# Process for implementing drought management actions [Part 1. Components of drought planning. 1.3. Methodological component]

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# Chapter 12. Process for implementing drought management actions

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**SUMMARY –** The implementation of actions is a major task in the operational component of drought management. The purpose is to provide planners with a framework for effective and systematic approach to develop strategies that respond to the drought risk situation, the objectives of water and land management and water right priorities, and the stakeholder needs. Although this component has been developed in the context of Mediterranean countries, it exemplifies many other situations with limited water supplies and conflicting users. The approach emphasizes risk-based drought management as a critical approach to mitigate the impacts associated to drought-induced water shortages. The operational process links science and policy and can be applied to other regions different from The Mediterranean.

**Key words:**

## Introduction

In recent years there has been a great effort to integrate drought management into the long-term strategies for water management and development (UNISDR, 2006). The effective management plans are the ones that include a major component of monitoring and early warning systems (Wilhite, 1997; 2005) since this decreases the vulnerability of exposed systems and populations in a significant way (Wisner *et al*., 2004). The development of specific drought management plans is at early stage in most countries; this chapter offers a guide to complement the ongoing efforts.

## Permanent planning and planning during drought

The operational component of the Drought Management Guidelines defines strategies to adopt drought management actions. This includes both the long and short term activities and actions that can be implemented to prevent and mitigate drought impacts. This chapter describes the process for implementing the actions and Chapter 13 of this publication describes the actions.

The operational component includes permanent planning and planning during a drought event (Fig. 1). Monitoring and preparedness planning is the first essential step for moving from crisis to risk management in response to drought, and can be viewed as permanent measures to cope with drought events. The management actions related to agriculture and water supply systems are presented together with a common conceptual framework based on the use of drought indicators for evaluating the levels of drought risk (pre-alert, alert, and emergency), that allow establishing linkages between science and policy. The rationale is that the actions relevant to all sector are derived based in common institutional organization, legal framework, and are implemented by a unique decision making structure (defined in the organizational component of the Guidelines).

## Preparedness, early warning, monitoring systems

Preparedness and early warning are the key factors for later operational management and determine the success of the overall drought management plan since they help to: (i) establish the drought plan; (ii) reduce social vulnerability; (iii) identify alert mechanisms; and (iv) establish the links between drought and water and development policies. Preparedness is the main process that encloses all subsequent tasks to be carried out during normal conditions and during drought periods.

Scientific advancements in seasonal to inter-annual climate forecast and monitoring systems offer the possibility for making the early warning systems effective in many regions, especially where the data and information systems are in place.

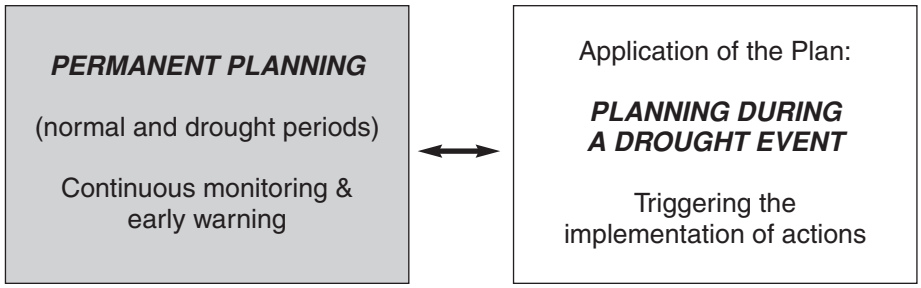


Fig. 1. Summary of the aspects of the preparedness and implementation aspects of the operational component.

## Advances in weather forecasts in the Mediterranean

The climate context for the region is one of very strong variability requiring careful management, together with a limited amount of seasonal forecast skill. Nevertheless research does suggest that sea-surface temperature forcing does yield some seasonal forecast skill for part of the rainy season, especially in the western region where the latter part of the rainy season (March-April) is correlated with the El Niño / Southern Oscillation (Rodo *et al.,* 1997, Ward *et al*., 1999; Bolle, 2002). This provides specific opportunities for incorporation of forecast information into water management strategies, especially related to irrigation. The North Atlantic Oscillation (NAO) exerts a strong control on rainfall in the region, especially through boreal winter (Lamb and Peppler, 1987, Rodo, *et al.,* 1997). Generally, there is considered to be little predictability in the NAO, though a repeating signal in NAO evolution from about August to the following March has been noted and offers prospect for some anticipation of NAO evolution (Lamb *et al.,* 1997). In addition to these small prediction signals, the very large interannual and decadal climate variability that is now known to exist in the region itself requires careful evaluation in the context of current methods and temporal scales for communicating risk to resource managers. The appropriate adoption of mechanisms of communicating climate information and sectoral risk should permit regional planners to reduce the devastating effects of drought and the uncertain effects of climate and weather in the more favourable seasons.

Major advances in understanding the Mediterranean climate have been made in recent years. Atmospheric scientists can now predict some of the medium-term (one or two seasons ahead) features of our climate with a reasonable level of skill. This provides specific opportunities for incorporation of forecast information into water management strategies, especially related to irrigation. Several regional studies are looking at the benefits of climate information and seasonal climate forecasts for different farm types and cropping systems in both northern and southern Mediterranean countries (Iglesias *et al*., 2002). The work focuses on improving timing of production and efficiency of irrigation water use. The regional studies focus on optimising traditional production systems since they are the current basis of agricultural production in the Mediterranean, but the research also has benefits for large-scale commercial systems.

## Integrated monitoring systems

The effective response to drought events relies on having a monitoring system able to provide adequate and timely information for an objective drought declaration and for avoiding severe water shortages through effective water resource management under drought conditions (Rossi, 2003). The goal is to incorporate the information about climate, soil, water supply, and potential yields in the monitoring system. Information should be in the public domain, sufficient to gauge the level of risk and make informed decisions about the future.

The appropriate adoption of mechanisms of communicating climate information and sectoral risk should permit regional planners to reduce the devastating effects of drought and the uncertain effects of climate and weather in the more favourable seasons. Integrated climate monitoring is an important element of adaptation strategies.

The main objective of a monitoring system is to help decision-makers identify the drought warning conditions and to provide useful information for identifying the best drought mitigation measures on the basis of a continuous monitoring of the drought evolution in terms of meteorological and hydrological variables and water resource availability.

A common feature of these systems is the particular emphasis generally given to the graphical representation of the results in order to foster an immediate and easy assessment of the drought severity and its evolution. Access to information is ensured through public web sites aiming to reach as many users as possible in addition to the public institutions.

Drought monitoring systems in operation are increasing, as their importance becomes essential and recognized at the institutional level. In recent years the information technology that simplifies the collection, elaboration and dissemination of hydrometeorological and agricultural data is widespread. These effective preparedness is based upon the deep knowledge of the processes that make the climatic system work and the statistical analysis of the past. Predictions, therefore, give "probabilities" of happening for a precise event, but at the moment they are still not infallible. An effective way of presenting the drought early warning is by maps, which show the variations in probability of drought events of a given level of severity (e.g., the probability of a 50 per cent reduction in annual rainfall). Several national and international efforts are currently underway to incorporate drought monitoring and prediction into early warning systems. Some examples of well established efforts include the National Drought Mitigation Center in USA, the Early Warning Systems for Agriculture from the Australian Bureau of Meteorology, agro-meteorological analysis by the Joint Research Centre of the European Commission, the Famine Early Warning System initiative of the US Agency for International Development, and the South African Weather Bureau. In Mediterranean countries, the National Drought Observatory of Morocco has been recently established to provide the agricultural community with a product easily interpreted by local stakeholders.

If drought indices are adequately calibrated to represent local features of the water resources system of the basin, they can be used as auxiliary tools for drought monitoring and forecasting. Droughts are slowly-evolving phenomena, and one of the most difficult tasks is identifying the beginning (or the end) of a drought. Drought effects are usually delayed in time, and once the economic or social impacts begin to be perceived it is usually too late to adopt mitigation measures. Systematic computation of drought indices, together with a thorough statistical analysis of historical droughts can be used effectively to identify the onset of drought and to make probabilistic forecasts about its magnitude, intensity or duration. For instance, drought onset can be identified using threshold values for a given drought index, according to historical information. Once the drought is started, the knowledge of the statistical properties of drought can be used to estimate the probability that the drought will reach a given magnitude or that the drought will last a given span of time.

Since drought index computation requires the ready availability of many meteorological and hydrological data, in certain real time and early warning systems it is better to use just a few representative variables to monitor drought occurrence and development. A statistical analysis can be performed on drought indices and raw hydrological variables to identify just a few key values that can explain most of the variance of the drought index time series.

## Establishing priorities for water use

Planning for droughts tends not to receive priority attention of decision and policy makers because drought has diverse impacts. The slow initiation and undefined end of a drought makes it difficult to select the opportunity to take defensive or remedial action. The measures are generally organized to protect water uses with different levels of priority. In all cases the first priority is to ensure adequate supplies of domestic water are available for public health, safety and welfare. The second priority is to minimize adverse drought effects on the economy, environment, and social well-being. The other priorities for water use depend on the water system can be established by stakeholders through a participative consultation process. In most cases conflicts arise when establishing priorities. The methodologies for stakeholder dialogue and conflict resolution are developed in more detail in Chapters 5 and 6 respectively.

## Defining the conditions and thresholds to declare drought levels

### Key issue: Drought declaration

The formal declaration of drought is both a controversial and an important issue. Most public institutions approach formal declaration with caution, and is only taken when a water shortage situation is of extreme magnitude, therefore in many cases, only emergency actions are possible. The MEDROPLAN Guidelines address this key issue by linking technical indicators of pre-alert, alert, and emergency to manage actions.

### Pre-alert, alert and emergency thresholds

In recent years there has been an effort to establish thresholds for drought management defined by using objective indicators in both academic publications (Garrote *et al.*, 2007; Iglesias *et al.*, 2007) and technical documents by a range of administrations, such as the EU Water Scarcity Groups or some river basin plans in Spain, among others. MEDROPLAN has synthesised these efforts, proposing the application of an indicator system to define three levels of drought. Table 1 summarises the thresholds for drought risk levels and the objectives and measures associated with these levels.

Table 1. Summary of the thresholds for drought risk levels and associated objectives and measures

| Levels of risk | Monitoring indicators | Objective of the plan in each stage | Measures |
|---|---|---|---|
| Preparedness | Indicators show a normal situation | To ensure that a preparedness and early warning plan is in place | Development of a management plan and strategy for revision and review<br>Implementation of a monitoring and early warning system<br>Structural, new infrastructure, intra-basin, inter-basin and transboundary transfers<br>Integration with development and land use policies |
| Pre-alert | Indicators show initial stage of danger; no observed impacts (meteorological drought) | To ensure acceptance of measures to be taken in case of alarm or emergency by raising awareness of the danger of drought | Low cost, indirect, voluntary<br>Non structural directed to influence water demand and avoid worse situations<br>Focus on communication and awareness<br>Intensification of monitoring and evaluation of worse case scenarios |
| Alert | Drought is occurring and impacts will occur if measures are not taken (meteorological and hydrological drought) | To overcome the drought situation and to guarantee water supply while emergency measures can be put in place | Low cost, direct, coercive, direct impact on consumption costs<br>Non structural directed to specific water use groups<br>Water restrictions for uses that do not affect drinking water<br>Changes in management<br>Revision of tariffs<br>Rights Exchanging Centres |
| Emergency | Drought is persistent and impacts have occurred; water supply is not guaranteed (socio-economic drought) | To minimize damage, the priority is drinking water | High cost, direct, restrictive, approved as general interest actions<br>Structural, new infrastructure<br>Non structural, such as permission for new groundwater abstraction points<br>Water restrictions for all users, including urban demand |

The classification of drought risk in different levels responds to the need to design measures in the most effective way to ensure that they are accepted and supported by the stakeholders. Each of these risk levels is associated with a clearly defined objective that determines the type of measures to be implemented.

The *pre-alert scenario* is declared when monitoring shows the initial stage of drought development, which corresponds to moderate risk (i.e. greater than 10%) of consuming all water stored in the system and not being able to meet water demands. The management objective in the pre-alert scenario is to prepare for the possibility of a drought. This means to ensure public acceptance of measures to be taken if drought intensity increases by raising awareness of the possibility of societal impacts due to drought. The kinds of measures that are taken in the pre-alert situation are generally of indirect nature, are implemented voluntarily by stakeholders and are usually of low cost. The goal is to prepare the organism and the stakeholders for future actions. Regarding the Basin Authority, main actions are intensification of monitoring, usually through the creation or activation of drought committees, and evaluation of future scenarios, with special attention to worst case scenarios. Regarding the stakeholders, the focus is communication and awareness. Generally, non structural measures are taken, aimed to reduce water demand with the purpose of avoiding alert or emergency situations.

The *alert scenario* is declared when monitoring shows that drought is occurring and will probably have impacts in the future if measures are not taken immediately. There is a significant probability (i.e. greater than 30%) having water deficits in the time horizon. The management objective in the alert situation is to overcome the drought avoiding the emergency situation by enacting water conservation policies and mobilizing additional water supplies. These measures should guarantee water supply at least during the time span necessary to activate and implement emergency measures. The kind of measures that are taken in the alert situation are generally of direct nature, are coercive to stakeholders and are generally of low to medium implementation cost, although they may have significant impacts on stakeholders' economies. Most measures are non structural, and are directed to specific water use groups. Demand management measures include partial restrictions for water uses that do not affect drinking water, or water exchange between uses. This may be a potential source of conflict because user rights and priorities under normal conditions are overruled, since water has to be allocated to higher priority uses.

The *emergency scenario* is declared when drought indicators show that impacts have occurred and supply is not guaranteed if drought persists. The management objective is to mitigate impacts and minimize damage. The priority is satisfying the minimum requirements for drinking water and crops. Measures adopted in emergency are of high economic and social cost, and they should be direct and restrictive. Usually there has to be some special legal coverage for exceptional measures, which are approved as general interest actions under drought emergency conditions. The nature of the exceptional measures could be non structural, such as water restrictions for all users (including urban demand), subsidies and low-interest loans, or structural, like new infrastructure, permission for new groundwater abstraction points and water transfers.

## Defining the actions

The actions are defined in two steps: description and ranking.

### Description

The description of the actions includes: a precise and quantified description of the action; definition of the organizational unit responsible for the action; and timeframe of implementation. In addition the description of the action needs to include comments on the application to other areas. Chapter 13 describes the actions and includes some of these aspects.

A first aspect to be described focuses on the type of response to drought events, distinguishing between a reactive and a proactive approach. A second aspect focuses on the public or private nature of the action. Finally a very important aspect refers to the time horizon of the scope of the action. Proactive actions are designed to prevent the potential consequences of drought rather than to remediate them. But this is not possible in most cases, and in fact, the only proactive actions are the design of a drought management plan.

The action is "public" when it is initiated and implemented by governments or administrative bodies at all levels. In this case, actions that are the result of a deliberated policy decision, based on an awareness of risk, and address collective needs. In contrast an action is private when it is initiated and implemented by individuals, households, private companies, or non-governmental organizations. It this case the action responds to the actor's rational self-interest.

Long term actions are established before impacts of drought are observed (anticipatory) to lower the risk of damage. In this case, the action addresses preparedness and risk reduction. In contrast, short term actions take place after impacts of drought have been observed, focussing on crisis management. Actions that are taken before the initiation of a drought event aim to reduce the vulnerability to drought or improve drought preparedness. They are long-term measures oriented to increase the reliability of water supply systems to meet future demands under drought conditions through a set of appropriate structural and institutional measures. The measures taken after the start of a drought are short-term measures which attempt to mitigate the impacts of the particular drought event within the existing framework of infrastructures and management policies, on the basis of a plan developed in advance and adapted to the ongoing drought, if necessary.

In order to incorporate the actions to drought management plans it may be useful to determine the proactive or reactive, as well as the public or private character of the measures. Table 2 summarises examples of short terms and long term measures. Chapter 13 extends the example and lists a range of long-term and short-term actions, subdivided into the three categories of water supply increase, water demand reduction and drought impact minimization. For each action the affected sectors are also indicated.

Table 2. Examples of long term and short term private and public measures to reduce drought risk

| | Public(1) | Private(2) | Mixed |
|---|---|---|---|
| Long term measures (3) | Insurance plan for agriculture | Education programmes by NGOs | Education programmes under private initiatives with Government funds |
| Short term measures (4) | Tax abatement to farmers impacted by drought | Water use reduction in households | Issue emergency permits for water use by a private company that manages urban water and/or River Basin Authority |

## Ranking

The general objective of every operational action is to minimize impacts of drought and water scarcity while maintaining social and ecological services of water. However, not all actions are suitable and applicable in every situation and moment. The ranking of actions allows for a certain level of prioritization depending on the evaluation of selected aspects, such as: (i) consideration of effectiveness to minimize the risk of impacts, cost, feasibility, and assistance required for adoption; (ii) consideration of adequacy for situation without drought (win-win strategy); and (iii) ranking according to different valuation criteria. These processes need to include stakeholders to ensure adequate action ranking according to the needs of each group and acceptance of the results. Table 3 gives an example for ranking and valuating the actions.

Table 3. Valuation of attributes to establish ranking of the actions

| Value | A<br>Effectiveness | B<br>Cost | C<br>Feasibility | D<br>Assistance required for adoption | E<br>Adequacy for non drought situation |
|---|---|---|---|---|---|
| 0 | none | none | non feasible | very high | highly inadequate |
| 1 | very low | very low | very low | very low | inadequate |
| 2 | low | low | low | low | somewhat inadequate |
| 3 | medium | medium | medium | medium | indifferent |
| 4 | high | high | high | high | adequate |
| 5 | very effective | very high | very high | none | very adequate |

## Criteria for selecting the actions

Drafting drought management plans requires the selection of the most appropriate combination of long term and short term actions with reference to the vulnerability of the specific water supply system or agricultural system and to the drought severity. Given the high number and the different types of mitigation measures, it is necessary to adopt a proper evaluation procedure for the choice of the best combination. A selection procedure based on purely economic criteria could include equating the marginal costs of long term measures with the marginal costs of implementing short term measures. A more advanced procedure could be based on assessing the expected cost of each combination of long and short term measures using the Montecarlo simulation. However, due to the variety of drought impacts and in particular to the difficulty of assessing environmental and social impacts in economic terms, a purely economic analysis does not seem adequate to simulate the real decisional process. On the other hand, application of a multi-criteria analysis may overcome the above difficulties because of its ability to take into account the points of view of different stakeholders on the different alternatives (Rossi, *et al.,* 2003).

## Implementation of the actions

A key point for efficient drought prevention and mitigation is represented by the way of selecting and implementing different interventions on the basis of the priority of water allocation among the various uses, the indications provided by drought monitoring systems and the method adopted to assess drought risk. The choice of drought management interventions has to consider two different priorities: the first is to ensure adequate supplies of domestic water available for public health, safety and welfare; the second is to minimize the negative effects of drought on the economy, the environment and the social well-being. Figure 2 summarises the process of the implementation of the actions. As described above, permanent planning takes place at all times, while the implementation of the actions takes place according to the drought risk level. The onset of the pre-alert actions is triggered by indicators that suggest that a drought may develop, but there are not measured impacts of drought.

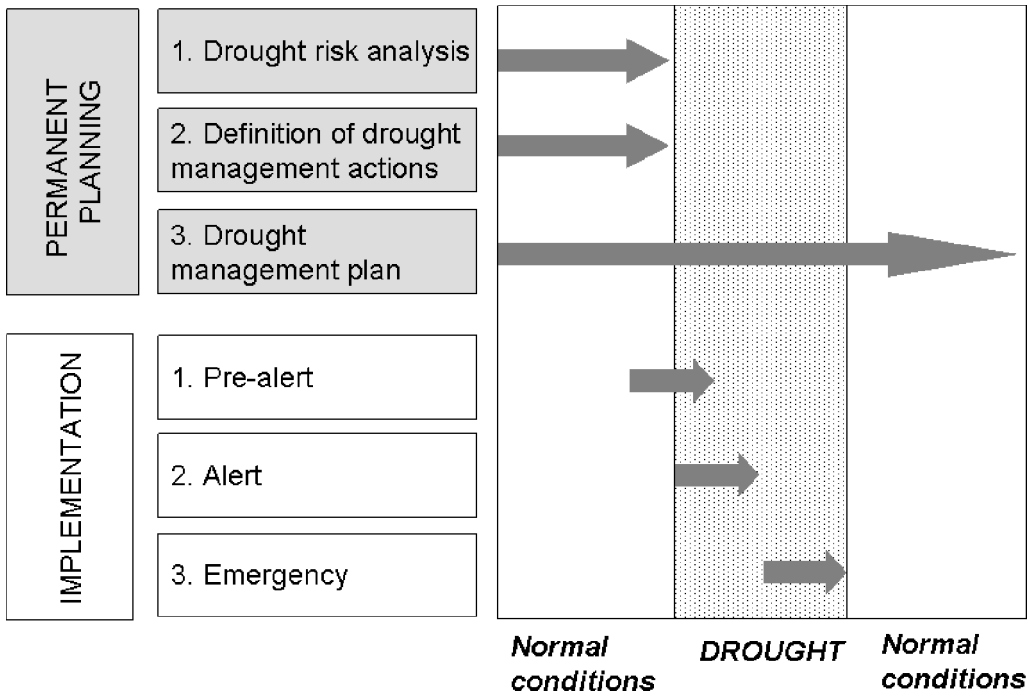


Fig. 2. Sequential steps for implementing drought management actions.

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