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 Identification of problem Issues



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Executive Summary

The aim of this document is the development of a theoretical support to the socio-economic framework. Above are presented the main principles to be followed by the case study partners to build each socio-economic report.

A substantial part of this deliverable is concerned with forecasting the changes in water demand given certain changes in the social and economic dynamics. Nevertheless, more than just a support to forecast, it is a framework to help a more exploratory approach which has the potential to provide some of the possible deviations from the expected future.

The deliverable presents an introduction to the approach of the problems definition. The structure of this document is divided in the following parts: Water Demand Issues; Socioeconomic analysis concerns on SMART project; and Suggestions to a deeper analysis.

The analysis of **water demand issues** is mostly concerned with the expected change in the demand of water, given certain levels of socio-economic changes, with special attention on population scenarios. These are based on a set of assumptions, extrapolated from current understanding of demand and its constraints. The assumptions are based on the principles to build water demands, adapted to each case study.

However, the population changes and its effect on water demand are not entirely predictable, especially when it takes into consideration all the interactions between the socio-economic processes.

This document also provides the procedure for estimate future water demand. The description provides additional details for implementing the water demand analysis in each case study. The water demand forecasting algorithm needs to operate on data corresponding to each case study, to each economic sector, and to each forecast year.

Forecasts are devising for domestic use and non-domestic (agricultural, commercial and industrial sub-sectors) for case study regions; and for 2005, 2010, 2015, 2020, and 2025. The projection of residential water use to 2025 will be simulated using a linear-predictive model to incorporate demographic, socio-economic, and climatic variables. The projection of non-residential water use to 2025 will be simulated separately using a constant rate model incorporating water use per economic sectors.

The relationships between the WP2 and other workpackages are presented in this deliverable. An interdisciplinary analysis is proposed to approach the best



way to integrate the socio-economy into this study. One of the suggestions is to develop the analysis based on the integrated thematic analysis between socio-economic aspects and policy framework.

In **suggestions for a deeper analysis** it is presented the potential improvements based on the analysis of the water scarcity management, and analysis requirements of WP2. These improvements, both thematic and methodological, are basically theoretical proposals.



Introduction

“The demographic growth and human concentration in some areas, together with an increase of individual and collective needs made water rare and often polluted. Large efforts have to be made to make it fit its various use and face floods and drought. Its management, more and more expensive and complicated, needs new methodologies, trained experts and important financial support”. (La charte sociale de l’eau, 1999)

The main objective of this deliverable is the identification of problem issues regarding both the socio-economic point of view and the methodological constraints.

As it described on the general objectives of the SMART project, the socioeconomic dimension is one of the components present on the final results “to develop and implement a set of tools (...) integrating physical and socioeconomic aspects within a common consistent framework of indicators of sustainable development.” (SMART Technical Annex, 2001)

This deliverable of WP2 focuses mainly the human systems, but also the natural systems, particularly on the interactions and feedback mechanisms between them.

The methods to understand the effects and consequences of socio-economic developments on the water available are particularly complex, sensitive and not obvious. Intricate relationships exist between the climate and the distribution and motivation of people who make land use decisions which affect water degradation. Forecasting when some policy decisions will affect the water quantity and quality available is very difficult and would be impossible without spatial interdisciplinary decisional support systems.

In SMART project to explore the nature of geoenvironmental and socio-economic interactions relating to water availability it was argued that a predicted model of water demand would be extremely useful. In the early stages of developing this model it became clear that it would have to be a mix of quantitative and qualitative model given the nature of the available data. Despite this imposed generality we believed such a model could at least be used in gaining a greater appreciation and understanding of the complexity and sensitivity of the processes involved.

The choice of the socio-economic methodology reflects the approach in terms of the assumptions that are made, which determines the variables that are used as inputs and spatial and temporal frame.

The method involved classifying and indicators building for the contemporary social framework, economic development, water use and pricing, projecting future of population and related scenarios of water demand forecasts. It is important to understand that the methodology proposal on WP2 offer a useful framework to approach possible impacts of policies on socioeconomic and water



demand indicators. The quality of the results achieved until this moment reflects the quality of the data inputs that have been used.

The Demand Water Prediction System (DWPS) that will be developed in the frame of SMART project is intended to investigate the nature of socioeconomic dimensions and forecast the likely impact of water available scarcity driven by global policy changes.

The goal is to develop a practical educational/support tool which raises consciousness of sustainable development sensitivity, improves water management and helps strategies to mitigate water scarcity problems. The DWPS provides for the TELEMAC a basic framework for a scenario based forecasting system that can be easily updated and extended as new and improved input data becomes available.

At an appropriate stage in the development of the DWPS, information about policy could be incorporated into the modeling to develop some form of decision support capability. It is expected that the result of the WP2 will primarily function as a way to raise awareness of socioeconomic driving forces that are involved on water management forecast.

In summary, the WP2 reports of each SMART case study implemented was not designed to directly attempt to TELEMAC hydrological model because this was believed to be almost impossible at the time in any non-trivial manner. Instead it was an attempt to classify the likely relative broad scale effects of recent policy options on socio-economic patterns and translate the expected changes in forecast water demand.



1. Water demand issues

This point is mainly about constraints information and issues that develops population and water demand projections.

One of the objectives of this point, the development of socio-economic data projections, has traditionally been accomplished to better understand the sense of the water resources modeling processes. All of the socio-economic projections involve the consideration of an extraordinary range of variables. These socio-economic variables are particularly difficult to forecast and measure, which demonstrate the vulnerability of the traditional modeling process.

To accomplish the socio-economic projections it is necessary to carry out a top-down methodology based on different levels of analysis and including a very large set of variables. With this type of method it is also possible to understand the framework of the decisional processes.

1.1. Population, demographic and migration policy analysis

One of the main results from this task is the demographic projections. These population scenarios will be fundamental to build water demand projections. The water demand projections require a coordinated plan of comparative studies conducted mainly at the regional level that specify the relationships between water use changes and a common set of independent variables, such as changes in population size, distribution, density, changes in economic structure and technology.

With these objectives of WP2 in mind, it is important to note that “census data are nearly always the only source of comparable socio-demographic data for different regions around the world” (WOOD, 1998). The needs to harmonizing the reference data to forecast population was a problem to achieve a comparative analysis. In fact the date of the census of these five countries is different.

1.1.1. Population projections

The technique for projecting regional populations is a cohort-component procedure, which uses the separate *cohorts* (age/sex groups) and components of cohort change (fertility rates, survival rates, and migration rates) to calculate future populations. Projections of each cohort are then summed to the total population. *cohorts* used in the projection process are defined as quinquennial-year-of-age *cohorts* by sex groups.

The components of *cohort* change include fertility rates, survival rates, and migration rates. Fertility rates for each female cohort are incorporated into the projection procedure for calculating the number of births anticipated to occur between each projection interval. Survival rates for each cohort are used to compute the change in the cohort size relating to the number of deaths anticipated to occur between each projection interval. Net migration rates for each cohort are used to compute the change in each cohort due to in-migration or out-migration in a specific region.



There are four main steps in applying the method: the first is to project the population alive at the beginning of the year who will survive to the target year; the second step is to project net migration by multiplying net migration rates by the adjusted population in the launch year; the third is to project the number of births and the net impact of mortality and migration on the youngest age group; and the fourth is to combine the results from the mortality, migration, and fertility modules.

The final calculations of the components of change combine the results from the mortality, migration, and fertility modules. For all, except for youngest age category, the projected population at each age is calculated as the survived population plus the migration balance.

The use of the *cohort*-component procedure for the projection of regional populations requires detailed data that are not usually available for areas smaller than the regional level (see the results from D1.1).

As it was unavailable the data enough to develop entirely the population projections methodology, it is presented another procedures to build the population scenarios. This alternative is based on the growth rate trends observed since 1990. The growth ratios method examines population growth between 1990 and 2000. It is then assumed that the area's share of the region population growth will be the same in the future as it was between 1990 and 2000.

1.1.2. Political options and population projections

Approaches to population policies could highlight direct population changes. For example, a favorable migration policy will have a direct influence on the potential active population. Nevertheless, other population policies like fertility have no immediate impact in the composition and structure of the population. Additionally, the policies of the immigrant-receiving countries play an important role in the population dynamics of these labor-supply countries.

In fact, a fertility policy can be in contradiction with the traditional, cultural and religious dimensions of the population, resulting in an ineffective policy.

The interaction of the economic and demographic forecasts occurs through migration policies. The population forecast is used to generate a labor force forecast. A primary driver of in-migration occurs when a tight labor market causes people to relocate to obtain employment. Migration is mainly dependent on employment, income, and the cost of living.

In general terms, there is a strong link between projections and policy options. This proximity it is observed in both directions. In one direction, projections can contribute to a rationalization of government in the area of economic development, urban planning and so on. They provide societies with a partial view of their future. In the other direction, population projections cannot be undertaken without the help and support of governments and major international organizations. "More than many other instruments of demographic analysis, the history of world population projections demonstrate (...) the intricacy of demography and politics" (Martinot-Lagarde, 2001).



1.2. Political and economic options adopted for the study areas

“The use of economic instruments by Member States may be appropriate as part of a programme of measures. The principle of recovery of the costs of water services, including environmental and resource costs associated with damage or negative impact on the aquatic environment should be taken into account in accordance with, in particular, the polluter-pays principle” (Point 38 in WFD introduction)

As it is describe on the general objectives of the SMART project the Water Framework Directive (2000/60/EC) is a key reference to compare and analyze the water policies of each country involved in the project.

Of all the new features introduced by the WFD, economic analysis is by no means the least. This will now constitute a decision-making aid, where choices have to be made.

First of all, the directive requires identifying the uses of water: leisure uses, abstraction for the drinking water supply, irrigation, industry, etc. Going beyond the localisation of abstraction and discharge, the directive requires the characterisation of the social and economic importance of these uses: what are the related economic activities; can they be assessed in economic terms, in terms of turnover, employment, etc.?

In the SMART project, the WFD is important as a reference for the analysis of water management resources. So, the comparative analysis of these five case studies will be achieved taking into account WFD principles and orientations.

One of the goals of WP2 is the identification of specific actions or programs that would lead to a more sustainable future for the case study areas. Thus, the following questions: What can be done? How can it be done?

- Consumer demand;
- Conflicts and competition for water;
- Jurisdictional and institutional boundaries and differences;
- Governmental programs, policies, and regulations, including institutional constraints;
- Fiscal pressures and constraints;
- Technology;
- Changes in land use;
- Social traditions and attitudes;
- Population changes, shifts, and demographics;
- Water use trends and conflicts
- Resource limitations
- Social conditions (e.g., domestic income, level of education, etc.)

The limits of a sustainable use of resources and the problem of tradition

As a work hypothesis it was assumed that the undervaluation of water, the lack of knowledge about factors affecting water availability on the future, and the



cultural fixation of a short-term commodity-producing economic system are significant limits for the sustainable use of these resources. As it described in the deliverable 1.01 there are different cultural and economic constraints dominating the socio-economic context in each case study.

Nevertheless, in all the case studies, the traditional view has been that water is there to produce better commodities. In the official discourse, some changes are occurring from an emphasis on economic values to greater appreciation of aesthetic, environmental, and ecosystem values and the preservation of the resources. This shift has occurred as the old and new mentalities are in potential conflict.

1.3. Competing water uses

The build of scenarios of water demand are is an important theme for the “competing water uses” task. The scenario approach can also provide a common framework for diverse stakeholders to map and address the critical concerns and identify alternatives. Those scenarios can be a starting point for a discussion and debate forum.

The development of scenarios generally begins with the characterization of the current situation. An important step is represented by the definition of the critical dimensions describing the scenario. Collectively, it can be define the multidimensional space within which scenarios can be mapped or constructed. Dimensions do not necessarily imply causal assumptions; rather, they are defined in terms of their relevance; they are descriptors of the most important attributes of the images of the future. Examples of possible dimensions are economic growth, social development, environmental quality, conflict level, etc.

The major driving forces must be identified; they represent the key factors, trends or processes which influence the situation, focal issue, or decisions, and actually propel the system forward and determine the story’s outcome. Some of these forces are invariant over all scenarios; that means they are in a large extent predetermined.

The major driving forces propelling the global water scenarios have been identified, by various experts, as pertaining to the following clusters (Schwartz 1991):

- Demographic (population growth).
- Economic (economic output; trade; prosperity in the South; water works investment).
- Technological (hi-tech expansion; water efficiency; unit water pollution; adoption of new crops; water sanitation investment; number of desalination plants; withdrawal efficiency).
- Social (global lifestyles; poverty; inequity).
- Governance (power structure; level of conflict; globalization).
- Environmental (water-related diseases; soil salination; groundwater; ecosystem health).

Those drivers influence, but do not completely determine, the future. Thus, while the initial drivers are the same in all scenarios, the trajectory of the global system follows a different course in each of them.



1.3.1. Water demand projections

In the SMART project one of the most important outputs of the WP2 is the framework for water demand projections: three projections of water consumption for the years 2005, 2010, 2015, 2020 and 2025 will be made for each case study area: business as usual; water crisis; sustainable water use. These three scenarios differ in terms of the assumptions about water use in the future (the scenarios are described on deliverable 2.2).

An analytical stochastic methodology to model domestic water consumption, based on the IWR-MAIN¹, is proposed to develop in the SMART case studies. This methodological proposal is based on observed relationships between water use and causal factors, or determinants, of urban and rural demand of water. These causal relationships will be important to consider the differences between urban and rural areas.

The causal factors are the specific reasons for changes to project water demand. The main reasons which influenced the water demand changes are the following:

- Population change (based on the population projections);
- Plans for the future development of the urban areas;
- Actual per capita use of water;
- Increase of per capita use of water;
- Factors that could influence the increase per capita municipal water use:
 - The number of people per household - this tends to cause a change in per capita use because household uses are increase over fewer people.
 - The commercial/tourism increase - this also tends to drive a per capita water use.
- Other factors:
 - Average household income;
 - Effective marginal price of water;
 - Fixed charge regarding to the water;
 - Housing density
 - Employment by economic sector

Water demand projections for domestic uses

To discriminate the urban and rural domestic consumption is presented the form of the equation to forecast the average water use (adapted from IWR-MAIN):

$$GWU = (a + b^{d1} + c^{d2} + d^{d3} + e^{d4} + f^{d5} + (\dots) + o^{dx}) / \text{Resident Population}$$

GWU	predicted gross water use per capita in liters per day
a	inelastic demand in litters/day
b	average temperature
c	average household income (€)

¹ - Planning and Management Consultants, <http://www.iwrmain.com>



- d effective marginal price of water (€)
- e average household size (persons/household)
- f housing density (based on the satellite images)
- o other factors to consider
- d1...dx elasticity values for each independent variable

The elasticity is a measure of the relationship between water use and an explanatory or independent variable. For example, an income elasticity of +0.5 would indicate that a 1 percent increase in income would result in a 0.5 percent increase in water use. The adopted elasticity depends on the assumptions, mainly related to the urban or rural characteristics. If three scenarios are considered, then it is possible to obtain three different elasticity values (or not). Some non representative sample of elasticity adapted from IWR is outline in the following Table 1:

Table 1 – Example of elasticity values

Variable	Business as usual scenario	Water crisis scenario	Sustainable water use scenario
Persons per household	+0.40	+0.40	+0.40
Housing density	-0.65	-0.30	-0.25
Average household income	-0.25	-0.15	-0.10

These values of elasticity depend obvious on the socio-economic conditions of each case study. This knowledge about the socio-economic framework is the base to support the decisions about the values adapted to the elasticity.

The simplest approach for projecting the future water demand in residential areas it is the use of projected gross water use per capita and projected population. Gross per capita use of water can be observed from known water consumption and known population. Projections can be made for different population growth scenarios combined with varying assumptions about future changes in the capita water use.

The total residential water demand for years 2005, 2010, 2015, 2020, and 2025 is determined as follows:

$$WDy = (q^{y*} h^y)/10^6$$

- WDR^y total residential water demand in year (y), in million liters per day;
- q^y gross water use per capita in year (y), as determined by equation of Gross Water Use
- h^y number of resident population in year (y), as determined by the population projections.

The results will be divided in six different scenarios regarding the three population scenario adopted for urban and rural areas (Table2).



Table2 – Water demand scenarios for domestic consumption

	Predicted gross water use in rural areas - residential part	Predicted gross water use in urban areas - residential part
Population Scenario 1	Water Demand Scenario RR1.	Water Demand Scenario UR1.
Population Scenario 2	Water Demand Scenario RR2.	Water Demand Scenario UR2.
Population Scenario 3	Water Demand Scenario RR3.	Water Demand Scenario UR3.

Water demand projections for non domestic uses

To forecast the industry, agriculture and services (including tourism activity) water demand is presented the form of the equation to project the average water use (adapted from IWR-MAIN):

$$WDnR = a + b^{d1} + c^{d2} + (\dots) + o^{d3}$$

- WDnR predicted gross water demand in litters/by economic sector/day
- a inelastic demand in litters/day
- b percentage of the employment by economic sector
- c marginal price of water (€/litter)
- o other factors
- ^{d1} ... ^{d3} elasticities for independent/explanatory variables

Based on this equation is determined the value of water demand by sector. The number of scenarios depends on the number of sectors considered more relevant no analyse. These scenarios will be developed also according to the population projections (Table3).

Table 3. Water demand scenarios for domestic consumption

	Predicted gross water use in industry	Predicted gross water use in Agriculture	Predicted gross water use in Services
Population Scenario 1	Water Demand Scenario I1.	Water Demand Scenario A1.	Water Demand Scenario S1.
Population Scenario 2	Water Demand Scenario I2.	Water Demand Scenario A2.	Water Demand Scenario S2.
Population Scenario 3	Water Demand Scenario I3.	Water Demand Scenario A3.	Water Demand Scenario S3.



1.3.2. Uncertainty in water demand predictions

The water-demand models were used primarily to test assumptions and the effects that various assumptions or changes would have on water use in the county rather than as a predictive tool to generate absolute values showing future water use.

As with any model, the degree of uncertainty increases as the length of time of the projections increase. Projecting 25 years involves assuming many political, environmental, economic, and technical factors will not shift radically. If the assumptions are changed (for example, population decreases in the area) the water-demand results will change. The results depend on the validity of the assumptions.

The uncertainty in the forecast of water demand is also determined by doubts on the projected values for population, number of people per household and average household income for all the scenarios.

1.4. Economic analysis of water resources

To manage the scarcity of water resources it is necessary to consider the social use of water and also as an economic good. In this sense it is essential to carry out an economic analysis in each case study to evaluate the actual economic cost of water resources, and the levels of tariff.

The scarcity affects all the users, from the households to farms, industries, tourism activities and other commercial sectors.

The economic analysis of water resources in the development of integrated management it must be divided in four components:

- Identifying linkages between socio-economic activity and water uses;
- Understanding relative social and economic value of competing uses;
- Identifying the extent to which economic values are reflected in current pricing Policies and regulatory standards;
- Identifying remediation options (standards, pricing, economic instruments) and costs (capital and operating).

Economic analysis may also suggest institutional changes or policy measures needed to sustain the financial and economic benefits generated by the project. Technical sustainability is looked after as part of the analysis of alternatives and determination of the least-cost option, which is done in the early project preparation or feasibility stage.



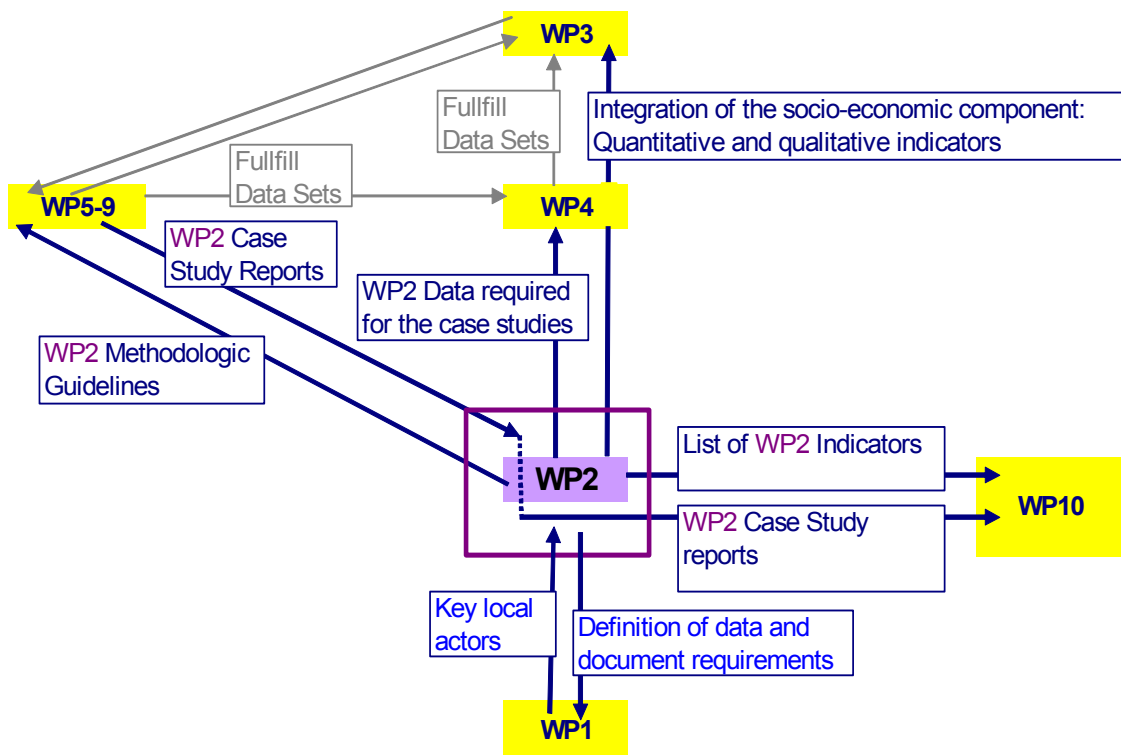
2. Socioeconomic analysis issues on SMART project

This point deals with the relationships between workpackage of the SMART project and the interconnections between different thematic tasks. Some methodological aspects appear as a result of constraints regarding this kind of analysis.

2.1. Links between WP's

Next, it is presented, point by point, what is expected to find in this methodological links (Figure 1).

Figure 1. Links between workpackages



WP1

The objective of WP1 was to define the guidelines for the socio-economic analysis: issues and indicators results from the adaptation of the socio-economic methodology according to the user requirements raised on WP 01; and to define the key actors, which is important to develop the local scale analysis and to involve the stakeholders in the framework of the project.

WP3



In each case study area, the field knowledge will provide a survey and typology to fulfill water resources variables. In WP2 was created a set of variables for each case study. This base of socio-economic variables will be used as an input of TELEMAT model system, which is the aim of the WP3.

The analytical tools of TELEMAT must include linkages with the socio-economic analysis. This is one of the most important improvements of this interdisciplinary tool: introducing socioeconomic analysis into hydrological model.

The result of demographic projections and mainly the result of the Water Demand Predictive System must be integrated on TELEMAT and faced with the water supply aspects to better understand the water scarcity problems and to support the decision-makers.

How to bring policy analysis to TELEMAT? This is another obvious link between WP2 and WP3. To solve this problem it is necessary to take into account the policy aspects defined by the case study partners when it will be defined as water management options to run the model.

WP4

The choice of the socio-economic methodology reflects the approach in terms of the assumptions that are made, the variables that are used as inputs and the spatial and temporal frame of its operation. In this sense the relationships with WP4 result from the needs to interface between WP2, WP Case Studies and TELEMAT WP (Fig. 1).

WP10

The overall goal of the socioeconomic indicators is to develop a set of regional indicators to provide a planning tool for application to water demand at regional level. Detailed socioeconomic data and catchment scale models provided a scientific basis for understanding a water demand and other aspects of water scarcity situation management.

The WFD, it will be an orientation document for the comparative analysis. Based on the principles of WFD it will be defined a structure of a comparative study. The WP2 represents, for the SMART, the very first time that WFD appear as an indication of socio-economic aspects and public participation objectives. After launched some of the following issues must be implemented during the different steps of the project:

- Regional economic and social approaches to water demand;
- Regional water demand scenarios development for population dynamic changes.

2.2. The integration of socio-economic variables

Below, the different WP2 tasks will be subject of a thematic analysis to define the relationships between socio-economic and policy framework.



2.2.1. Population and water stress²

At a time when many countries are approaching or exceeding the limits of their renewable fresh water resources, the population of those five case studies is growing by larger increments than ever before.

Population growth not only increases human water needs, it also helps accelerate environmental disturbances that reflected on the water quality. Many of the human activities are responsible for the increase of the water pollution. This fact contributes for limiting the water amounts that should be supply.

Malin Falkenmark, the hydrologist pioneered the concept of a "water stress index," based on an approximate minimum level of water required per capita to maintain an adequate quality of life in a moderately developed country in an arid zone. Falkenmark began with the calculation that 100 liters per day (36.5 cubic meters per year) is a rough minimum per capita requirement for basic household needs to maintain good health. The experience even of water-efficient and moderately developed countries shows that roughly five to 20 times this amount tends to be needed to satisfy the requirements of agriculture, industry and energy production, she found. Based upon these findings, Falkenmark suggests specific thresholds of water stress and water scarcity

The SMART project is about the water scarcity. The water scarcity is one of the biggest situations that influence the Water Stress. Other Indicators regarding to the socioeconomic dynamics are present on the base of water stress definition:

- Population, Health and Development;
- Urban and coastal pressure
- Population equal access to freshwater

2.2.2. Water scarcity and conflict

There is an emerging understanding about the characteristics of water scarcity roughly along this WP2 integrated point of view.

As OHLSSON (1999) said, the water resources are extremely unevenly distributed in relation to population concentrations and the demand from rapidly expanding economic activities.

Growing regional and local scarcity cannot be addressed by conventional supply-oriented measures, since the accessible supply is already taxed to the limit, and since there is an economic limit to large-scale water infrastructures with a long-distance capability.

Compared to all other sectors agriculture is the largest consumptive user of water by. On the other hand, water availability increase is identified as the limiting factor for agricultural productivity increases. Water scarcities on a country basis therefore quickly are translated into a food production constraint. Critical areas are countries with unfavorable climatic conditions, high population increases, and with strong developmental expectations.

² - **Water stress:** condition in which the annual availability of renewable fresh water is less than 1,667 and greater than 1,000 cubic meters per person in the population .



The water scarcity is often perceived as an absolutely static condition. Dealing with it requires viewing it in relation to present water-use practices, and the choices made between which economic activity water is used for. There is large room for efficiency improvement in the different usages for water; and a still larger room for putting available water resources to better economic usage.

In this perspective, water scarcity is transformed from an absolute constraint into a strong driving force for societal and economic structural change.

Almost by definition, however, change means societal stress. It is to the inherent conflict potential of this stress we now turn.

Resource scarcity can exacerbate pre-existing tensions or invite new ones, and water is no exception.

2.3. Methodological issues from WP2

On the SMART project it is important to take into account the interdependency between socio-economy dynamics and the scarcity of the water resources, not forgetting that the properties of biophysical systems are part of the set of constraints which are bound to socio-economic activity. The constraint set has its own internal dynamics which react to economic activity under-exploiting the water resources. Feedbacks then occur which influence economic and social relationships.

For the integration of biophysical and socio-economics to be of any value for regional scale decision making it is very important to adopt a multi-level of analysis. Additionally, the top-down analysis methodology should be interacting between national and municipality level.

In water resources management research clarifying the time and spatial scale differences and feedback mechanisms are essential issues. This makes possible to formulate the following (research) question/theme (Ziemer, 1997):

How can we approach to the variety in temporal and spatial scales of natural and social systems in order to obtain a description of feedback mechanisms in case study regions?

Some examples of temporal issues are presented below:

Feedback mechanisms in social systems: the time interval between the recognition of a (perceived) issue and policy action.

Time scales in natural systems: the time gap between human action and their effect on the water resources. Problems become only apparent many years after the action has been taken. When a policy causes negative effects on the environment (with its inherent delay time) what is the feedback which implements remedial action.

Cannot generalize the experience for all the country: the lack of possibilities to generalize the results through the regional differences in social and natural systems;

Comparative studies between different countries: the comparative analysis is very difficult because the different policies directives for the most relevant aspects that involve the water resources management. The differences in time scales between social and natural systems and their



feedbacks are increased by the non unique policy options between countries.

If the national policies are generating different impacts in the heterogeneous social and biophysical settings; than it is easy to understand that are also observed huge differences.

2.4. Key research topics

Through close analysis of the relationship between water scarcity and conflict, it is possible to identify a common biophysical, economic, and social dynamics in a variety of contexts. The follow questions could be some issues to survey by the SMART case studies:

- Under certain circumstances, scarcities of fresh water (and in general of renewable resources) should be the source of instability. “Environmental scarcity acts mainly by generating social effects, such as poverty and migrations, that analysts often interpret as conflict's immediate causes” Homer-Dixon (1993);
- Water scarcity is caused by the degradation and reduction of water resources, the increased demand for these resources, and/or their unequal distribution. These three sources of scarcity often interact and reinforce one another;
- Societies can adapt to water scarcity either by using their local environmental resources more efficiently or by decreasing their dependence of the water. The countries that adapt to water scarcity can avoid unnecessary suffering and social stress. The strategies for adaptation fall into three categories Ohlsson (1999):
 1. A society can continue to rely on its indigenous environmental resources but use them more sustainable.
 2. The society can sometimes decouple itself from dependence on its scarce environmental resources by producing goods and services that do not rely heavily on these resources.
 3. If social and economic adaptation to the water resources scarcity is failed, the economic development constrains could be at the source of large number of population migrations

2.5. Overview

To date, the decision-making community has not had adequate access to the best research findings on the linkages among water resource management, socioeconomic analysis and decision support systems.

Therefore, the information and analyses generated by the WP2 will:

- Help decision-makers better understand where to intervene to improve socio-economic result;
- Strengthen the research methodology and theories that could help researchers and decision-makers understand the patterns result from the interrelationships between all analyzed factors;
- Gather together a large quantity of relevant water demand data and make these data available to a better development of the TELEMAC



- Strengthen the network of experts from different countries and from different disciplines with the same objective.



3. Suggestions for a deeper analysis

The impact of future demographic trends on the water system in the Mediterranean Middle East countries should be examined. If the assumption is that the coastal and urban population will continue to grow next years then it will be important to foresee the changes in the demand for different types of water uses.

The framework of new WFD launch an inevitability of the most significant participation of all social actors involved on the water management decision-making processes. In general, the WFD must represent the impulse for an increase of the participatory approach inside and outside of the EU limits.

3.1. People's participation

“Member states shall encourage the active participation of all parties concerned in implementation of this directive, and particularly in the production, revision and updating of river basin district Management Plans. Member states shall ensure that the following are published for each river basin district, and submitted for the observations of the public, including users: a schedule and work program [...], a provisional summary of important questions [...], a draft river basin district management plan...” (Art. 14 of the WFD)

The WFD introduces the notion of public participation, as defined by the Aarhus Convention. This Convention considers access to information, public participation in the decision-making process and access to justice in environmental matters. Its aim is to implement principle 10 of the Rio declaration on the Environment and Development (June 1992): according to this principle, decisions in the field of the environment must be taken with maximum transparency. That involves a policy of information, consultation, dialogue and monitoring, and the development of a "participative democracy", in parallel with the traditional mechanisms of representative democracy.

3.2. Understanding of geographical relationships between socioeconomic dynamics and the water available

Further improvements in the surfaces could be made by both reducing the number of input variables and employing some kind of bootstrap which might also reduce training times.

As GIS pre-processing becomes more advanced and generates more useful population variables from the source data and as modifications in the training scheme and the selection of more appropriate network configurations are made based on experiments, the performance of successive models should improve and result in more realistic population spatial distribution.



3.3. An alternative methodological proposal: Water Demand Prediction System

So the apparently limited initial objective of adding the socio-economic component to add in SMART might be transformed into the task of developing and applying a Prediction System designed to estimate plausible impacts of socio-economic changes on water demand across the Mediterranean Middle East countries.

To design and develop the prediction system something could be change because many of the theoretically data sets are either not available or do not exist whilst there are significant uncertainties in all the data that do exist.

Additionally, the systems already known with these characteristics are deficient as virtually all the principal mechanisms for linking the dynamics of the biophysical datasets with the associated socio-economics are as yet very poorly understood.

In essence, the underlying and most basic problem is that biophysical process models are far better developed than any of the models of socio-economic systems particularly those concerned with water use and management DSS.

If you ask the question “What is the likely effect of massive urbanization on the hydrology of a specific coastal areas? Then the prediction methods couldn’t indicate any answers.

If you ask the question “What is the likely impact of agricultural subsidies on the quality of water and consequently on the fresh-water available? Then there are no existing models for the current situation

The solution is to build a new modeling system which implements a GIS style of approach to the problem. Using GIS it is probably the best available and probably the only feasible scientific way available to make a localized geographical projections of the possible impacts of water demand for up to 25 years time.

This part of the report advance a principle to build, apply and develop a Water Demand Prediction System (WDPS) that uses a mix of GIS and neurocomputing technologies to attempt this almost impossible but potentially extremely important interrelationship.

Constraints to design the Water Demand Prediction System (WDPS)

The objectives of WDPS could be (Openshaw, 1997):

- Develop a GIS base model founded on the relationship between water resources inputs (climate, runoff, soil characteristics, etc.) and socio-economic variables to predict water demand;
- Translate the land use changes (mainly the urban/rural balance) into surfaces of catchment degradation risk in order to generate a WDPS.

The resulting Water Demand Prediction System (WDPS) functions rather like a long term forecast, where unavoidably the geographical details are error prone.

However, overall the expectation is that the more general synoptic or forecasts will be reasonable once they have been aggregated and generalised to a sufficiently coarse level of meta scale detail.



The simplest view is that of a series of key input variables that are related with a computer model (neural network based).

In operationalising the WDPS the choice of input variables had to be restricted to those which could be generated from the data available for SMART research. The available variables are not ideal but then probably no one knows what would be ideal in this context.

3.4. Problems of deeper analysis

The problem of the relationship between climate, physical environment, and socio-economic factors is mediated and affected by at least the following aspects: market mechanisms, available technology, historical tradition, inertia, culture, and various economic factors such as subsidies which have not been taken fully into consideration. All these aspects are currently invisible to the model and are not directly present in any of the available data; although their integrated effects are somewhat present in the current patterns of land use that the neural net model is being asked to represent. It would of course be nice to have a model into which the price of crops, the national agricultural subsidies, irrigation practices, and each farmer's micro-behaviour could be input and then make the model operate at a fine spatial scale for each case study regions.

However, such a model is presently beyond technological feasibility and data availability. It is possible that such models could be built one day by discovering how to model individual people in artificial world laboratories using a bottom-up approach, but this is probably at least 10 to 20 years off.

Although it is hoped that the missing variables are invisibly present in the data that are used and are thus taken into account implicitly by the multicriteria analysis that are applied to model the relationships.

This is probably a most optimistic view particularly when the forecasts made for 25 years hence assume a continuation, at the same level as today, of all these invisible influences that may or may not be having a direct impact.

There has been little choice in this matter given the urgency of the task and the constraints of current technology, knowledge, data, and research resources.

Certainly, one of the most compelling justifications for a suggested approach is the belief that there can come a point in conventional models where improved precision and more detail in the systems of equations can result in a deterioration of performance; see KOSKO (1994).



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