CAPACITY DEVELOPMENT IN DROUGHT RISK REDUCTION AND ADAPTATION : FINDINGS OF THE CATALYST THINK TANK AS ILLUSTRATED BY THE PUGLIA REGION OF SOUTHERN ITALY

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EXTENDED ABSTRACT

This article presents preliminary findings of the CATALYST project's Think Tank on best practices and capacity development needs for improving Drought Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) in the European Mediterranean (EUM) region. Where available this article illustrates these findings with examples from the Puglia region in southern Italy. Drought is considered a major natural hazard in the EUM region and will increase in intensity according to many climate-model projections. Under these conditions, it is argued that shifting from crisis management to an integrated risk management approach is crucial in order to implement effective drought management strategies. Several barriers have hampered the shift from crises to risk management. Among them, the communication gaps between scientists and practitioners has played a crucial role. The CATALYST project (http://www.catalyst-project.eu/), funded by the European Commission under Framework Programme 7, seeks to narrow the knowledge gaps in best practices in disaster risk reduction and climate change adaptation by means of a think tank process in which the goal is knowledge sharing on good practices in drought management among representatives of the scientific community, governmental agencies intergovernmental bodies (such as the UN) and NGOs as well as private enterprise. The EUM region is one of the four focus regions in the CATALYST project.

A workshop on capacity development in drought risk management was organized in Puglia with the aim of identifying the main issues to be addressed in the EUM region and to share the knowledge concerning both good and bad practices identified within the think tank network. Monitoring and early warning were found to be crucial to increasing preparedness under uncertain conditions. Early warning systems should provide timely and effective information through designated organizations that allow individuals and institutions at risk to take action to avoid or reduce the impacts of the hazard and prepare effective responses. Conflict analysis should be carried out in order to facilitate the implementation of drought policies. Past experiences in Puglia highlighted the existence of communication barriers between monitoring and drought risk managers The outcome of the think tank discussion stressed the need for adopting holistic integrating approaches and enhanced communication on uncertainties associated with early warning by including drought in integrated water resources management. Limiting the use of resources, and particularly groundwater abstraction, is of utmost importance in Mediterranean regions as Puglia. Furthermore, what is needed is not only improved climate forecasting, restricted to the physical implications of climate scenarios, but also the reverse, in the form of backcasting, accounting for the preferences of the affected population and their anticipated behavior, thus integrating top-down and bottom-up approaches. Major improvements in drought risk management, however, are not likely to occur without investment in institutional capacity development.

Keywords Natural Hazards, Capacity Development, Drought, Think Tank Process, Integrated Drought Management, Puglia Region

1. INTRODUCTION

Drought has long been considered as one of the major natural hazards globally, becoming particularly important in Europe during recent years (EEA, 2012, 2009). Even though drought has been historically a recurrent feature in European climate, several studies have lately demonstrated an increasing trend in Europe's exposure to drought hazards (IPCC, 2012). Under various scenarios of several climate change models drought episodes are predicted to intensify in most of Western Europe, and particularly in the Mediterranean region.

The character and severity of drought impacts and their intensity depend on both the physical nature of the hazard (the hydro-meteorological hazard) and how impacts are managed. Management focused primarily on reaction rather than adaptation supported by experimentation is the traditional approache to addressing water scarcity and drought. Under such crisis management approaches, drought gets the attention of decision makers only when the phenomenon is at its peak of intensity and spatial extent (Hamdy 2004). Mounting evidence of the ineffectiveness of the crisis management approaches has gained increasing support in recent years with the adoption of a more proactive risk-based management approach (Wilhite et al. 2007).

Risk-based approaches focus more on the causes of drought impacts than on the effects themselves. Evidence for the need to shift from crisis to risk-based drought management can be easily found within the scientific and policy communities (Hamdy 2004; Iglesias et al. 2009).

The centrality of capacity development efforts in drought risk management has been strongly emphasized by the Hyogo Framework for Action (UNISDR, 2007). In this article we refer to the definition of capacity development adopted by the United Nations International Strategy for Disaster Reduction (UNISDR): "the process by which people, organizations and society systematically stimulate and develop their capability over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions – within a wider social and cultural enabling environment" (UNISDR, 2009, p.6). It also adopts Alaerts & Kaspersma's (2010) focus on the importance of knowledge production - i.e. the collation and synthesis of knowledge, as a key components of capacity development. Capacity development needs to be sustained through institutions that support capacity-development and capacity maintenance as permanent on-going objectives.

Based on these premises, the project Capacity development for hazard risk reduction and adaptation (CATALYST) (http://www.catalyst-project.eu/) – a coordinating action funded within the EU Seventh Framework Programme – is bringing together existing networks of researchers, policy and decision makers, members of nongovernmental organisations, and small- and medium- sized enterprises to identify and share information about best practices and critical knowledge gaps in Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) (Hare et al. in press). The challenge is how to take advantage of this knowledge. With this aim, CATALYST creates opportunities for capacity development in collaboration with experts and stakeholders with the aim of effectively assembling, analysing, and making use of existing knowledge in disaster risk reduction, and subsequently publishing these knowledge products.

The role of CATALYST in fostering capacity development processes is twofold. On the one hand, it provides capacity development through the identification and use of the most suitable tools to support DRR/CCA networks, knowledge production, knowledge management, knowledge exchange and peer learning. On the other hand, CATALYST aims to facilitate the identification of best practices in DDR and CCA. To support knowledge sharing a Think Tank was established in for four geographical regions: Central America and Caribbean, East and West Africa, the European Mediterranean, and South and South East Asia. In addition to the organisation of virtual meetings, an interactive website and online fora for knowledge and information exchange, four workshops

focused on capacity development in DRR and CCA have been organized in each region. For more information on the Think Tank, see Hare et al. (in press).
This article reports on the outcomes of the capacity development workshop for the EUM region Think Tank. The workshop was held in the Puglia region of Southern Italy, bringing together local and international experts in DRR and CCA and local stakeholders. The workshop was intended to promote the sharing of examples and experiences among experts and stakeholders in order to illustrate both good practices and less-than-satisfactory practices, facilitating the identification of the main barriers to capacity development in DRR and CCA in the EUM area.
This article describes the results of the knowledge sharing process activated during the workshop. More information on solutions applicable to the wider European Mediterranean region, can be found on the project website.

2. The CATALYST Euro-Mediterranean workshop

The European Mediterranean workshop began with keynote lectures intended to inspire and initiate discussions, both in the plenary session and in small group discussions. These discussions were then taken into plenary sessions for knowledge-sharing and summarizing the discussions. Finally, local perspectives were included by means of round table discussions with experts, stakeholders and decision makers from the Puglia region.
The two days of discussions were focused on: (1) state-of-the-art and good practices, (2) gaps and filling gaps, and (3) fostering further capacity development in drought DRR and CCA. Within these thematic issues, crucial aspects of drought DRR and CCA were addressed, as described in the subsequent sections.

2.1. State of the Art of drought DDR and CCA, including good practices

Key information on state-of-the-art of drought DRR and CCA practices in the EUM region including selected surrounding countries, the latter mainly from the knowledge and experiences of Think Tank members in their own countries, was subdivided into areas concerning measures, monitoring and communication. During the discussions, experiences concerning successful stories – i.e. good practices – and lessons learned as a result of unsuccessful attempts to manage drought risk were shared.

2.1.1. Measures in drought risk management

Concerning drought risk management measures, workshop participants agreed to clearly differentiate the various aspects of drought, and to try to overcome the simplistic definition adopted in many studies that have been based exclusively on meteorological data (see introduction to this article). Participants also agreed that distinctive risk reduction and adaptation measures tailored to hydrological drought, agricultural drought and institutional aspects of drought, without neglecting the fuzziness of the boundaries of these categories are needed.

Hydrological drought
Hydrological drought occurs when storage and flow of water are less than normal, reducing the capacity to satisfy water requirements of both the natural environment and anthropic activities. Hydrological drought can be characterized by a complex web of cascading effects on various components of the socio-environmental system. On the one hand, it can cause socio-economic impacts, such as shortages of drinking water and loss of agricultural production. On the other hand, workshop participants were clear that groundwater salinization due to limited recharge and overexploitation is becoming a pressing issue in coastal areas of most of the EUM countries and particularly in the

Puglia region. Also hydrological drought can be accompanied by heat waves, wild fires and dust storms. Currently, most common measures to cope with hydrological drought can be short- or long-term. Short-term measures aim to optimize the allocation of reduced volumes of water by regulating water consumption according to designated priorities. Most of the time, priorities are given to anthropic uses of water, particularly for drinking purposes, whereas little or no attention is given to the water required for ecological purposes potentially violating requirements of the EU Water Framework Directive (European Union, 2000). These types of measures are commonly implemented when the drought is at its peak. These measures can have two main negative side effects. First, it can reinforce the unsustainable use of drinking water by communities, simply because they tend to ignore the occurrence of a drought event unless they experience first hand a reduction in water availability. Second, the current optimization measures during drought conditions tend to drastically reduce the water released into water bodies for environmental purposes, resulting in highly negative impacts on the quality of river ecosystems. This issue is particularly pressing in Puglia Apulia where most of the rivers s are ephemeral.
Innovations in Information and Communication Technology are proving to be useful in enabling behavioural changes among water users. For example, smart metering technologies and smart water markets are increasingly used e.g. in the context of Smart Cities. Innovation in smart metering technologies allows one to collect real-time information about water consumption at the household or farm level. This information can be used by water managers to enhance the reliability of models for the analysis and forecasting of water consumption and demand at sub-daily time scales, as well as to enable behavioural changes in the habits and hence consumption patterns of water users. Knowing who, when, how and why water is consumed at different scales, identifying the dynamics of consumption patterns and correlating them with activity patterns, enables the optimization of water using actions tailored to various types of consumers.

Agricultural drought
Agricultural drought is concerned specifically with the effects of water shortages on crops, including grasses and other forage crops. Therefore, agricultural drought is most closely associated with deficiencies that occur in soil moisture and lead to losses in yield. Agricultural drought links various meteorological and hydrological characteristics to agricultural impacts, focusing on precipitation deficits, differences between actual and potential evapotranspiration, soil water deficits, and reduced groundwater levels. Agriculture is usually the first sector to experience the devastating effects of drought. During the workshop discussions it emerged that only a few cases of agricultural adaptation to the increasing occurrence of drought events can be found in the EUM region. Most common measures to cope with agricultural drought are aimed at reducing the economic losses through relief mechanisms or emergency assistance to the affected areas or sectors. These policies often lead to an unexpected side-effect. Such mechanisms often serve as a disincentive to shifting towards more sustainable forms of irrigated agriculture. These policies reinforce existing management practices that may not be sustainable in the face of increasingly recurrent severe droughts.
Other common short-term measures to cope with agricultural drought simply reduce water consumption by reducing the quantity of water available for irrigation. Evidence in the Puglia region suggests that these policies could generate significant conflicts between water authorities and end users. This, in turn, results in a decrease in policy effectiveness (Giordano et al., 2013; Portoghese et al., in press).
Few success stories concerning the re-use of treated wastewater for irrigation purposes were mentioned by Think Tank members. Their experiences demonstrated that although most of the technical issues concerning water treatment processes have been addressed, issues related to the social acceptability of treated wastewater still need to be

solved. In many cases, farmers' perceptions of the quality of recycled water is the main constraint. In other examples, restrictive legislation concerned with water quality standards for irrigation provoked an increase of the water price, which was considered unsustainable by local farmers.

Institutional drought

During the workshop, the experts also emphasized the role of the so-called *institutional-driven drought*. This drought type is based on the assumption that mismanagement can make access to water difficult. The mismanagement of stored water is mainly the result of a lack of medium-term reservoir management plans. The allocation plans are currently based on an annual evaluation of the stored volume and an assessment of water demand, whereas a mid-term forecast of both water availability and demand would allow water shortages as a result of drought events to be addressed.

2.1.2. Monitoring and forecasting

Drought forecasting is recognized as a difficult task for climate modelers. The state-of-the-art seasonal forecast models tend to show onset conditions of an agricultural drought only a few weeks in advance (Sheffield and Wood, 2011). This tendency limits the ability of forecasters to predict agricultural drought conditions a month or more ahead of time which would be necessary for a proactive response. Rudimentary droughts forecasts can be made almost entirely just on the basis of remote sensing data focusing on vegetation stress indices related to soil moisture deficit and climate observation networks (Sheffield and Wood, 2011).

The European Commission issued a Communication on "Addressing the Challenge of Water Scarcity and Droughts in the European Union" (COM(2007) 414) in 2007 aiming at suggesting the implementation of adaptation and mitigation measures against the effects of drought and climate change in Europe. Among them a European Drought Observatory (EDO) was launched with the aim of providing consistent and timely information on drought occurrence and evolution from continental to regional and local scales (European Drought Observatory, 2011). Though not yet fully operational, the EDO is being implemented by the JRC's Institute for Environment and Sustainability, in partnership with the Directorate General for Environment, the European Environment Agency and the Member States. The main feature of the EDO is providing a European-wide picture of the occurrence, severity, extent and duration of droughts in Europe, including direct access to information provided by national, regional and local services with freely access to the data from the JRC website (http://edo.jrc.ec.europa.eu). However, more sophisticated drought forecasts require the integration of remote-sensing data, in situ monitoring of meteorological, hydrological and agro-physical parameters and various types of models representing the current state of available water resources during drought events. For this reason the Committee of the Regions (COR) of the European Union has proposed that "the current European Drought Observatory be converted into a European Water Observatory, with a wider remit that includes validating and ensuring the uniformity of available information on the condition of European water resources as a dynamical tool for drought risk management across Europe (Committee of Regions, ENVE-V-008, 2011, p.10). This proposal is strongly supported by the state government in the Puglia region whose president was appointed as rapporteur for the Committee of Regions contributing to the opinion paper on the role of regional and local authorities in promoting sustainable water management.

According to the Hyogo Framework for Action (HFA), drought monitoring and early warning systems should provide reliable, understandable, timely and affordable information about drought risk. This information should be delivered to decision-makers, the general public and communities at risk in an appropriate format and on a regular basis. Resilience to drought could be enhanced through the development of a people-centered monitoring and information systems, or in other words, a system focused on

reaching the people affected by drought and providing them with meaningful information that they can act upon (UNISDR, 2009). To achieve this objective it is crucial to negotiate a credible and legitimate knowledge system, which should include both expert and local knowledge (Vogel et al., 2007; UNISDR, 2009).

2.1.3. Drought risk communication

Huntjens et al. (2010) demonstrated that information management and particularly joint information production, consideration of uncertainties, and broad communication efforts have significant positive correlations with cooperation structures (cooperation among the different decision-making levels and conflict resolution). The research of Huntjens et al., (2010) provides evidence that drought response/ adaptation seems to be slower than responsiveness to floods. The authors explain this by differences in risk perceptions and in the availability of solutions. In addition, they suggest that these differences might be explained by the nature of the problem itself. Whereas flood management is determined by safety concerns, drought management is determined by water scarcity and related problems in the allocation of water resources. The threat of floods is often perceived as more immediate and acute than the threat of droughts, since the latter take place over a longer time periods and consequences are often felt indirectly. This is further complicated by the fact that groundwater is a less visible resource.
Kok and Van Delden (2009) identified a number of promising and novel methods relevant to the examination of drought risk communication. These methods are based on scenario development which links narrative storylines and spatial models with participatory models (Story-And-Simulation approaches / SAS), drawing on the practice of land use and land cover modeling. Here, a mix of qualitative, semi-quantitative and quantitative methods for capturing knowledge and understanding relationships can be applied to improve drought risk communication. Qualitative methods with the use of post-it note exercises, rich pictures, collages etc. allow for visions of the future to be explored. Semi-quantitative methods,such as Fuzzy Cognitive Maps, Bayesian belief networks, agent-based models and system dynamics, are tools that allow stakeholders to better understand the characteristics of drought phenomena together in a participatory exercise. A key point here is the need for effectively dealing with the different knowledge frames (ambiguity) and uncertainties that needs to be communicated and handled explicitly in order to select efficient adaptive drought risk management strategies. The authors of this article propose that the semi-quantitative methods and tools mentioned in this section allow for the integration of knowledge, for engaging stakeholders and for dealing with multiple uncertainties (Henriksen et al., 2012)

2.2. **Barriers to good practices**

Workshop participants pointed to a number of reasons that are slowing the shift from crisis to risk management. First, in the literature there is no clear, generally accepted, definition of drought, leading to confusion in terms of social awareness and inaction on the part of the decision makers that are often caused by the divergent opinions of experts because of disagreement on the existence of drought conditions and severity. Second, the prevailing technical orientation of drought management has imposed a one-dimensional definition of drought and drought impacts – that is a departure from normal precipitation and a reduction in the amount of water available for human uses. This narrow perspective blocks the shift to risk-based approaches in drought management. Third, risk management requires a comprehensive assessment of drought risk based on a deep understanding of the complex web of impacts and of the underlying environmental, economic, social and institutional causes. Workshop participants stated that this knowledge is not available for decision-makers in most EUM regions. A deep

gap is hampering the transfer of knowledge from scientists to practitioners at multiple operational levels.
Drought effects are also largely non-structural and spatially extensive (Wilhite et al., 2007), making drought impact assessment difficult. Moreover, the effects of drought occur at different spatial scales, over different time horizons. The conclusions of the workshop participants clearly point to the lack of coupled monitoring-modeling systems (e.g. data assimilation techniques) capable of collecting data on various drought impacts and providing reliable knowledge to policy- decision-makers is inhibiting the ability to deal with the wide range of impacts. The causes of those impacts remain largely unresolved.
The severity of drought impacts are also perceived differently by different actors. Drought perception is an important issue that needs to be addressed at the policy-making level. Empirical investigations emphasize the ambiguity in drought perception and definition (Noemdoe et al., 2006). The way in which a drought phenomenon is defined, as well as the system of values and objectives among diverse stakeholders influences their expectations of future occurrences, and their behaviour so that they act or react in different ways . Knowing how people respond to drought is crucial to evaluating social vulnerability to drought. As emerged during the workshop, this information is missing in current drought assessment approaches in the Puglia region.
Thus, differences in drought perceptions often lead to conflicts among different stakeholders. To avoid conflict or, at least, to reduce the level of conflict, the various interested/impacted parties should be involved together in participatory drought risk management processes. The mutual skepticism between decision-makers and stakeholders remains an obstacle to implementing these processes in many countries in EUM region and particularly in Puglia, as discussed by Giordano et al. (2013). On the one hand, the predominant organizations concerned with environmental and natural resource management promote skepticism among decision-makers in the abilities of stakeholders to provide knowledge that is useful for decision-making. On the other hand, stakeholders, and in particular farmers, are aware of the top–down approach to decision making and, consequently, it is still of the opinion that, even if a participatory approach is adopted, the decisions will taken without reflecting their views and concerns. Nevertheless, there is an increasing awareness of the importance of stakeholders' involvement to support sustainable drought risk management.
Drought risk communication is characterized with several barriers. The relevant information that has been collected, compiled and analyzed is mainly technical in nature and primarily focused on meteorological drought, reducing the ability of local communities to obtain a comprehensive view of the drought phenomenon and to comprehend the risk management policies that are possible to address the event. Moreover, the availability of timely information from, for example, Early Warning System a drought is still far from standard. This, in turn, impedes farmers in responding quickly and appropriately, and adapting their behavior to the changing conditions.

3. DISCUSSION: FOSTERING FURTHER CAPACITY DEVELOPMENT IN DROUGHT DRR AND CCA

The CATALYST European Mediterranean workshop participants are of the opinion that several steps are required to foster enhanced capacity development in drought DRR and CCA in region. These interventions ranged from strongly technical to more social in their orientation towards drought risk. A synthesis of the results of these discussions are presented in this concluding section in the form of recommendations.

Drought monitoring and forecasting
Most of the participants pointed out that current drought monitoring and forecasting should be capable of tackling the complex nature of this phenomenon. According to their

opinion, Drought DRR requires systems capable of providing decision-makers with reliable seasonal forecasts, allowing them to prepare drought risk management plans well in advance, and not when drought is imminent or at its peak. The discussion on case studies revealed that the availability of reliable and timely information concerning reduced water availability for irrigation purposes could have a positive impact on farmers' behaviour by encouraging them to adapt their cropping plans to changing conditions. This, in turn, would result in decreasing pressure on water resources, and in a reduction in conflicts between farmers and water authorities. To this end the US Drought Monitor \ is a positive example since it provides both monitoring data and short- and long-term drought forecasts.

Communicating uncertainty associated with drought forecasts is an issue of utmost importance. Drought monitoring should encourage decision-makers to continually assess the wide range of potential drought impacts and take appropriate actions. As stated in the introduction, shifting from crisis management to risk management requires a strong knowledge base concerning direct and indirect drought impacts and their causes. Therefore, the implementation of integrated drought policies requires the continual collection of information concerning the factors influencing the vulnerability of the socio-ecological system to drought. These monitoring systems should help to overcome the simplistic view of drought as a deviation from average levels of precipitation and instead enable a management approach in which drought is considered part of integrated water resources management.

To support this, the integration between drought monitoring and modelling has been identified as crucial. Modelling can support the identification of variables (such as socio-economic impacts) that are critical for monitoring drought conditions The models help to understand/interpret the dynamic implications of these relationships among variables associated with drought through the simulation of various scenarios. This, in turn, allows drought monitoring networks to be designed (and adapted) according to the model results. The simulation of future scenarios through modelling can support the categorisation of drought variables according to speed of change, i.e. slow-changing variables (e.g., socio-economic indicators) and fast-changing variables (e.g. precipitation). The categorisation of variables according to speed of change can be used to program the frequency of data collection, making it easier to identify the trend associated each variable (e.g. driving to extend the monitoring of drought socio-economic impacts). This allows the time scale issue of drought impacts to be addressed. The integration between monitoring and modelling has to be considered as an iterative process. The availability of new data allows the revision and updating of models.

The role of drought monitoring and modelling has to be carefully reconsidered in light of the arguments made in this article. A closer integration with the policy/decision-making process is required. In an innovative drought risk management framework, monitoring and modelling should be used to continually assess and criticize the assumptions underlying an adaptive strategy for drought risk management and to suggest changes in both goals and strategy when appropriate.

Institutional capacity for greater stakeholder participation in decision-making

According to UN World Water Development Reports (e.g., UNESCO-WWAP, 2009), the key to improving water resources management worldwide is developing the institutional capacity to formulate and implement effective policies, agreements, laws and modes of multi-stakeholder cooperation. It is certainly true that drought risk management cannot leave aside issues of social acceptance of relevant policies, since the effectiveness of those policies can be strongly impacted by the level of social acceptance they have gained. It is argued by CATALYST think tank members that this acceptance requires a multi-stakeholder approach to drought risk management. Common sense suggests that if the most important stakeholders, in terms of policy implementation, are not involved in the definition of risk management strategies, the outcomes of decision processes can be

controversial and generate strong opposition, rendering potential solutions unfeasible (see Daniell et al. 2010 for examples related to drought management). Although the technical (water quality) issues related to the re-use of treated wastewater have been addressed, in many parts of the EUM the actual implementation of this irrigation source as a measure is still far from effective, due to its low level of social acceptance. In Puglia region, attempts to protect the groundwater quality through restrictions in water use for irrigation failed due to strong opposition by farmers. Therefore, institutional innovations are needed to enable multi-stakeholder decision-making processes. Unilateral action on the part of decision makers creates the illusion of efficiency in the decision-making process since although it allows the time, expense and uncertainties associated with a negotiation process to be avoided, implementation problems and subsequently time delays will almost certainly arise because stakeholders have not been involved. It is hoped and anticipated that participation in decision making will lead to greater stakeholder and public acceptance and support of those decisions that will strengthen CCA/DRR and capacity development in this arena. In addition to institutional innovations, existing methods and tools can be a significant support to multi-stakeholders processes (e.g. as described Hare et al, 2006) .

4. **CONCLUDING REMARKS**

The experiences shared during the EUM regional workshop within the CATALYST Think Tank process have allowed some preliminary conclusions to be drawn concerning capacity development for drought DRR and CCA in this region. First, drought is a complex phenomenon which has to be faced by adopting a holistic approach. As a result there are a plethora of studies addressing this issue already available (e.g. Hamdy, 2004; Pereira et al., 2009; Iglesias et al., 2009). Knowledge has been produced from different scientific domains and diverse regions, and concerns a variety of aspects of the drought risk management challenge. Nevertheless, efforts are required to overcome the social/cultural as well as institutional barriers hampering the knowledge transfer (lack of understanding of the complexity of drought, insufficient or lack of drought risk communication, conflict among different users, etc.). Barriers exist between scientists and practitioners, but also within the scientific community. The barriers among members of the scientific community take the form of disagreements over the definition of drought and how to assess the severity of its impact. The CATALYST project is attempting to reduce these barriers by compiling existing knowledge on DRR and CCA, and making it available to practitioners.

Second, the analysis of failure stories in drought risk reduction have demonstrated that technical innovations are ineffective without complementary socio-institutional changes. The implementation and the sharing of those innovations are required. To do so, institutions capable to foster innovations spreading and a high level of social acceptability are crucial.

Thus interdisciplinarity, through for example, the integration of society, environment and economy, as well as efficient institutions is required in order address the many conflicting issues of present and future water allocation and drought management in general. Drought DRR and CCA especially in the context of ongoing groundwater abstraction requires that we address the concept of resilience to drought, sustainability and equity issues. Furthermore the challenge at hand has a high level of uncertainty and low controllability/high complexity/high causality, so in this situation scenario development is a effective tool for integrated analysis and for communication, conflict management and long-term participation. However, they have to be backed up by credible groundwater models. These models are time and resource demanding as a tool, and thus a financing and commitment to regional scenario development for Puglia and many other Mediterranean regions is a primary challenge.

It is expected that by facilitating continued knowledge exchange between key practitioners and scientists, the CATALYST project, by the time it concludes in September 2013, will provide in-depth and practicable guidance on such a holistic approach to DRR and CCA in the European Mediterranean region

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