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Strategic and management plans for an agricultural water supply system in Southern Italy

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SUMMARY – According to European policy on drought and water scarcity a proactive approach is proposed to cope with drought phenomena in one of the most important agricultural areas in southern Italy. First, a strategic plan is developed in order to reduce the vulnerability of the irrigated area by means of long-term measures. Then, according to the implemented strategic plan, a management plan and a contingency plan are developed to schedule short-term measures to be adopted in case of water scarcity. Through appropriate early warning indicators different conditions were defined (Normal, Pre-Alert, Alert and Alarm) with the aim of determining the best mix of measures to be chosen.

Key words: Drought, water scarcity, proactive approach, water resources management, Southern Italy.

RESUME – *"Plans stratégiques et plans de gestion pour un système d'approvisionnement en eau pour l'agriculture dans le sud de l'Italie". En suivant la politique européenne en matière de sécheresse et de pénurie d'eau, une approche proactive est proposée pour répondre aux phénomènes de sécheresse sur une des régions agricoles les plus importantes de l'Italie du sud. D'abord un plan stratégique est développé pour réduire la vulnérabilité de la région irriguée au moyen de mesures à long terme. Ensuite, selon le plan stratégique exécuté, un plan de gestion et un plan d'urgence sont développés pour programmer des mesures à court terme à adopter en cas de pénurie d'eau. Selon les indicateurs de signes avant-coureurs appropriés, différentes conditions ont été définies (Normal, Pré-Alerte, Alerte et Alarme) dans le but de déterminer la meilleure combinaison de mesures à choisir.*

Mots-clés : *Sécheresse, pénurie d'eau, approche proactive, gestion des ressources hydrauliques, Italie du Sud.*

Introduction

Recently the European Commission (2007) stated that the challenge of water scarcity and droughts needs to be addressed both as an essential environmental issue and as a precondition for sustainable economic growth in Europe, and highlighted the necessity of progressing towards full implementation of the EU Water Framework Directive (WFD) 2000/60. The WFD is the EU's flagship Directive on water policy, explicitly defining long-term planning as the main tool for ensuring good status of water resources. Nevertheless, it does not indicate criteria and actions to face risk of drought, delegating National Legislations to concretely realize its framework.

In Italy the EU WFD has been taken into account with the Legislative Decree 152/2006 on environmental protection. Though this act is quite recent, it seems to be far from being adequate to actually cope with drought, mainly because it does not stress the necessity of passing from a reactive to a proactive approach (Yevjevich *et al*., 1983; Rossi, 2003), based on preparedness and mitigation actions planned in advance with the contribution of all the involved stakeholders, ready to be implemented when drought phenomena occur.

Within a comprehensive drought management planning process Rossi *et al.* (2007) proposed the identification of three main tools: Strategic Water Shortage Preparedness Plan, Water Supply System Management Plan and Drought Contingency Plan. In this paper the proposed guidelines are applied to plan the best mix of measures for coping with drought phenomena on one of the most important agricultural areas in southern Italy, the Low Esaro and Sybaris Plain.

Methods and tools

An Agricultural Strategic Water Shortage Preparedness Plan (ASP) is aimed at reducing the vulnerability of the water supply system to drought impacts through the adoption of long-term structural and non-structural mitigation measures. It should be prepared by the Basin or Hydrographic District Authorities, that are the bodies responsible for planning, and corresponds to the Drought Management Plan included into the River Basin Management Plan provided in the WFD. Since the ASP has to be drown up choosing among several combinations of long-term mitigation measures, a suitable evaluation procedure has to be adopted. A multi-criteria technique could provide an as much as possible objective comparison among different alternatives, according to a series of economic, environmental and social criteria, and taking into account the point of view of all the stakeholders. The tool adopted in this study for multi-criteria analysis is NAIADE (Munda, 1995).

Once the long-term mitigation measures are defined, an Agricultural Water Supply System Management Plan (AMP) has to be developed with the aim of defining the best mix of long and short-term measures to avoid the beginning of a real water emergency. It is prepared by the authority responsible for agricultural water management (i.e. the Land Reclamation Consortium), and the operative measures defined have to be adopted according to the values of early warning indicators, showing Normal, Pre-Alert or Alert conditions. The threshold values of the indicators can be chosen through an objective function or, if several aspects have to be accounted for, through a multi-criteria analysis.

If a particularly severe drought occurs, and the indicators signal Alarm conditions, the Agricultural Drought Contingency Plan (ACP) has to be adopted, defining the most appropriate short-term measures to reduce the impact of emergency situations. In this case the efforts are turned to protect the essential activities of the agricultural system, and the threshold values of the indicators have to be chosen taking into account this objective, preferably using a probabilistic approach, that allows the decision-makers to evaluate the effective risk of having water deficit for different scenarios. The ACP should be prepared by the Basin or Hydrographic District Authorities, with the collaboration of the Civil Protection.

Case study

The core of the analyzed water supply system is the Farneto Dam (Fig. 1), closing the Esaro Catchment (about 245.4 km^2) in southern Italy. The dam is aimed at: (i) containing the ordinary floods and mitigating the extraordinary ones, on condition that the reservoir level is maintained almost empty from October to March; and (ii) supplying water (about 30 hm^3 from April to September) to the downstream agricultural area (about 85 km^2), sited in the Low Esaro and Sybaris Plain. At present about the 63% of the irrigable area uses open channels.

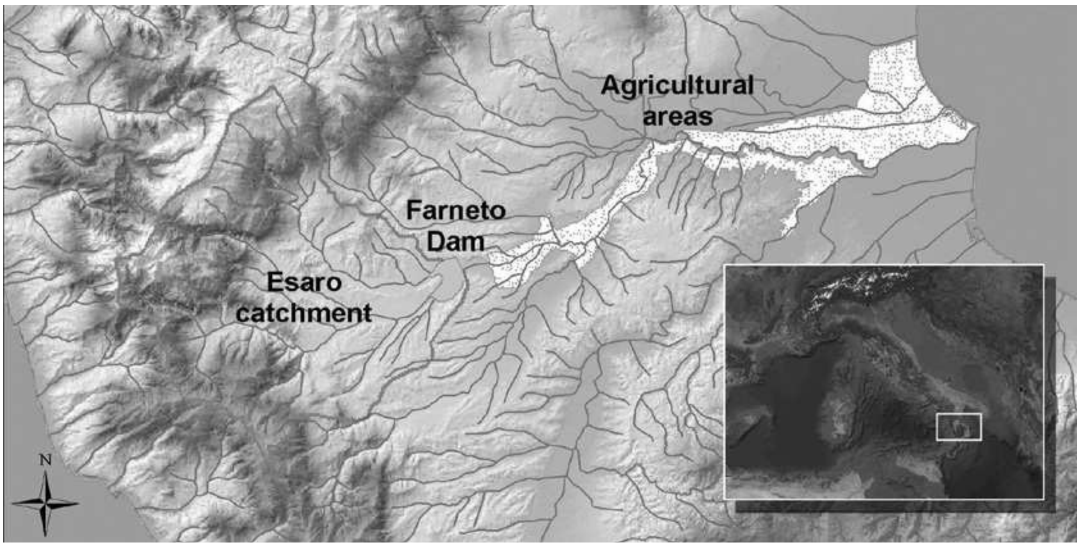

Fig. 1. Study area.

Results

Agricultural Strategic Water Shortage Preparedness Plan

Table 1 shows 13 selected alternatives (from A to M), obtained combining the following six long-term mitigation measures: 0) System in current configuration; 1) Modernization of the irrigation network for reducing water consumption; 2) Construction of farm ponds; 3) Construction of another dam upstream; 4) Economic incentives and educational activities for water saving; 5) Allowing the dam to store a little volume during the winter (i.e. dam not empty in March).

Table 1. Long-term mitigation measures and alternatives

Measure	Alternatives												
	A	B	C	D	E	F	G	H	I	J	K	L	M
0	X												
1		X				X	X			X			X
2			X								X		
3								X				X	X
4				X		X			X	X	X	X	X
5					X		X	X	X	X	X	X	X

The alternatives have been compared by means of NAIADE according to four economic criteria (construction costs of infrastructures, operation and maintenance costs, crop yield losses and amount of public aids needed), two environmental criteria (failures to meet ecological requirements and reversibility of the alternatives) and four social criteria (system vulnerability, temporal reliability, realization time of the infrastructures and employment increase). Both the multi-criteria analysis and the conflict analysis involving the stakeholders showed the highest ranking for alternative J.

Agricultural Water Supply System Management Plan

The measures to be adopted in the AMP consist in exploitation of groundwater resources (Pre-Alert conditions) plus reduction of the release for minimum flow requirements to 50% and for irrigation to 80% (Alert conditions). The objective of the analysis was to minimize not only system vulnerability, but also groundwater withdrawals and failure to meet minimum flow requirements. The selected indicators are SPI in April, since at the beginning of this month the dam is almost empty, and the volume stored in the dam in the next months. The calculated thresholds are shown in Fig. 2.

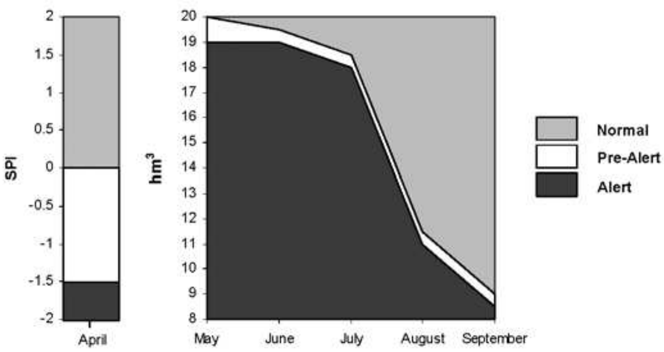

Fig. 2. Agricultural Water Supply System Management Plan: Pre-Alert and Alert thresholds.

Agricultural Drought Contingency Plan

The ACP followed a probabilistic approach. Hypothesizing that all the short-terms measures were already adopted, a 1000 years series of generated runoff data was used to assess for every month, for different volumes stored, the probability of having failures in meeting demand either in the same month or in the subsequent irrigation period, and the percentage of deficit respect to demand. The results, allowing the decision-makers to evaluate the effective risk of having water deficit for a specific storage in a specific month, are shown (from May to August) in Fig. 3.

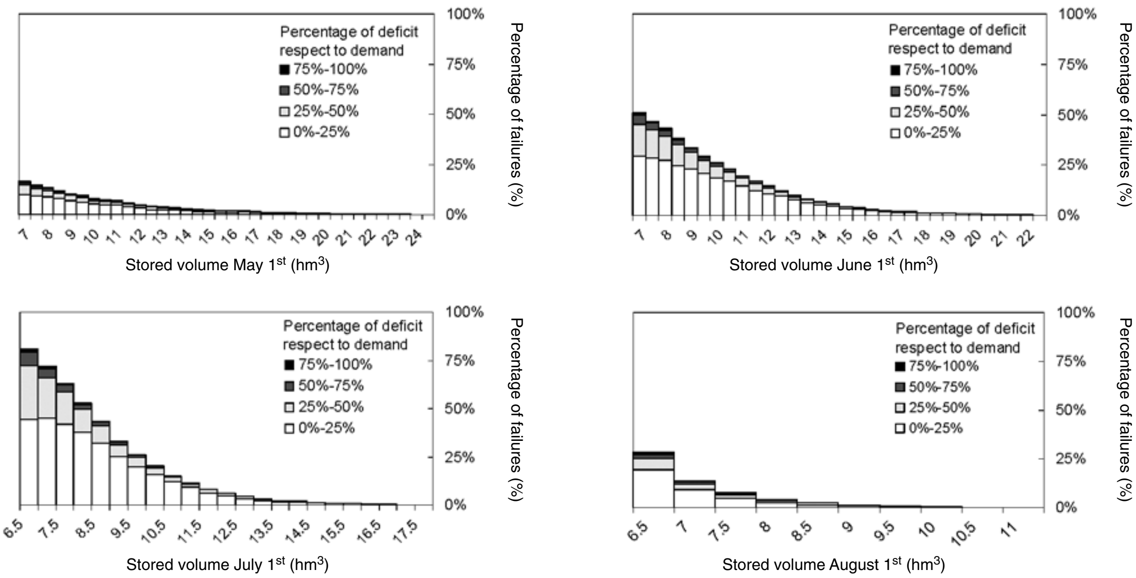

Fig. 3. Agricultural Drought Contingency Plan: probability of having failures and percentage of deficit respect to demand in the months from May to August (September excluded for lack of space).

Conclusions

An example of application of a proactive approach in agricultural water supply system planning in southern Italy is presented. The adopted Strategic, Management and Contingency Plans suggest in advance the best mix of long-term and short-term measures to be adopted in order to reduce the probability of having water scarcity (ASP and AMP) and to minimize the effects of extreme droughts (ACP). This kind of approach, taking into account the EU WFD and avoiding policies based on emergency measures (reactive approach), seems to be adequate to cope with drought considering in the meanwhile economic, environmental and social criteria.

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