	1.9	8308
Germany	35.70	0.49	4.90	12.04	33.72	4.03	51.1	6614
Denmark	4.31	0.45	1.50	2.27	52.68	19.78	9.0	6088
Hungary	9.30	0.23	2.30	4.80	51.60	4.79	16.7	4719
Slovak Republic	4.90	0.18	NA	1.56	31.84	11.73	3.8	4099
UK	24.29	0.11	4.65	5.71	23.51	1.93	21.0	7192
Poland	31.27	0.10	4.20	12.90	41.25	0.78	29.6	3212
Finland	33.84	0.08	2.50	2.26	6.68	3.54	4.2	3543
Cyprus	0.93	0.04	0.02	0.14	15.14	28.57	0.1	2149
Belgium	3.30	0.04	0.27	0.86	26.06	4.65	2.9	8788
Czech Rep.	7.89	0.02	0.40	3.30	41.84	0.73	8.8	4716
Lithuania	6.50	0.043	2.62	2.61	40.15	1.65	2.8	3450
Austria	8.39	0.004	0.21	1.46	17.41	0.27	5.0	5978
Estonia	4.52	0.004	-	0.56	24.50	0.36	0.6	2007
Slovenia	2.02	0.008	0.08	0.20	9.90	4.00	0.5	4162
Ireland	7.03	NA	1.15	1.12	15.94	NA	2.5	7442

Source: ICID (2010)

Appendix Table 3: Indicative values of the average field application efficiency

Irrigation methods	Field application efficiency
Surface irrigation (border, furrow, basin)	0.60
Sprinkler irrigation	0.75
Drip irrigation	0.90

Source: Wriedt et al. (2008)

Appendix Table 4: Irrigation method types in the EU

	Type of irrigation method by area (ha)			Type of irrigation method by percent		
	Surface	**Sprinkler**	**Drop**	**Surface**	**Sprinkler**	**Drop**
Belgium	100	860	150	9	81	14
Bulgaria	**127 490**	**7 190**	**1 400**	**94**	**5**	**1**
Czech Republic	90	1 760	260	4	87	12
Denmark	0	9 300	190	0	99	2
Estonia	0	0	0	:	:	:
Ireland	0	0	0	:	:	:
Greece	340 630	180 040	184 600	59	31	32
Spain	**358 990**	**78 830**	**208 460**	**55**	**12**	**32**
France	13 080	84 580	19 930	12	80	19
Italy	**233 080**	**221 400**	**136 560**	**42**	**40**	**24**
Cyprus	10 500	6 180	19 740	32	18	60
Latvia	10	100	0	9	90	0
Luxembourg	0	0	0	:	:	:
Hungary	4 970	17 190	6 310	18	62	23
Malta	620	1570	2 870	16	43	78
Netherlands	0	18 440	1 360	0	97	7
Austria	840	3 560	2 280	14	59	38
Portugal	145 480	20 000	18330	83	11	10
Romania	46 200	36 330	990	57	45	1
Slovenia	230	660	320	20	59	28
Slovakia	2 720	1 420	260	64	33	6
Finland	0	0	0	:	:	:
Sweden	:	5 200	:	:	100	:
Norway	0	9 280	440	0	97	4

Source: Eurostat (2003)

Appendix Table 5: Indicative values of the average conveyance efficiency (by soil type)

Canal length	Sand	Loam	Clay	
Long (> 2000m)	0.60	0.70	0.80	0.95
Medium (200-2000m)	0.70	0.75	0.85	0.95
Short (< 200m)	0.80	0.85	0.90	0.95

Source: Wriedt et al. (2008)

Appendix Table 6: Farms with relative surface area equipped for irrigation and effectively irrigated in regions and geographical zones (surface area in hectare) / Italy

Regions	Farmers with irrigation technology		Surface equipped with irrigation technology		Farms with irrigated surface		Irrigated surface	
	Number	% of all farmers	Absolute Values	% to total cultivated surface	Number	% of all farmers	Absolute Values	% to total cultivated surface
Northern regions	245,373	54.6	2,357,953	50.1	198,274	44.1	1,694,452	36.0
Central regions	76,534	28.5	372,939	16.0	57,110	21.2	182,347	7.8
Southern regions	355,831	37.1	1,219,611	20.9	308,279	32.1	789,406	13.6
ITALY	**677,738**	**40.4**	**3,950,503**	**30.7**	**563,663**	**33.6**	**2,666,205**	**20.7**

Source: Istat (2010)