ICARUS - IWRM for Climate Change Adaptation in Rural Social Ecosystem in Southern Europe

First Progress Report

December 2010

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1 Introduction

Overall, the project ICARUS focuses on how to improve water resource management through the introduction of the climate change adaptation perspective, and in particular on water saving practices in irrigated agriculture. Over a 24-months time span, it intends to devise adaptation strategies through scenarios' simulation and the application of a decision support system tool, mDSS. Its final aim is to draft guidelines for identifying and implementing adaptation strategies for sustainable irrigation management in both Southern Europe and the wider Mediterranean region.

The present paper summarises the results of the first phase of the project, where the partners established in practical terms and internal deadlines the methodological procedures and the communication structure. Moreover, there was identified an external team of irrigation and water experts and institutions per case study to consult during the project.

2 Methodology

The main methodological procedures to accomplish the analysis cover: Identification and analysis of climate change, land-use change and socio-economic change scenarios; Analysis of the main institutional drivers (water framework directive, water laws and policies, decision-making structure and actors) of water resources management; Analysis of conflicts concerning water quality and water quantity; Analysis of the decision-making frame: main actors and their interactions; development of methods and tools for support decision-making / policy making in an integrated and participatory approach.

Scenario simulation where hydrological scenarios, for instance, will be matched against scenarios of agricultural development, (WP2), comparative analysis of agricultural and irrigation practices (WP3), and assessment of both irrigation management legal and institutional framework and potential conflicts arising between users (WP4) will support the development of different adaptation measures, which will then be evaluated, tested and compared through participatory processes with the support of the e-tool (WP5).

In order to achieve this in practice, and in particular to implement the tasks allocated to WP5, we propose to develop upon the NetSyMod methodological framework (Network Analysis – Creative System Modelling – Decision Support), developed during several years of research conducted by Carlo Giupponi and collaborators. This methodological approach assembles various tools that aim primarily at the identification of key actors within a given decision-making context, and then at their involvement in those development phases where models of analysis are constructed.

The ICARUS consortium could preliminary discuss the usefulness of such approach and propose the needed improvement for the aims of the project.

The NetSyMod framework comprises of the following phases:

1. Actors' identification: to identify all the potential carriers of interest/ experts on the matter under discussion. The proposed method suggests the organisation of brainstorming sessions with a limited sample of stakeholders, all of whom should be grounded on the issue, who single out those most apt to attend the participatory phases. A "snow-ball" technique is often applied as it allows to select a whole group of actors interested in the decision-making project, whether directly or indirectly.
2. Social network analysis: to represent the relationship between the identified stakeholders of a given social network. Such analysis permits to highlight roles,

responsibilities, and relationships of every actor within that network, which in turn may lead to a second selection of stakeholders to invite to the successive phases. This process both limits the risk for the participatory process to be hindered by some powerful groups and ensures a high rate of representativeness whilst at the same time maintaining the number in a manageable size.

3. Creative system modelling: to represent in a correct manner the knowledge, opinions, and the preferences of the stakeholders involved. The key actors gather in a meeting during which the problem is conceptualised through the construction of cognitive maps – individual and/or collective. Such exercises, elicited according to the context, allow the representation of the various understanding of the system under analysis. During this phase one can also proceed to the shared construction of the cause-effect chains, through either the conceptual model DPSIR (Determinants, Pressures, State, Impacts, and Response) or the elaboration of future scenarios that stimulate the identification of potential solutions/ innovative approaches to the problem under scrutiny. Given that the indicators selected will then truly represent the various interests and opinions of the actors, a multicriteria analysis will be carried out – both individually and collectively.
4. DSS design and analysis of options: All the information gathered during the previous phases of the NetSyMod methodology are assembled through the Decision-Support-System *e-tool*, an updated version of mDSS, a software conceived during the EU project MULINO[1]. The mDSS software application extrapolates the decisional criteria and their relative weights from the shared models mentioned above. The latest version of the e-tool adds a multi-criteria spatial analysis to the previous mDSS versions. This allows the ordering of the various options under examination and thus it facilitates the decision-makers' final choice.

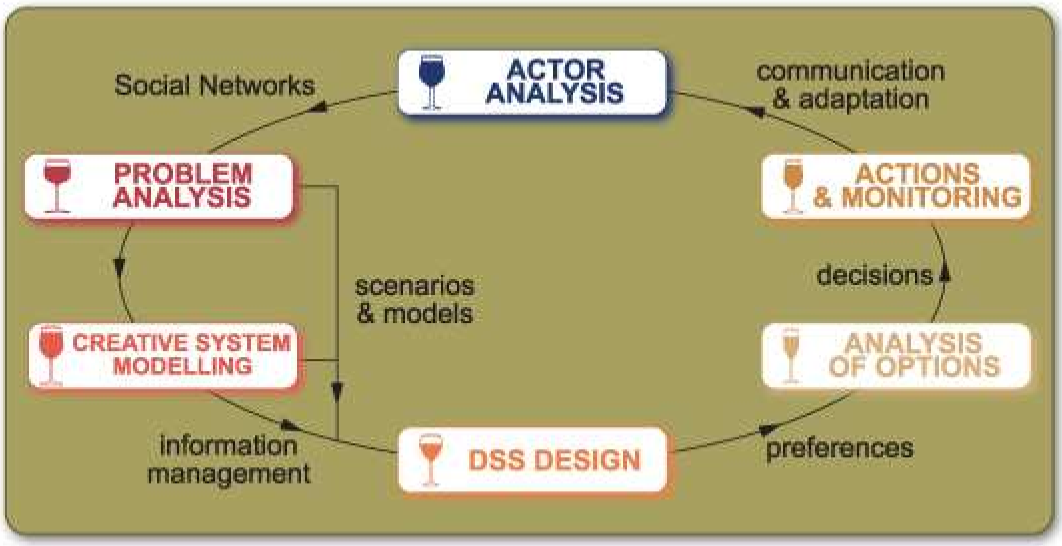


Figure 1 Main methodological phases of the NetSyMod approach

[1] "MULtisectoral, Integrated and Operational Decision Support System for sustainable use of water resource at the catchment scale"

3 Case studies' description

3.1 Italian case study: Venice Lagoon Watershed

The Venice Lagoon Watershed (VLW) is located in the North Eastern part of Italy and consists of several hydrographical sub-basins discharging into the Venice Lagoon. The Venice Lagoon Watershed covers about 2.038 km^2, of which around two-thirds are cultivated, and comprises of 8 main sub-basins and 7 minor sub-basins. It is divided in 108 municipalities which account for around one million inhabitants.

It is almost an entirely flat area, with some parts lying below the sea-level. From a geographical viewpoint (see Figure 2), the area can be divided into the following:

- a small high plain in the north, where deep aquifers exist, with a broader spring belt located further south;
- a so-called "mid-plain area" to the south;
- vast areas of reclaimed land lying below sea level, which are maintained by pumping systems, towards the landward edge of the lagoon;
- a small hilly area to the west, part of the Euganean Hills.

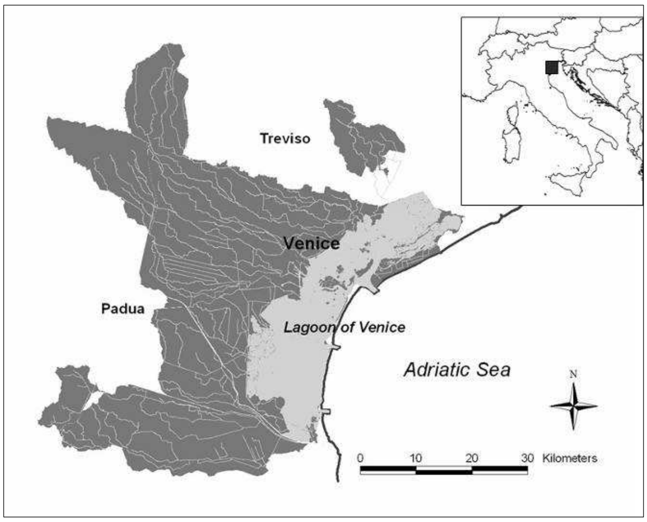


Figure 2 The Venice Lagoon Watershed

In climatic terms, the VLW area may be divided into three zones with different rainfall patterns (Southern, Central, and Northern), with an average rainfall of 743, 802, and 1049 mm/year respectively (Giupponi & Rosato, 1999).

The average annual volume discharged into the Venice Lagoon accounts to about 109 Mm^3. The VLW is characterised by a very complex hydrology, with rivers, artificial canals, and 27 outlets in total. In the northern part of the watershed, groundwaters recharge surface waters, significantly contributing to the hydraulic and nutrient load discharged into the Venice Lagoon. Moreover, due to the intensive agricultural land use, the VLW is characterised by a very complex network of irrigation channels which very often receives also direct sewage discharges. Irrigation is a common practice with different methods and varying efficiency and it is very relevant for determining both the volumes of water flowing across the watershed and the quality of water bodies, in particular for what concerns the content of nutrients which may significantly contribute to the eutrophication of the Venice Lagoon.

From a pedological perspective, six main types of cultivated soil characterise the area: gravelly, medium textured, sandy-silt, sandy, organic, and clay soils. The medium textured soils are in the NE and S part of the watershed and are generally associated with clay soils. The sandy-silt soil typify primarily the NW and the central areas, whereas gravelly and sandy soils lie in the extreme SW. The land use is distribute as follows: 75% rural land (65% cultivated), 15% urban, 5% industrial, and the remaining 5% comprises vegetated areas, tourist infrastructure, urban parks, and so forth (Giupponi et al, 2008).

The most important crops are maize (over 56% of cultivated land), soybean, sugarbeet, and small grains. Moreover, census data states that 210,000 bovines and 130,000 swine are reared in the area. Agriculture has a high input of fertilisation and the livestock production is intensive and scarcely integrated with crop production. During 1980's and 1990's, high nutrient loads in the VLW have been responsible for a sever eutrophication of the Lagoon.

In the past years the nutrient discharge of the VLW has been widely studied because of the critical effect on the eutrophication of the Venice Lagoon and the intensive agricultural land use was identified as one of the main pollution sources. A recent monitoring activity (2005-2007, ARPAV) indicated a total load discharged into the VL of about 4,430 t/yr for nitrogen and 280 t/yr for phosphorus, in line with the Management Plan 2000 (Piano Direttore 2000). Moreover, there appeared a receding trend of the presence of these pollutants in the lagoon.

The main challenges that the agriculture of the VLW will face over the coming years are therefore related to the maintenance of profitable farming activities while facing increasing environmental constraints related to unstable rainfall, increasing conflicts for water resources and also increasing constraints in terms of environmental protection norms.

3.2 Portuguese case-study

In Portugal, the Alentejo is one of the regions most easily identifiable as economically and socially peripheral. Environmentally, it is likewise a region where extreme climate conditions and insufficiently fertile land limit the development of a competitive agriculture such as those in other regions of Europe. It is an entirely different place in structural terms: it owes its ecological, economic and social particularity to the dominant large landowner system of extensive monoculture. As such, it can be considered the periphery of the periphery, inasmuch as it is an under-populated, non-industrialised, and a deeply marginalized region

The landscape of Alentejo, which is dominated by the huge peneplain of the Alentejo where small ranges of hills rise up, notably the Serras de São Mamede, Grândola, Cercal and Ossa, is marked by the presence of Montado oak plantation constituting a system of extensive land-use of the agro-silvo-pastoral kind, where open tree cover (mainly holm and cork oaks) is combined with the use of the soil layer, which today is mainly used for cereals (mostly wheat) and pastures. This production system is particularly well adapted to the limiting climate and soil conditions and is made possible by the large dimension of the holdings in the Alentejo.

The climate is clearly Mediterranean in the region of the Alentejo, with a hot and dry season stretching from May to September. The rains are concentrated in the period between November and March. The occurrence of heavy downpours in the spring and autumn and the great irregularities in the yearly rainfall make it difficult to plan crops and necessary irrigation.

In accordance with the national classification of soil use capability, which is related to its capacity for growing cereals, it is notable that in Alentejo the soil classes D and E, having the sole capacity for forestry use and with great limitations, are clearly predominant (64%). The soils with fewer limitations for agricultural use (class C) correspond to 20% and the best soils (classes A and B) to 16% (World Bank, 1984).

The Alentejo region with a low population density (large number of municipalities have less than 20 inhab/km2) is dominated by large and very large holdings and the land of each farm unit is relatively concentrated in a few blocs.

Agricultural and forestry activities remain responsible for the employment of a significant part of the active population. In recent years, a sharp increase has been observed in the active population employed in services, particularly in the public and private services that cater to the population. This fact reveals the inexistence of economic activities that function as a viable alternative to agriculture.

Recent trends on land cover changes in Alentejo

The analysis of some agricultural indicators shows us that the most recent decades have been marked by some significant changes in the landscape and agricultural structures of the region. It is possible to distinguish the following phases in the last fifty years:

- In the 50s/60s a decrease in available wage-earning labour (internal migration and emigration) is observed, with the consequent mechanisation, simplification of tilling and agro-pastoral cropping systems and partial modernisation (fertilizers, irrigation), and the continuation of protectionism of cereal cropping.
- In the 70s a partial and temporary agrarian reform, with prolonged uncertainty of the agrarian situation and land ownership.
- In the 80s there is a gradual return to the previous agrarian situation and entry into the EEC in 1986.
- In the 90s there are the effects of the CAP reform with alteration (absolute and relative) of prices.

In the 1980s, and in a more obvious way in the 1990s, the land use changes were already evident, above all in the reduction of arable crops (mainly of cereals) in about 1/5. The surprising increase of permanent pastures in this period is nothing more than the result of the abandonment of crops. This is a significant sign of extensification, which can be noted as well in the reduction of woods and forests with under-covered agricultural crops.

Irrigated areas

The scarcity and the high irregularity of precipitation obviously condition cropping systems. From April to September, it rains less than 150 mm and the pluviometry in Autumn/Spring is very variable. On the average, the farmers of the Alentejo have one very good cereal year in four.

However, irrigation is increasing in the region, associated with the construction of several medium-size dams. Most of the 11 perimeters in the Alentejo (some of them within the case-study area) are of reduced size, unable to resist a few successive years of drought. Moreover, they are characterised by very low levels of land and water use, until very recently concentrated for the most part in monocultures of rice and tomato for industry.

Study area

The irrigation schemes in Baixo Alentejo (Figure 2) concern three dams (Odivelas, Alvito e Roxo) and a total irrigated area of around 11,000ha.

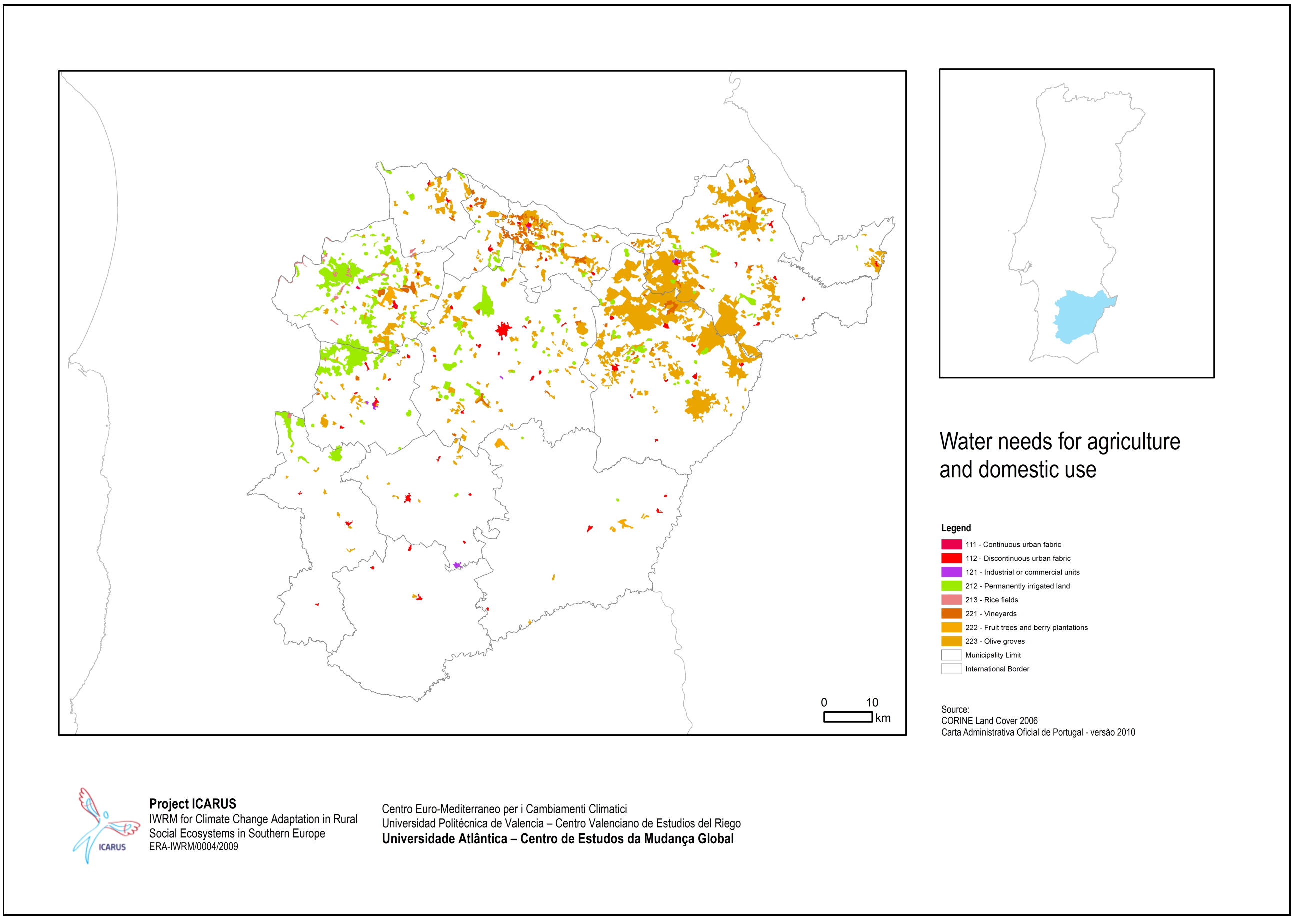


Figure 3 Water use competition in Baixo Alentejo

The irrigation schemes in the study area concern three dams (Odivelas, Alvito e Roxo) and a total irrigated area of around 11.000ha.

Recently, the construction of Alqueva dam, and its irrigation scheme (not yet completely accomplished) introduced an important factor of change for the production systems: in 2025, around 115000 ha will be irrigated promoting the conversion of the agricultural production systems from rainfed farming to intensive irrigated productions. However, these effects can only be seen in the medium/long-term.

The main irrigated crops (rice, corn, sunflower and olive trees) present different evolution in the last decades, with decreasing of rice areas and increasing of olive trees area.

The main challenges in the area are related with the increasing conversion of the agricultural production systems from rainfed farming to intensive irrigated productions. This conversion will happen in a context of Climate change and therefore the water management model should be adapted to these conditions. Furthermore, the adaptation of farmers to new water price policies and their integration in the EU market corresponds to a significant change in a region where the farmers are quite old and the environmental conditions constrain the development of a competitive agriculture.

3.3 Spanish case-study: Júcar River District Watershed

The basin of the river Júcar is made up of 21,578 km^2. Since 1934, management of Júcar River by the Spanish State is executed by the *Confederación Hidrográfica del Júcar* (CHJ). This hydraulic authority stretches an area wider than the Júcar basin, including also Millars, Turia, Vinalopó, Serpis and many other minor coastal waterways. Thus, the total extension of the Júcar River Basin District (42.989 km^2) doubles the real river basin surface and encompasses lands of four Spanish political jurisdictions, the autonomous regions of Valencia, Castilla-La Mancha, Aragón and also a very small part of Catalunya.

Júcar River watershed could be divided in four sectors, which present different physical conditions.

- Serranía de Cuenca encompasses the northern mountainous area. Mean annual temperature reaches 9º and rainfall values vary between 550 and 800 mm. It's a rural area where irrigation has almost no relevance and there's no urban pressures.
- Plateau of La Mancha, is the western part of the Castilian Meseta. It is a plain or tabular relief, badly drained, which presents several endorheic and semi-endorheic areas over marls. Rainfall never gets up 400 mm per year and, around the city of Albacete (170.000 inhabitants), there's 100.000 hectares where maize is the main crop.
- The alluvial plain (La Ribera) and coastal valleys, where traditional surface irrigation is placed, harvesting oranges, rice and vegetables. Conjunctive use is also quite common to adjacent irrigation systems of Júcar valley. Mean annual temperature reaches 17º in the Ribera and yearly rainfall always exceeds 500 mm.

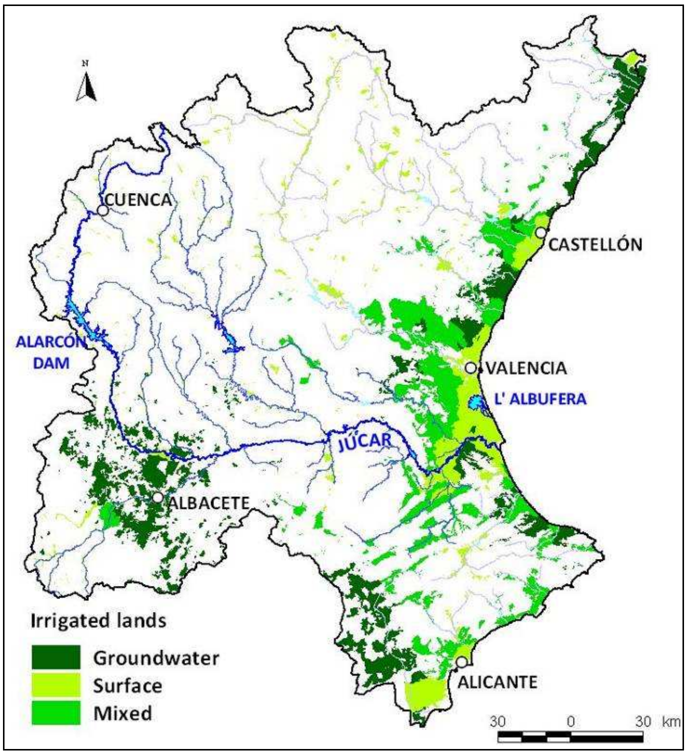


Figure 4 Irrigation in Jucar River District

The *Confederación Hidrográfica* estimates a mean annual runoff about 80 mm, which represents approximately 15% of yearly rainfall in the hydraulic district. Thus, the mean renewable resources of Júcar District are 3.251hm^3/year, according to 1940-2006 data; nevertheless, this value has decreased to 2.934 hm^3/year if we consider the period 1980-2006 and only 2.700 for the last ten years period. Interpretation of this phenomenon differs depending on the source used. Whilst some authors defend that most of this fall is due to climatic fluctuations –a dry period 1980-2005, after a wet one 1960-1980–, many other put the accent on human actions: recent development of irrigation in La Mancha as the principal cause of resources decreasing in Júcar River.

In any case, unfortunately, this generates a recent unbalance between resources and uses: according to the estimations of the Confederación Hidrográfica del Júcar, yearly consumptive uses in the district reaches 3.231 hm^3, the half part of which is required in Júcar watershed (see Table 1).

Urban uses in the basin have been increasing during last decades. Most of the urban supply systems of Júcar basin are provided by groundwater, but three large urban areas receive surface water from Júcar, consuming the 17% of total basin resources. Only one of these areas, Albacete, to which 31 hm^3/year have been allocated, is physically inside de basin. Outside the basin, Valencia urban area and Sagunt receive 220 hm^3/year from the river. Some industrial uses are not considered in these amounts because, although most part of factories is connected to urban networks, many of them manage their own wells to exploit groundwater. However, 35 hm^3 are reserved for the nuclear power station of Cofrentes (1.025 MW), which return 42% of these resources to the river.

Table 1 Water demand and water resources available in natural regime in Júcar District (data from CHJ).

Watershed	Demand					Resources Average 1980-2006
	Urban	Agrarian	Industrial	Recreational	Total	
Sénia-Maestrat	18	84	1	<1	103	174
Millars-Plana de Castelló	55	232	13	1	301	365
Palancia-Les Valls	14	74	7	<1	95	83
Turia	145	459	31	2	637	416
Júcar	140	1.414	56	1	1.611	1.489
Serpis	31	82	5	<1	118	165
Marina Alta	30	54	<1	1	85	120
Marina Baixa	26	34	<1	2	62	58
Vinalopó-Alacantí	93	106	18	2	219	64
Total CHJ	**552**	**2.539**	**131**	**9**	**3.231**	**2.934**
	17%	**87%**	**4%**	**0%**		

Thus, irrigation is main destination of Júcar River resources, almost the 88% of them. Demands in the high lands are very low. In the Serranía de Cuenca there are only small riverside *vegas*, without winter consumption and with a total uses of 14 hm^3/year. The fields of La Mancha Plateau require 185 hm^3/year. Some of these water (105 hm^3) comes from the aquifer, whereas part of them (80 hm^3/year) are pumped from the river to restore groundwater levels, seriously damaged by overexploitation. The biggest proportion of irrigated lands of Júcar Basin are placed in the Ribera, where traditional farmer's associations own allocations that add up to 758 hm^3/year. Transformation projects to dripping irrigation are being developed in this area to reduce consumption and to release resources to provide water for the Júcar-Vinalopó Transfer Project, devoted to reduce water deficit in Alicante Province.

Finally, according to the Júcar Management Plan,100 hm^3 were allocated to guarantee l'Albufera wetland conservation, supplementing irrigation runoff that arrives to this Ramsar site. The arrival of pollutants from industrial and urban areas that surround the wetland, through irrigation and drainage canals –due to the lack of sewer networks and sewage treatment--, caused the eutrophization of the lagoon during the 70', reducing biodiversity and landscape degradation. In the 90', the improvement on wastewater treatment reduced the entrance of pollutants and increased water quality and environmental conservation, but recently, fall of basin water resources is again generating crisis of anoxia and hinders macrophites recovery.

In this context of high pressure on water resources, the identification of water saving practices and the development of adaptation strategies for future scenarios, based on a robust knowledge of the ecological socio-economic and institutional framework, becomes a major necessity.

4 WORK PACKAGES

4.1 WP1 - Coordination, Management and Dissemination

Leading partner: CMCC

	CMCC	UATLA	UPV
PM	11	2	1

Description of the work

To assess and monitor the execution of the global structure of the project. This task involves the implementation of the usual project coordination and management activities. This will be done by identifying knowledge gaps and organisational constraints, by implementing the internal quality control procedures, and by compiling all the regular intermediate and final reports.

To establish the structure for internal and external communications. This structure will allow the communication within the consortium and with other stakeholders, decision-makers and policy makers.

To supervise and coordinate the Kick-off Meeting, the Intermediate Assessment Meeting and the Final Dissemination Conference. During the Kick-off meeting, different local experts were invited to present and discuss specific problems related to water management issues in the region. These discussions will contribute to focusing the activities on crucial subjects.

Table 2 List of irrigation experts per case study

Country	Experts
Venice Lagoon Watershed (Italy)	Paolo **Parati**, ARPAV Lorenzo **Furlan**, Dirigente Settore Ricerca Agraria, VENETO AGRICOLTURA Giustino **Mezzalira**, Direttore Sezione Ricerca e Gestioni Agro-Forestali
Baixo Alentejo (Portugal)	Francisco **Palma,** President of the Associação de Agricultores do Baixo Alentejo Maria **José Roxo,** Faculdade de Ciências Sociais e Humanas da Universidade Nova de Lisboa
Jucar River Basin (Spain)	Juan **Valero de Palma**, secretary of FENACORE and Acequia Real del Júcar Alberto **Hervás**, secretary of USUJ

The Final Dissemination Conference will have invited lectures and poster presentations to disseminate the knowledge and to present and discuss the achievements with other participants. Local stakeholders will be invited to participate but this final conference will be open for all the ones showing interest by the issues discussed. A special attention will be paid to involve young scientists.

To disseminate the outcomes of the project, especially trough the implementation of a home page, an electronic newsletter, the publication of papers, and of a book.

The **Kick-off Meeting**, hosted by EIA/UATLANTICA, will take place on month 4

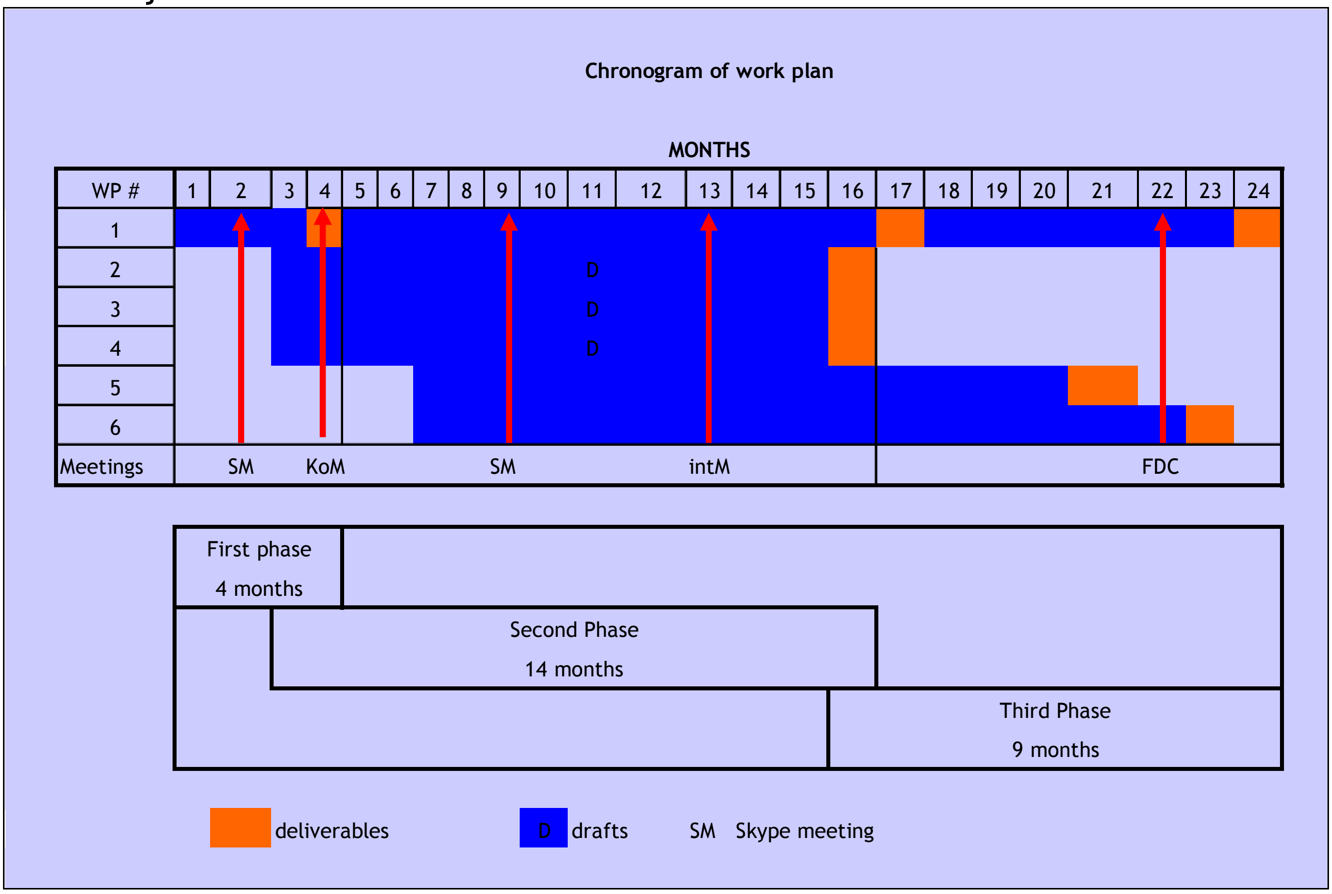
The **Intermediate Assessment Meeting**, hosted by UPV, will take place on month 13

The **Final Dissemination Conference**, hosted by CMCC, will take place on month 22 (see Table 3 below)

Expected Results

1. Webpage (November 2010): http://www.cmcc.it/research/research-projects/icarus-1/icarus
2. Proceedings of the Kick-Off Meeting (December 2010)
3. First Progress Report (December 2010)
4. Second Progress Report (January 2012)
5. Proceedings of the Final Dissemination Conference (July 2012)
6. Final Report (August 2012)

Table 3 Project's GANTT



4.2 WP2 Scenarios of change: Socio-economic, Land Use and Climate Change

Leading partner: CMCC

	CMCC	UATLA	UPV
PM	5	4	2

Description of the work

The main goal of this WP is to provide a prospective analysis of environmental and socio-economic changes.

This will pass through the development of macro scenarios to the period of 2015-2030, i.e. the prediction of biophysical and socio-economic variables that will represent some of the constraints for sustainable decisions concerning water management.

Task 1 – Climate change scenarios

The division Numerical Applications and Scenarios (ANS) focuses on the study, above all through numerical simulations and theoretical studies, of natural variability of the climate and the climatic changes due to the anthropic effects, with a particular emphasis on the European and Mediterranean region. The tools used by the activity of research are characterized by numerical models of different complexity and realism, from simple and linear models to more complete and coupled models atmosphere- ocean - sea-ice - vegetation - marine biogeochemistry. Such activities will provide the ICARUS project with state-of-the-art climate change scenarios and modelling data to be implemented in order to describe the climatic forcing variables and their possible evolution over time.

Task 2 – Land Use change scenarios

For what concerns agriculture, previous CMCC experiences focus on the implementation of different methodologies for Land Suitability evaluation, such as the LCA and the AEZ. At local scale, the assessment of the impact of climate change on crops such as cereals (food production) is conducted with the aim of evaluating the risk related to climate variation and provides directions about possible adaptation strategies. Decision Support Systems are used to identify the most suitable areas for allocating crops on landscape level, based on simplified physiology, and market and policy scenarios. Such approach can be applied to evaluate the local impact of climate change and to identify the possible adaptation strategies for specific management scenarios. Similar analysis have been already performed on the Italian study area both on historical and on future projections, in previous research projects.

Task 3 – Socio-economic change scenarios

CMCC developed novel modelling tools for the economic analysis of policies aimed at climate change control, addressing world-wide vulnerability, mitigation, impacts and adaptation to climate change. Among them, 3 deserve to be highlighted. First, the WITCH (World Induced Technical Change Hybrid Model) is a recursive-dynamic energy-economy-climate model designed to assist in the study of the socio-economic dimension of climate change (Bosetti, Carraro et al., 2006). The second is ICES (Intertemporal Computable Equilibrium System Model), a recursive-dynamic Computable General Equilibrium model able to assess a wide set of climate change impacts (sea level rise, health, tourism, agricultural productivity, intensity and frequency of extreme events and energy demand). Third is LUC, a land use change (LUC) model, taking into account both climate change effects and responses, and useful to support further impact models regarding agriculture. All these previous and ongoing experience will be exploited for the application to the case studies, focusing in particular on robust methods for spatial-temporal downscaling.

Expected Results

1. Report on climatic forcing variables and downscaled climate change scenarios fort he study areas for the period 2015-2030.

2. Report on land use scenarios for the study areas for the period 2015-2030.

3. Report on socio-economic scenarios and constraints for irrigation management for the period 2015-2030.

4.3 WP3 - Water resources and agriculture in the Mediterranean countries: processes of change

Leading partner: UPV

	CMCC	UATLA	UPV
PM	1	1	5

Description of the work

The main goal of this WP is to provide the necessary baseline information on the use of scarce water resources (actual and potential) in the regions analysed by the project. It aims at producing a comparative analysis of agricultural practices optimal use of water use. Therefore it will carry out an analysis of the irrigation systems according to their potential for saving water. Furthermore, it will analyse the relationships with other sectors in view of providing the ground for IWRM.

Task 1 - Comparative analysis of agricultural practices for a best water use

Compilation and analysis of available information about the present situation and trends on:

- Systems of management and distribution of water at basin scale: Dams, main intakes and canals, etc.
- Systems of local management of water: operating procedures of water users' associations (demand, rotation, etc..)
- Systems of plot irrigation: gravity, sprinkler or drip irrigation
- Water losses in systems of distribution and comparison of water saving techniques in plot irrigation.

Moreover, those factors conditioning the use of water saving techniques will be analysed (prices, organizational factors, institutional, etc.).

Task 2 – Expertise and background in saving water in Mediterranean agriculture

Classification of the methodologies or tools proposed for increasing agricultural water use efficiency and promoting water saving (in the case-studies or other closer regions with similar characteristics); comparative analysis of the advantages and/or disadvantages of the technologies; evaluation of the potential adaptability or applicability of water saving measures to the case-studies selected for the current project;

Estimation of the potential impacts of different water saving measures in terms of sectoral benefits (potentially on the socio-economic development of the rural regions and the environmental improvements) of agriculture in the Mediterranean region

Expected Results

1. Regional report on agrarian practices of water use and explanatory factors (hydrological, biophysical, historical, social and economical).
2. Report on the agricultural water saving technologies in the Mediterranean area
3. Report on comparative analysis of water saving practices in agriculture.

4.4 WP4 - Competition over a scarce resource

Leading partner: UATLA

	CMCC	UATLA	UPV
PM	3	5	2

Description of the work

Managing water resources was traditionally approached by the supply sector, building reservoirs, and distribution network systems, finding new water sources. It was considered that the major strategies should comply with the needs of humans in terms of drinking water, food, etc. Although this continues to be a major obligation for human societies, it is also clear that water is necessary for more than domestic use or production of food. Water is also crucial for the functioning of ecosystems, and for the goods and services these ecosystems produce to society, therefore to the sustainability of societies' development. Nowadays water management must be implemented taking into consideration change and adaptation: both in society itself and in society's interactions with nature. The integration of the demand management principles is essential to increase efficiency in use while maintaining or improving the benefits associated with the use.

The main goal of this WP is to contribute for better and scientifically sound water governance through the analysis of legal and institutional frameworks in which decisions regarding irrigation management take place and through the assessment of the conflicts arising from the involvement of key water management decision-makers and stakeholders and from the sectorial competition over water resources.

Task 1 To make a comparative analysis of water policies and an assessment of the institutional framework in which decisions regarding irrigation management take place. This will be done through the identification and analysis of local networks of key stakeholders in irrigation management (research institutions, water users, planners, and decision makers), as a means to understand the role they play in the irrigation decisional context, identifying potential and actual conflicts among them. It will not only address water policies but also agricultural and environmental policies in the area.

Task 2 To analyse the needs of local population in terms of water consumption, and the potential and actual conflicts of water uses. A special attention will be given to the identification of the local features of virtual water. The agricultural production systems require large amounts of water. The "water footprint", as in the total volume of water that is used to produce the goods and services consumed by the inhabitants of the nation, is a significant concept, especially for water stressed regions. In these regions, it is important to adapt the production systems to less water-intensive products. Analysing the relations between "water footprint" and physical water can be a significant contribution for achieving a balance of economic and population growth, as well as towards ecological sustainability. Naturally, this process implies socio-economic changes that should be thoroughly analysed.

Expected Results

1. Report on water consumption needs and water uses conflicts.
2. Report on the decision making framework and potential conflicts among social actors

4.5 WP5 - Decision/Policy making: methods and tools. An integrated participatory approach

Leading partner: CMCC

	CMCC	UATLA	UPV
PM	**8**	**5**	**3**

Description of the work

The main goal of this WP is to assess the identified adaptation measures and strategies to improve water management and irrigation systems. These strategies will be analysed and compared through a participatory approach.

This approach is based on the concept that all the local actors should be involved during all the phases of the decision making process.

The analysis and assessment of the adaptation strategies will be made:

i) considering different simulated scenarios and understanding their mechanisms,

ii) discussing the obtained simulation results,

iii) testing the development of the different scenarios.

In order to assess the economic and environmental sustainability of the system it's necessary to develop an ad hoc procedure and a decision support tool, derived from previous research efforts and application.

Development of an algorithm and a computer based platform (software). This electronic tool has to host different data (including environmental, economic, social, territorial and other relevant data) for each water user category/class. Then the tool has to provide to the end users (who will be able to load the main features of the area from databases and GIS layers describing the main features of the area, according to the standardised set of indicators selected by the project as representative for the specific problem analysis) clear answers concerning, e.g.:

- visualisation of the – previously estimated - impacts of climate change on the site they are interested in;
- a list of possible adaptation strategies/policies/actions (together with WP6); and, most importantly,
- preferable solutions in terms of adaptation strategies, according to the specific characteristic of the case study area and to the preferences and priorities of the end users;

Thanks to the above listed capabilities, the tool will provide the intended users with a decision support system (DSS), in which information and knowledge acquired by the project will be made efficiently utilisable, for supporting the analysis and ranking of adaptation strategies according to a set of criteria previously identified in accordance with the stakeholders and the experts involved.

In order to provide a flexible tool capable to implement both the scientific evidence and the local knowledge, interests and preferences, a multi-criteria analysis tool will be developed upon previously existing algorithms and configured according to the specific need of the project.

The local problems and socioeconomic and environmental systems will be formalized according to the DPSIR conceptual framework proposed by the European Environmental Agency (Driving forces, Pressures, State, Impacts, Responses) further developed to become a conceptual model of the climate change impacts and for the analysis of adaptation measures.

In order to become the conceptual framework for a decision support system, the DPSIR approach will be adopted by the software interface, allowing the user to formalize the problems of the study site by means of indicators, use them to quantify the criteria upon which the selection of options should be performed, weight them according to the preferences of those involved in the analytical process, and apply MCA decision rules to eventually the preferred adaptation strategy and explore trade-offs between alternative options.

Three main phases are identified for the process, according to the current literature on operations research and decision analysis: an explorative phase (Conceptual or Intelligence Phase), a Design Phase, and the final Choice Phase, as depicted in the figure below.

The decision support system will not be “the” solution of the problem to decision makers and other end users, but will instead provide a tool for exploring and supporting possible decisions by analyzing their performance when applied to a map describing the variability of the main evaluation criteria (types and levels of impacts, economic consequences, vulnerability, etc.) and, very importantly, to facilitate the involvement of stakeholders, by means of techniques such as Group Decision Making. Complementary functionalities will be added to pre-existing algorithms and software code at CMCC, such as sensitivity analysis of the resulting ranked options (exploring the robustness of the result obtained according to the subjectivity of users expressed in the weighting of criteria) and sustainability analysis (exploring the balancing between environmental, social and economic criteria).

A testing phase will assure the system capability to provide appropriate information to the end users. Subsequent releases of the prototype will be made freely available for download from the Internet, in order to collect the feedback from the users involved in the projects, but also to reach a much broader community of potential users.

A training course will be planned for the users, in which a whole implementation process will be simulated and, if already available, the case-study data sets will be preliminary assessed for their compatibility with software requirements, and, if needed, instructions will be provided for problem solving.

The DSS tool is expected to be a substantial outcome of the project. It works as a flow-diagram wherein different choices in a first phase result in different outcomes in a second phase. Different impact assessments and adaptation strategies are connected to different data categories and sub-categories. The final answer provided by the system will be the scientifically robust, transparent, and documented analysis of adaptation strategies that better fit for the tourist location having the features indicated by the end users and according to their stated preferences and objectives.

Expected Results

1. Participatory processes implemented in the case study in support of the development of shared visions and cognitive models of the problems in question
2. Decision support system tool

4.6 WP6 - Adaptation measures and strategies to improve water management and irrigation systems

Leading partner: UATLA

	CMCC	UATLA	UPV
PM	**5**	**10**	**3**

Description of the work

The main goal of this WP is to integrate all the information collected in the previous WP's as the ground to establish a framework for participatory integrated irrigation management, based on a ecosystem approach. Furthermore, it will identify prospective adaptation strategies for sustainable irrigation management in Southern Europe agriculture. The chosen alternatives should represent benchmarks of possible strategies which possess a certain potential to improve livelihood of local communities and to protect and conserve water resources in the study areas.

The work will be done through:

Consultation workshops within and outside the research consortium for the identification of different potential strategies for saving water in agriculture. Selection of evaluation criteria.

Meetings with stakeholders and scenario simulation. Assigning scores and weights to the evaluation criteria according with each alternative. Evaluation and ranking of the potential adaptation strategies for sustainable water management.

Using DSS and GIS to identify strategies for sustainable water management. The chosen alternatives should represent benchmarks of possible strategies which possess a certain potential to improve livelihood of local communities and to protect and conserve water resources in the study areas. The work should include stakeholders during meetings and workshops.

Development of a framework, based on a set of prospective adaptation strategies for sustainable irrigation management, highlighting the conservation of quantity and quality of water resources for irrigated agriculture.

Expected Results

1. A framework for governance, policy options and participatory integrated water management.
2. Report on prospective adaptation strategies for saving water in Mediterranean agriculture.

NB: Wp5 and WP6 develop along similar lines. Yet, WP6 contributes to the initial identification and exploration of Social Network Analysis and process of involving stakeholders. Meanwhile, WP5 identifies the materials to be used. In the end, WP6 proposes options for an up-scaling at Mediterranean level (overarching framework), whilst WP5 coordinates workshops in the case study areas for the development of measures.

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