AGRICULTURAL WATER USE IN PORTUGAL: A PROSPECTIVE VIEW

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Abstract

Water resources are subject to increasing multiple pressures resulting from economic growth and increasing living standards. In the presence of water scarcity situations, allocations of the available resources have to be made parsimoniously. In this context, an important approach to water resource management aiming at water conservation is the "demand management" approach that focuses primarily on the reduction of consumer demand through the implementation of policies that include various measures that are able to reduce the pressure on water consumption.

Based on the data available for Portugal presented by the responsible institutions and the consultation of experts and researchers, various scenarios were developed (Ramos and Correia, 2001) leading to the formulation of recommendations for demand management in agricultural water use.

The results point out the difficulty in accessing adequate information, as well the uncertainties associated to evolution in Common Agricultural Policy (Ramos and Correia, 2002), global markets and climate change that may undermine any scenario approach.

The study presented in this paper was undertaken in the framework of POLAGWAT research project[1] *dealing with the possible use of demand management policies for water use in irrigation in the Mediterranean countries.*

1 INTRODUCTION AND BACKGROUND

Water is commonly acknowledged in the Portuguese society as an essential factor for social and economic development. In some areas, especially in the southern part of the country, it may even be a limiting factor for some economic activities such as agriculture, industry and tourism.

In spite of the recognition of water as a crucial factor, there has been no established tradition of a formal mechanism or procedure to integrate water issues in social and economic planning. This has been done usually on a case by case approach, with an *ad-hoc* evaluation of water requirements for any specific project. However, it is recognised that the water sector still requires a significant amount of public investment in order to improve domestic water supply, wastewater treatment, and control of industrial pollution, irrigation and power production.

The access to the European structural funds had a positive impact on the planning system of the country. The need for a rational use of the significant resources that are made available, and the requirements and the discipline imposed on the use of those funds, have been responsible in recent years for a very significant improvement both in sectoral and integrated regional planning.

[1] POLAGWAT Project: AGRICULTURAL WATER USE AND SECTORAL POLICIES IN MEDITERRANEAN COUNTRIES - IC18-CT97-0165 (EC, DG Research, INCO-DC)

There are two main institutions dealing with planning of agricultural water use in Portugal: The National Water Institute and the Institute of Rural Development and Hydraulics.

The National Water Institute (INAG) is the main agency of the Ministry of the Environment, responsible for the promotion and implementation of water policies. This Institute has direct contacts with other agencies such as agriculture, industry, energy and tourism, and certainly contributes for the general awareness of the importance of water for social and economic development. INAG provides inputs for the preparation of plans at all levels, and is responsible for the construction of the major water structures, which require some degree of participation in the definition of strategies for economic development.

The Institute of Rural Development and Hydraulics, (IDRHa) and the Regional Directorates of the Ministry of Agriculture (DRA), also play a very important role in the strategic planning of water use in agriculture. These institutions are involved with INAG in the construction of some important multi-purpose water systems. The public irrigation schemes are managed by Irrigation Associations, which include besides the farmers also a representative from the state who is a member of IDRHa. These Associations are not directly involved in planning but they are important in the management process.

Both the Ministry of Environment and the Ministry of Agriculture have been engaged in developing national water planning based on different assumptions and meeting different requirements, naturally leading to two scenarios for future water demand in agriculture that do not coincide entirely, as presented in the next section.

In the approach for the development for demand management scenarios data from both institutions had to be used since they cover different aspects of water use in agriculture.

2 SCENARIOS OF AGRICULTURAL WATER USE

The report on water resources in Portugal and its use published by INAG is meant to be a state of the art before starting the preparation of the river basin plans and the national water plan recently presented.

In those documents, projections were made of future water uses and water demands sector by sector. Those projections point out to an increase in irrigated areas of 25% in year 2015 (from 977,558 ha to 1,225.833 ha). This increase in area is accompanied by an increase in water demand for irrigation which is estimated in 12,077 $10^6 m^3$ for 2015 (9,383 $10^6 m^3$ for 1995) which means a 28% increase in demand in the agricultural sector. This larger value for water needs does not mean less efficiency but it is rather related with the crops that are being produced.

The projections on water demand were built by multiplying the planned area to be equipped by the water needs of the most common crops as they are distributed in the agro-ecological regions that differ in terms of water availability, evapotranspiration and other physical and agricultural characteristics. The water use efficiency factor introduced is estimated based on the age of the irrigation infrastructures. Three different situations were identified, ranging from 60% in the north to 75% in the very south.

These values of efficiency are expected to increase 10 % in each region due to major improvements in the infrastructure that are being implemented.

This scenario (Table 1) presented by the Ministry of Environment in 1995 is somehow a maximum possible value because the concern of that Ministry at that time was not to make a sectoral plan for agriculture but rather to analyse the most demanding scenario of evolution of that sector and to study under which circumstances that scenario was not threatened by water shortages. With this concern in mind, maximum possible values were used to assess if those values would be guaranteed by upstream uses, notably in the Spanish part of the river basin.

Table 1 - Water demand for irrigation (total abstraction in hm^3)

River basin	Actual	Medium term (2015)	Long term (*)
Minho	127.58	131.44	132.13
Lima	186.51	200.31	189.58
Cávado	387.75	410.47	457.88
Ave	414.29	416.32	529.81
Leça	29.69	29.69	76.72
Douro	2,089.71	2,360.51	3,128.70
Mangas e ribeiras da costa	0.74	0.74	9.63
Vouga	498.18	516.38	1,028.50
Mondego	853.14	853.14	1,720.11
Liz	79.33	79.33	251.90
Tejo	2,661.79	3,357.11	6,890.29
Ribeiras do Oeste	233.70	280.17	1,268.52
Sado	1,017.30	1,123.08	3,078.79
Mira	134.57	140.69	248.46
Guadiana	1,201.80	1,205.63	4,260.75
Ribeiras do Algarve	616.02	931.18	1,292.54
TOTAL	**10,532.1**	**12,036.19**	**24,564.31**

(*) In fact long term means the maximum possible value

The basin plans propose water management strategies, summarised in Table 2, which seem to be not driven by water demand management concerns.

Table 2 – Main vectors and strategies for water management according to the river basin plans

Vectors	Strategies	Direct contribution to water demand management
Social	• Satisfy basic needs of the population	No
	• Improve the quality of water services	No
Institutional	• Clarify responsibilities	No
	• Improve transparency of administration	No
	• Involve users' organisations	Possibly
Economic	• Recognise the economical value of water	Yes
	• Water pricing as a tool for sustainable water use	Yes
Environmental	• Water uses should avoid a negative impact on the natural environment	Possibly
Informational	• Provide adequate information for decision making	Possibly
Technologic	• Option based on efficiency	Yes

The first priority is of social nature and focuses on the satisfaction of human uses (households). It is not expected to reduce demand. On the contrary, it is likely that as standards of living improve, with more people connected to water supply systems, the domestic water consumption increases as well.

The institutional and informational vectors are not likely to have a large and direct impact on demand, although the involvement of user's organisations is associated with a better awareness of water problems and may possibly have an impact on a more cautious use of the resource. The same effect may possibly be associated with the environmental and informational measures.

The vectors dealing with economic and technologic issues will have a direct and significant impact on demand. Through the recognition of water pricing as a tool for sustainable water use, its implementation might stimulate consumers to optimise its use, for instance through the use of more efficient technologies, which reduces losses and thereby demand.

Unfortunately, there is very little data published by the Ministry of Agriculture that deal explicitly with water use. And even figures of the irrigated surface is still an estimation exercise based on various sources, 600,000 ha is, at present, a consensual order of magnitude for that figure (632,000 ha is used by FAO, 2003).

In 1998 the Ministry of Agriculture presented an Irrigation Plan that formulates the target of building 54,672 ha of new irrigation schemes to be increased to 110,000 ha in the medium term with the Alqueva project in Alentejo region. This plan was not revoked since then.

With the negotiation of the 3rd Community Support Frameworks for the period 2000 - 2006 the public investment in new irrigation schemes to be implemented in that period came down to 72,299 ha, including only 26,000 of the Alqueva project.

Besides the construction of new schemes the Institute of Rural Development and Hydraulics (IDRHa), responsible for defining the policy in agricultural water use at the national level, has plans to allocate funds to improve efficiency, especially with the modernisation of old irrigation schemes which should reduce losses in the distribution of water.

The Operational Programme for Agriculture and Rural Development (AGRO and AGRIS) defines the rules for the allocation of funds for the period 2000-2006 to which the farmers may apply for. Measure 4 aims at the funding and better management of hydro-agricultural infrastructures. 165 millions euros are allocated to this measure which represent 9,5% of the total budget of the programme.

The only document published by the Ministry of Agriculture, which calls for a more efficient use of water is the booklet, titled “Handbook of Agricultural Best Management Practices: Soil and Water Conservation”. This publication was distributed to farmers and presents recommendations for a more efficient use of water at the farm level.

3 SCENARIO BASED ON WATER DEMAND MANAGEMENT

3.1 Water Demand Management: Background

The concept of "demand management" seems to be not entirely clarified in the literature. It is identified as a set of policies aiming at bringing demands in line with supplies through the reduction on the demand side, according to four main areas of concern: financial incentives, technology, education and administration (World Bank, 1993). Also de OECD identifies 5 main groups of policies in demand management which are in line with those presented by the World Bank, even though more focused on administrative policies. Those policies are: (a) pricing through the use of tariff structures (financial incentives), (b) regulations (administration), (c) education, (d) increased flexibility in water use rights and (e) operational control (administration).

The approaches to demand management, and to the policies that should be part of a demand management strategy, are based on the definition of "demand management" and even on the definition of "demand" itself. The latter can be understood as referring to the needs of households, agriculture and industry; or indicating the amount of water actually consumed; or from a merely economic perspective, the price-quantity function with respect to the purchase of water (Merren, 1997).

Based on the definition of demand, Merren (1997) defines "demand management" policies as "policies to reduce the quantity of water that users choose to consume". This definition points out that the policies to be implemented should act on the consumers' choice as a mean to reduce demand.

Financial incentives are pointed out as being one of the most import and efficient policy measures in demand management. The combined use with the other policies mentioned above (i.e. education, administration and technology) has proved to be effective in water conservation and in limiting the need for new supplies in time of water scarcity. Among the financial incentives water pricing stands out since it shows the possibility to encourage consumers to adopt efficient water use practices (World Bank, 1993). One reason that is pointed out is the fact that consumer's behaviour seems strongly economically driven and thus demand is responsive to price. The underpricing of water has caused serious misuse in many regions of the world, because its availability at low price does not pay to invest neither in technology to augment efficiency on the consumers side, nor in educational programmes or in monitoring devices and administrative measures on the administration side (World Bank, 1993).

Education includes the provision of information and education about water conservation and the exercise of moral persuasion by water authorities (OECD, 1989). Education may be regarded as a demand management policy in its own right, or alternatively as a complement to pricing and regulation.

Demand management policies and programmes may be structured as follows:

1. Decreasing consumers' demand
    - Varieties of crops that are better adapted to resist diseases and water stress
    - Varieties of crops with short cycle
    - Shift in crops to less demanding in water (ex: from rice to maize)
2. Increasing efficiency
    - Leak detection programme in distribution systems,
    - Detection and reduction of losses in the infra-structures,
    - Irrigation equipment designed to use less water
    - Regulation of equipment
3. Increasing control
    - Control of uses (by installation of meters)
4. Administrative controls
    - Rationing
    - Restriction of certain uses
    - Abolition of water consuming crops
5. Financial incentives
    - Water pricing
    - Subsidies for new equipment

3.2 Baseline for Demand Management in Portugal

In Portugal water is not a scarce resource in average terms, with a per capita value of 6,600 m3/year. This value is relatively high among European countries, notably among the Mediterranean countries. Nevertheless, this value has to be assessed and valued carefully considering the Portuguese geographic context (Correia, 2000).

In fact, in Mediterranean countries the average values may have little meaning because there are very significant fluctuations throughout the year and from year to year. The problem is not to have enough water on the average, but to have water at the appropriate moment and guaranteed every year. This is the rational of increasing storage through the building of dams that is an important component of water policies in the Mediterranean countries.

The geographical and temporal variability of water distribution calls for major investments in water storage to insure the fulfilment of the water needs throughout the year and in dry years. Demand management may help overcoming this difficulty but it is very questionable that standing alone it is enough to solve seasonal shortages and scarcity in dry years which are "structural" characteristics of water availability in Portugal and other southern European, Mediterranean driven, climatic regions (Correia *et al.*, 1998).

3.3 Scenarios for Demand Management in Portugal

Three scenarios have been considered, going from a more likely to happen to a more demanding one, in terms of farmers involvement. The scenarios are based on the implementation of public investments, financial incentives (water pricing and subsidies for new equipment), and adequate education programmes and technical advice to farmers.

The main purpose is to reduce water demand by improving the efficiency of the irrigation schemes, acting on the distribution system and on the irrigation technologies used by farmers. The scenarios are developed for the public irrigation schemes only (Figure 1), representing circa 13% of the total irrigated area in Portugal, in which more reliable data is available. In those schemes it is easier for the governmental agencies to have direct control of the investments and also on farming practices and therefore they can be considered as pilot areas.

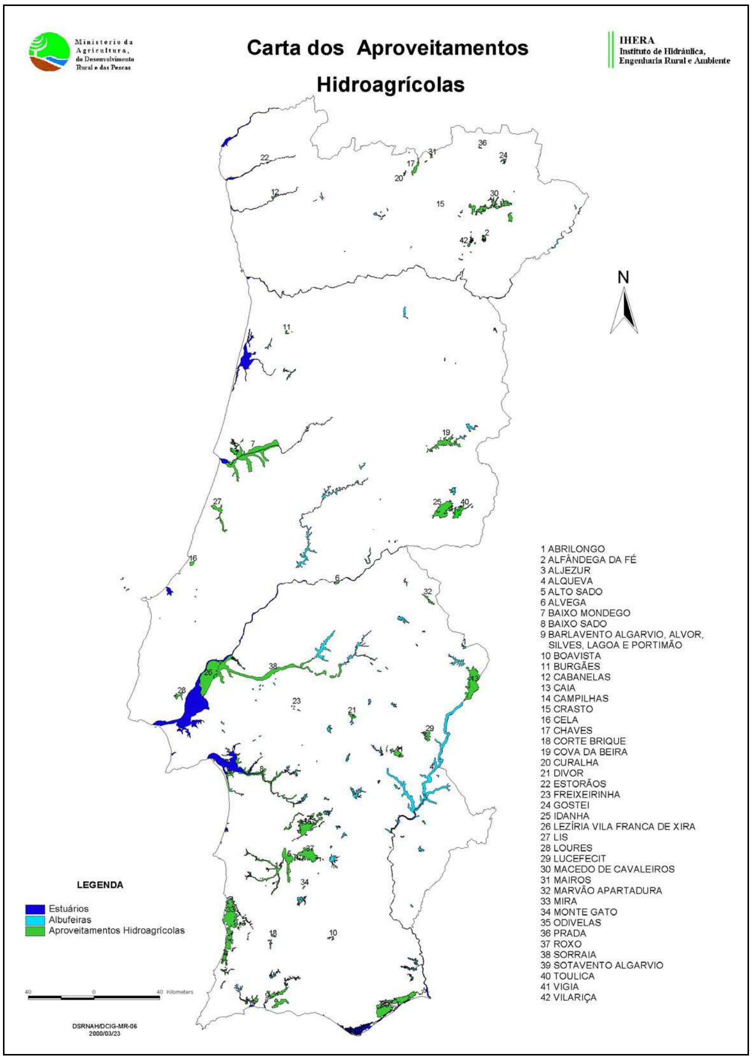

Figure 1 – Public irrigation infrastructures

In the light of the trends expected for CAP it is to foreseeable that agriculture is going to split in to (a) a highly intensive and business like agriculture and (b) a more extensive and quality concerned agriculture within the framework of an integrated rural development policy.

Thus, the areas in which the best production conditions, such as a fertile soil and water availability can be found are the ones that are going to be pushed towards a higher productivity. These conditions are present in almost all public irrigation schemes, located in alluvium soils of river corridors. Therefore, it is likely that even if other areas may be abandoned for irrigated agriculture because they are not competitive or because of environmental restrictions (nature conservation or landscape protection), those public systems tend to stay in production and may even expand.

At present the most used irrigation technology is still gravity irrigation even though it has been drastically reduced from 86% in 1989 to 69% in 1999. The irrigation types under pressure have augmented. Aspersion represented 1989 only 12% and shifted in 1999 to a 21% share. Drip irrigation meant no more than 1,2% in 1989 and moved to 5,2% in 1999. Those figures give us a trend and show a clear shift towards aspersion and drip irrigation. This trend is expected to continue and may have a considerable influence on water demand pattern for irrigation purposes. As stated by officials of IDRHa, the reason behind this trend is little related with water management but mostly with an increasing lack of men-power available in rural areas.

This fact was determinant for the scenario development presented in this paper. Based on the known dynamics of the irrigation practices, future scenarios were drawn with the support IDRHa officials and other experts on agriculture and irrigation from the Higher Institute of Agronomy (ISA) in Lisbon.

One major difficulty for the scenario development was the lack of data because there are no statistics on water consumption for the entire country since private irrigation schemes prevail (76,4%).

The official data are only available for the public irrigation schemes and even in those cases it is often inconsistent. Those schemes represent only 13,2% of the whole estimated area irrigated and they are mainly located in the most water-stressed areas of southern Portugal.

The scenarios for the public irrigation schemes were developed based on the analysis of the available data on water consumption. Those data show an average value of water consumption for irrigation of 6,000 m3/ha.year. The most consumptive crop is rice that uses up to 12,000 m3/ha.year. The average value is used for the development of the reference scenario (scenario 0) by multiplying it by the areas of public irrigation schemes built until 1999 (104,000 ha).

In scenario 1 (Modernisation of water distribution infrastructures) only public investment is considered. That investment is used to increase the efficiency of the distribution of water in irrigation schemes by reducing water losses. The farmers are not involved or asked to play an active role. This scenario corresponds to the first step of the process within the proposed stepwise approach. This scenario is expected to result in a 10% decrease in water consumption.

Scenario 2 is built on Scenario 1 plus water pricing (level 1). After the implementation of scenario 1, scenario 2 introduces water pricing. It should be at a very low, almost symbolic, level. This slight increase in prices is accompanied by technical advice that will stimulate farmers to optimise the existing technology. For instance, the use of siphons in gravity irrigation, a better regulation and adaptation of the sprinklers to the crops in aspersion irrigation, a better calculation of crop water needs through soil analysis, and shifting to crops with a shorter cycle requiring water during a shorter period of time.

Within this scenario it is expected that some farmers might shift from very water consuming crops, such as rice, to less consuming crops. It is also considered that some might shift from gravity irrigation to aspersion or drip. This scenario is expected to reduce demand in a total of 15%.

In scenario 3 (Scenario 1 plus water pricing (level 2) and equipment renewal) the water price will rise more significantly than in scenario 2 and simultaneously financial assistance will be provided to invest in new equipment. If equipment is financed at a 50% level, it is expected that most of the farmers (90%) currently using gravity irrigation will shift either to aspersion or drip. It is considered that 60% will shift to aspersion and 30% will shift to drip irrigation. Farmers prefer aspersion to drip because it leaves them more freedom to change crops every year and give them more flexibility to adapt to the economical context. Drip irrigation will be favoured by farmers specialised either in orchards or some horticultural crops such as melon, cucumber, etc. Also in scenario 3 it is expected that some farmers abandon water-consuming crops such as rice. Scenario 3 will reduce the water used for irrigation in a total of 30%.

Water demand estimations were performed for each scenario of the area of the public irrigation schemes. Table 3 presents an overview of the expected decrease in water demand for each scenario, based on the previous considerations.

Table 3– Estimated water consumption in the public irrigation schemes for three demand management scenarios in $10^6 m^3$

SCENARIOS	Scenario 0	Scenario 1	Scenario 2	Scenario 3
	Reference	Modernisation of water distribution infrastructures	Scenario 1 + water pricing (level 1)	Scenario 1 + water pricing (level 2) and subsidies for new equipment
EXPECTED INCREASE IN EFFICIENCY	0%	10%	15%	30%
Entre Douro e Minho	5,016	4,514	4,264	3,511
Trás-os-Montes	42,210	37,989	35,879	29,547
Beira Litoral	43,464	39,118	36,944	30,425
Beira Interior	12,048	10,843	10,241	8,434
Ribatejo e Oeste	103,464	93,118	87,944	72,425
Alentejo	281,736	253,562	239,476	197,215
Algarve	76,104	68,494	64,688	53,273
Total area of public irrigation schemes (13,2%of total irrigated area)	**624,042**	**561,638**	**530,436**	**436,829**

As presented before in Table 1, INAG estimates an actual consumption of 10,532.1 hm3 for the total irrigated area. 13,2 % of this value is 1,369.173 hm3. The actual water consumption value presented by IDRHa is less then half. This discrepancy may have various explanations. One could be that the farmers practice a more rational use of water in the public schemes because they have to pay a small price, even though the price is not always related to the actual consumption of water, but often based on estimation per culture. A second and more plausible reason could be related to the fact that the irrigated area with public infrastructure is not fully used, some reports mention 70% as the actual irrigated area (INAG, 2001).

This exploratory exercise shows that an increase in efficiency associated to changes in crops, modernisation of equipment and water pricing, may be able to contribute to a considerable reduction of agricultural water consumption. Nevertheless it seems to become more evident in Portugal, as it is already being accepted in Italy, that irrigated areas are decreasing. The reasons for this trend in Italy can be explained in PAC's price policy, its goal to reduce production and the global market agreements. Especially in regions that have experienced severe water scarcity, farmers are discouraged to cultivate irrigated crops because the level of uncertainty on the availability of enough water stored is increasing. In years of drought, the priority of the distribution of stored water is put on domestic uses, including also tourism uses which are seen as more important in terms of regional development than agriculture (Ramos and Correia, 2002).

4. CONCLUSION: FROM SCENARIOS TO RECOMMENDATIONS

In Portugal, such as elsewhere, policies that push towards a restrained use of water are not popular among farmers. Water pricing is seen, even by the responsible authorities like IDRHa, as a limiting factor for the economical viability of farms that can cause social and economical problems such as unemployment and depression of rural areas. Therefore, among the wide range of policies included in demand management, farmer education and technology improvement are seen as priorities to change the attitudes and behaviour of farmers before advancing with water pricing or making steps towards a full cost recovery approach.

Even though farmers are strongly responsive to pricing, they are not prepared to respond to drastic increases in water costs that could make their economic activity become unfeasible. However, a reasonable increase in water price seems to be fundamental to make them react, to increase their awareness of the water scarcity problems and to make them more receptive to innovation and change. That increase in water prices should be implemented stepwise and accompanied by education, technical and financial assistance provided by the responsible authorities.

Education should stimulate the use of more updated technology and help to make a better use of existing technology. It should be first targeted to the professionals responsible for the design of hydraulic projects so that they can engineer better irrigation systems and give better technical assistance to the farmers.

In this context, demonstration plays an important role in order to convince farmers. Demonstration projects in the public irrigation schemes, and also oriented research, should also provide accurate information on the water needs of each crop in the different agro-ecological regions. Take advantage of the traditional crop varieties that are more resistant to water stress would also help.

Other recommendations, not directly derived from the scenario approach, should be also taken into account notably at the water planning level. The irrigation plans and other water plans should include often discarded issues such as the expected trends in PAC and in the global markets, the expected scenarios to occur in the framework of climate change, the environmental impact resulting from irrigation projects, and their conflicts with environmental legislation.

Portugal is a quite small but very diversified country. It has a large agro-ecological (soils, climate, morphology) and social variability (characteristics of the farmers, land ownership patterns, traditions, etc.). Therefore agriculture plans should take into account those factors at a sub-regional scale in order to adapt better to reality and to be able to understand how to move towards a more active participation of the users in water demand management.

Finally, a recommendation on the availability of information. It is very clear that more scarce than water is the information on agriculture activities. No plans or policy formulation are possible without a good data basis and it seems that a long road still needs to be driven in Portugal in that area

Although demand measures are important to help solving water conflicts under scarcity conditions, they can not be seen as a panacea and they can not be used as a remedy for the very structural problem of the irregularities of water availability due to the geographical characteristics of the country.

Furthermore, factors affecting agricultural water use such as the mentioned above trends in PAC and global markets, and possible scenarios resulting from climate change are sources of uncertainty that are by several orders of magnitude larger then the ”elasticity” associated to water charges.

4 ACKNOWLEDGEMENTS

The research activity presented in this report was done under the research contract nº IC18-CT97-0165 with the European Commission. Dr. Adeline Kroll, the coordinator of the project, is acknowledged for her efforts in leading the research activities in such a complex area and with such a diversity of the backgrounds of the teams. Sébastien Treyer is also acknowledged for coordinating the scenario formulation component of the project.

We would like to especially acknowledge experts, researchers from ISA and IST and ministry officials from MAOT and IDHRa for their contributions to the scenario development, by alphabetic order, António Gonçalves Henriques, António Moura, Luciano Passos, Francisco Avillez, Gonçalo Leal, José Luis Teixeira, João Bragança and Pedro Leão.

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