Blue Plan Papers 10

# ADAPTING TO CLIMATE CHANGE IN THE WATER SECTOR IN THE MEDITERRANEAN: SITUATION AND PROSPECTS

Stéphane Simonet

PLAN BLEU
UNEP/MAP Regional Activity Center

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# Introduction

## Context and issues

Water resources in the Mediterranean basin are irregularly distributed in both time and space. 85 % of renewable resources for the Mediterranean basin as a whole[1], amounting to 600 km3/yr, are concentrated in Turkey and the Northern Mediterranean countries (Benoit and Comeau 2005).

According to Falkenmark's indicator, most countries on the Mediterranean's Southern and Eastern shores are facing "chronic scarcity", with less than 1000 m3/capita/yr. Some have less than 500 m3/capita/yr, corresponding to a state of "absolute scarcity" (Algeria, Tunisia, Libya, Israel, Gaza and Malta). The limited nature of national water resources is particularly well reflected in the high levels of imported agricultural products ("virtual water" imports).

Water resources in these countries are exposed to significant tension, as can also be illustrated by the renewable resource exploitation index corresponding to the ratio of total abstractions to renewable resources (Table 1).

These trends are expected to worsen in the future under the combined effect of increased demand for water and the impact of climate change. Indeed, the 4th report from the Intergovernmental Panel on Climate Change (IPCC) is unequivocal: throughout the 21st century the Mediterranean basin will be one of those regions most seriously affected by climate change. By 2100 the climate in the region is expected to witness a rise in average temperature of between 2 and 4°C, a 4 - 30% drop in rainfall and a rise in sea levels of around 18 - 59 cm (IPCC, 2007; Plan Bleu, 2008).

It would thus appear that Mediterranean countries are particularly vulnerable to the consequences of climate change on water resources and their use, particularly due to the increasing deterioration of such resources (over-exploitation, pollution, salination, diminished rainfall...) and growing demand in the agricultural, urban and energy sectors.

According to the Plan Bleu's trend scenario published in 2005, water demand in the region should continue to grow, reaching 330 $Km^3$/yr in 2025. This scenario did not consider the effect of climate change on water resources or demand (for energy and agriculture in particular) (Plan Bleu, 2009). Moreover, most climate scenarios concur on a drop in average rainfall, which would result in available water resources shrinking by as much as four-fold in certain countries to the South and East of the Mediterranean (SEMCs) (World Bank, 2008).

Most studies on climate change in the Mediterranean region also agree that rainfall will show greater variation in time and space, triggering an increased number of more intense extreme events (floods, heat waves, drought...) and associated risks in terms of economic losses and loss of human life.

These developments could thus have major consequences at environmental, economic and geopolitical level, particularly in the SEMCs. Via the water issue it is therefore the viability and appropriateness of policies and development lines which are actually being called into question.

Mediterranean countries have an age-old tradition of managing hazards and scarcity expressed as a constant concern to optimise resource use and adapt activities to climate constraints. Nonetheless, a large number of countries are currently facing issues, the sheer scale of which requires that types of water management and strategies for combating risk be revisited in order to reduce vulnerability in the short, medium and long term. Adapting to the effects of

Table 1: Relative share of human abstraction in the Mediterranean and pressure on water resources

| Areas | Total abstractions ($Km^3$/yr) | Abstractions per sector by volume and as % of total abstractions | | | | | | Renewable resource exploitation index (%) |
|---|---|---|---|---|---|---|---|---|
| | | Drinking water | | Irrigation | | Industry and energy | | |
| | | $Km^3$/an | % | $Km^3$ /an | % | $Km^3$ /an | % | |
| North | 137,7 | 22,3 | 17% | 57,7 | 45% | 47.7 | 38% | 19% |
| East | 54,3 | 8,7 | 14% | 47 | 78% | 4.7 | 8% | 25% |
| South | 97,3 | 7,9 | 9% | 76,6 | 83% | 8.3 | 9% | 104% |
| Total | 289,3 | 38,9 | 14% | 181,3 | 65% | 60.7 | 22% | 27% |

1. All Mediterranean catchment basins in the Mediterranean riparian states

climate change on water resources will require the implementation of technical, political, institutional and behavioural adjustments in dramatic fashion. These adjustments will draw on a broad range of measures, both structural (construction of new installations, reuse of wastewater, maintenance of urban networks...) and non-structural (land planning, fiscal and economic policy towards better demand management, insurance schemes against natural hazards...) to be rolled out at the various levels of public action (local, national, regional).

Mediterranean regional cooperation has a crucial role to play to this end in pooling knowledge and know-how, speeding up the transfer of technology towards the most vulnerable countries and drumming up the funds necessitated by current and future change in the water sector.

## Objectives

As part of the Plan Bleu's programme of activities on water demand management and regional climate prospective analysis, the purpose of this study was to:

- List and analyse technical, regulatory, institutional, economic and governance adaptation measures and as far as possible take stock of the progress made on these various fronts by the countries examined;
- Identify avenues to be explored in order to promote the adaptation of water management in the Mediterranean.

## Scope and methodology

The scope of the study encompasses water resources (surface and ground), the main water uses and demand likely to be directly or indirectly affected by changes to the water cycle (irrigation, drinking water and sanitation, industry and energy production, management of large scale installations, environmental services...) as well as management tools (legal and institutional frameworks, management policy and strategy, tax and economic instruments, installations, operation and maintenance...).

The study does not specifically discuss management of the impact of climate disruption on water quality. To some extent, however, this is also linked to quantitative-type impacts.

In view of the data available, the scope of the evaluation of adaptation strategies focused on a limited group of 7 countries representative of the range of situations to be found throughout the Mediterranean basin in terms of water management and governance. This sample of "indicator" countries comprises Spain, France and Albania for the Northern banks, Morocco, Tunisia and Egypt for the Southern and Turkey for the Eastern banks.

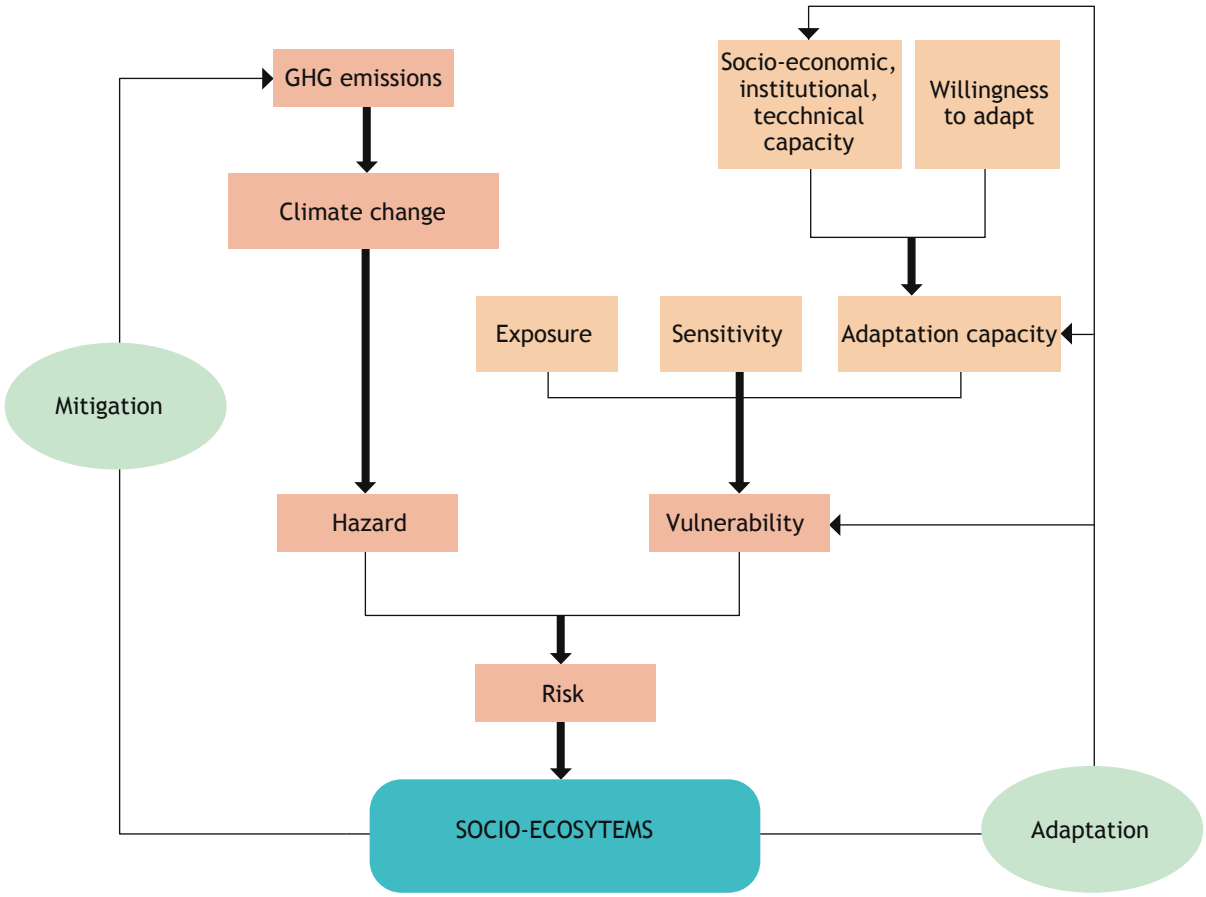
The study is based on :

- The collection and analysis of bibliographical sources available for each country: official documents such as National Adaptation Strategies, National Communications to the United Nations Framework Convention on climate change (UNFCCC), as well as various reports and studies by governments or international organisations: World Bank, United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), European Union (EU)...;
- Targeted interviews conducted with a small group of national and regional experts, allowing different points of view to be collected on the issue and enriching documentary analysis;
- A questionnaire circulated amongst the Plan Bleu's main partners in the Mediterranean countries (focal points, national experts and international organisations).

As far as possible the analysis is based on the quantification and comparison of situations observed at national level, using a typology of adaptation measures and benchmarking semi-qualitative methods. The aim of the exercise was to propose a peer review of the various national situations. Given the limits of the exercise, it does not claim to establish a classification between the countries.

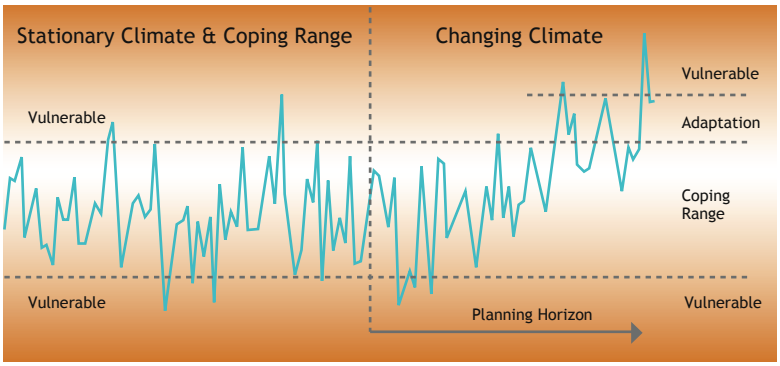
The report sheds light on the state of adaptation strategies and measures implemented in the water sector in the Mediterranean. It focuses in its conclusion on the key messages and recommendations for promoting adaptation in the water sector and on the role of regional cooperation.

Figure 1: Links between vulnerability, risk and adaptation




(Source: modified from the European Environment Agency, 2008)

Figure 2: Diagram showing the relation between the area of tolerance of eco-socio-systems to water variations, vulnerability, risk and adaptation




(Source: IPCC, 2007)

# Adapting the water sector : scoping aspects

## The concepts of vulnerability and risk

The notions of vulnerability and risk are central to the adaptation concept. Figure 1 illustrates the link between these various dimensions.

Risk is generally defined as being the product of the probability of occurrence of a climate phenomenon (hazard) and the consequence of this event, which is closely dependant on the vulnerability of the natural or socio-economic system affected.

According to the IPCC (IPCC, 2007b), vulnerability corresponds to the "degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes". Vulnerability results from the combination of three factors, these being (i) exposure of the system to climate impacts and hazards (nature and extent of climate disruption), (ii) its sensitivity (potential damage) and (iii) its capacity to adapt (the system's capacity to adjust in order to cope with the consequences of the disruption).

The greater the sensitivity and exposure and the lower the capacity of an economic activity, a use or more generally of a population to adapt, the greater its vulnerability will be. Thus, in the case of exceptional rains causing flooding, the vulnerability of a given area will depend on:

- The extent to which it is physically exposed to the flooding phenomenon (hazard),
- Its socio-economic features, which will determine how sensitive it is to the hazard, in other words the type of issues affected by the flood (such as the number of inhabitants, value of real estate and economic assets...) and the level of human and material damage caused,
- Its capacity to adapt, in other words its aptitude to deal with the flood and design and deploy responses intended to mitigate the damage: monitoring and early warning systems, access to assistance, feedback, risk prevention plans, etc...

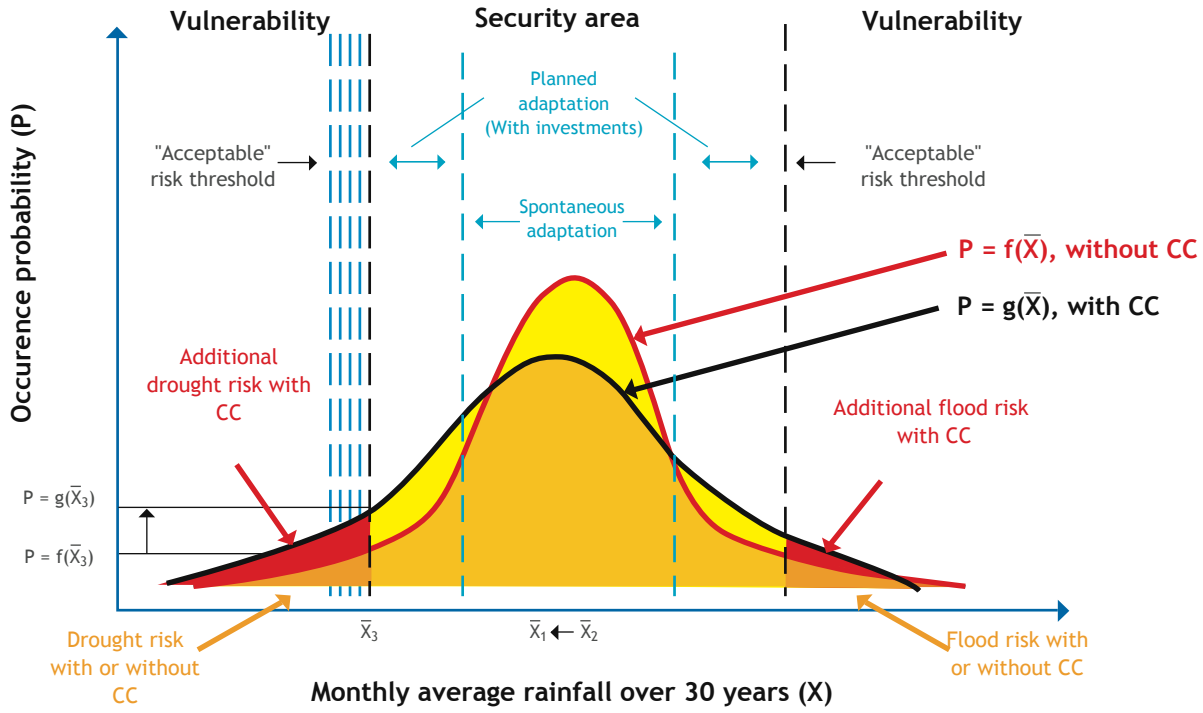
The notions of risk and vulnerability are not new concepts for research, water managers and users. Even in the past, human society had to adapt to climate variability and intra as well as inter-annual fluctuations in rainfall. In the Mediterranean, the history of water management has first and foremost corresponded to managing scarcity and hazard. Following an empirical approach, Mediterranean peoples have progressively developed technical, institutional and social responses able to contain the whims of the climate and to secure uses and peoples. Such responses and water strategies have, however, been implemented against the backdrop of relatively stable hydrological conditions.

As can be seen from Figure 2, territories, uses and even water infrastructure all have a "coping range", which is the result of an on-going historic process of adaptation to the climate conditions most frequently encountered over time. This interval of tolerance to climate variation is defined by conditions at the limits (or «critical» thresholds) beyond which changes to the water variables constitute a major risk to the viability of the system under consideration and tip it over into a state of vulnerability characterised by major impairment of its performance and potentially high levels of damage.

Within a stable climate regime (as in the pre-industrial age), such thresholds tend to be overstepped on an exceptional, one-off basis. Within a context of climate change, however, they may be crossed more frequently, more intensely and even in a permanent and irreversible manner in the longer term (Figure 3). Such is the case, for example, for the areas on the northern fringes of the Sahara, for which IPCC models point to a sustainable trend towards drying up.

In the medium and long term, changes in the variability of hydrological conditions will be compounded by changes in mean values, such as the decrease in rainfall and average river flow forecast for a large number of countries to the South and East of the Mediterranean. These changes will have a particularly marked effect on water security in these countries. Taking average monthly rainfall for a given timescale and in a given area as an example Figure 3 illustrates how, by changing the distribution function of the probability of occurrence of a given average monthly rainfall, the statistical frequency of certain extreme hydrological events (floods or drought) increases. Under these circumstances, the probability and intensity of the risk of drought and flooding (in red on the diagram) is consequently increased. It might even happen that the historic so-called "water security" zone decreases as the result of certain types of human pressure (greater demand for water, pollution and the over-exploitation of resources...), driving the thresholds of tolerance to hydrological disruption even further down and further limiting the scope for coping with it. The situation may become

Figure 3: Effect of climate change on the probability function of a hydrological variable (here, average monthly rainfall, calculated over 30 years) and its consequences in terms of water security




(Source: amended from Kabat, 2009)

particularly critical when drastic climate change threatens to tip mean rainfall conditions beyond the limits of the interval.

Generally speaking, climate change will probably be reflected both in the intensification of existing hydrological disruption and risks, but also in the emergence of new, hitherto unknown or rare types of risk: marine submersion, intrusion of a saline wedge into coastal groundwater, torrential floods and risks linked to the melting of alpine glaciers, etc.

Further effort will be required to boost resilience and increase "acceptable" maximum risk levels for the public and stakeholders in the water sector. The scale and rate of adjustment required will largely depend on the timescale under consideration and the degree of probability of thresholds of vulnerability being affected at these various points in time. Such are the stakes of adaptation.

## Defining adaptation

Adaptation is defined by the IPCC as "the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities[1]".

Adaptation encompasses all the political, technical, institutional, societal and behavioural changes which must be wrought by societies as a whole or more specifically the stakeholders in a given sector in order to mitigate negative impacts or benefit from the opportunities engendered by climate change, be it gradual, abrupt, permanent or one-off. Thus adaptation appears to be as much the state of the system at a given time as the on-going and dynamic process through which the system adapts (Magnan et al., 2009). Few benefits are to be expected from climate change in the Mediterranean water sector. Thus approaches applied to adaptation will mainly focus on pre-empting and limiting potential damage. To this end, they may strive to reduce exposure to the risk (by constructing dykes in flood zones, for example), to reduce hazard-sensitivity on certain fronts (by switching use or amending the

1. It should be stressed that as far as the Mediterranean region is concerned it is highly likely that the net impact of climate change on hydrology and water resources will prove negative. There is consequently very limited scope for potential opportunities arising from future hydrological conditions (maybe apart from stimulating research and technological innovation or accelerating certain particularly crucial reforms for the water sector).

value of certain assets exposed to risk), to boost the ability to act and react to the consequences (rescue plans) or even to recover more quickly and effectively from any damage sustained (insurance, national solidarity funds...).

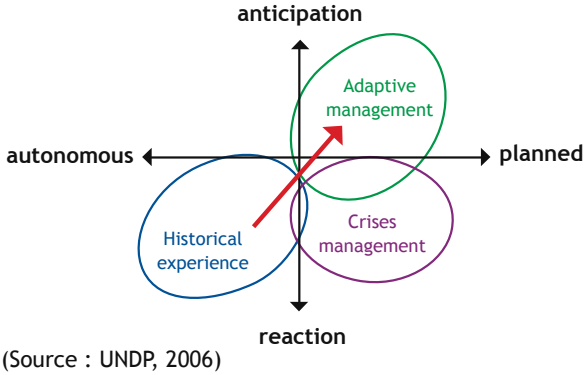
As can be seen from Figure 1, adaptation is a complementary strategy to mitigation and equates to the second axis of a single climate risk management approach. Whereas mitigation strives to reduce the causes of climate change, adaptation aims to contain its effects through measures, which will reduce vulnerability and increase the resilience of eco-socio-systems facing unavoidable disruption and hazards.

Moreover, the adaptation concept is not set in stone and may adopt various shapes depending on:

- *The intentional and deliberate nature of the action :* in this case adaptation is said to be "spontaneous" (or autonomous) when it involves the natural adjustment of ecosystems or a direct human act not deliberated from a strategic point of view. Conversely, it is deemed to be "planned" when it is the result of deliberate strategic decisions based on a clear perception of current and future changes and the measures needed to minimise potential risk;
- *The type of players and stakeholders :* adaptation is "public" when it stems from policies implemented by stakeholders in "intentional" water management or "private" when it derives from individuals or companies;
- *The timing of the decision :* adaptation is said to be "in anticipation" or "in reaction", in other words before (ex-ante) or after (ex-post) a hazard or climate stress has emerged. The former tends to be preferable when the cost of non-action is high and requires robust preventive action (as is particularly the case with water demand management policies in the agricultural sector);
- *The degree of inertia and irreversibility of the action (Dumas, 2006) :* adaptation is deemed to be "inert" when it gives rise to actions with a long rollout time (changes to value systems, for example) or "irreversible" when it involves long-lasting measures, which cannot be immediately or cheaply replaced.

Historically, certain water management practices emerged in reaction to hydrological extremes or crises (dyke construction, multiplication of private drilling or pumping, etc.). In the long term, the cost of reactive, autonomous action may turn out to be much higher than that of preventive, coordinated measures. Thus one of the issues with adaptation in general and in the water sector in particular is to ensure the transition from a short-term reactive approach to one of long term adaptive, risk prevention management (cf. Figure 4 and section 2.4).

Figure 4: Changes to water management paradigms




(Source : UNDP, 2006)

Water stakeholders may adopt various types of strategy and adaptation measures in order to ensure this transition. Six major types of strategic options can be distinguished in the water field, depending on the nature of the risk under consideration, the objective sought by decision makers or even technical and institutional constraints likely to limit action (Burton, 1996; European Environment Agency 2007) :

- *Accepting risk and loss.* This is the strategy which consists of "doing nothing" and accepting damage when its cost remains low (maintaining farming land in flood-prone areas) or on the contrary when protection measures prove technically unacceptable or financially prohibitive (loss of coastal aquifers due to rising sea levels and seawater intrusion);
- *Loss sharing.* This type of adaptation measure consists of sharing out the risks within society or between stakeholders in the sector. This strategy of risk and loss pooling and transfer may come in the guise of national solidarity mechanisms (through assistance to the people affected), rehabilitation and damage reparation operations or even insurance schemes;
- *Effect prevention.* One frequently applied approach involves preventing the effects and impact of climate change and variability through the application of structural measures (technology, infrastructure...) as well as non-structural ones (town planning standards, establishing flood zones, etc.) to reduce exposure and render uses and people less vulnerable;
- *Shifting uses and activities.* Where the hydrological impact of climate change makes it impossible or extremely risky to pursue a use, the use in question may be switched;

Table 2: Typology of adaptation strategies in the water sector

| Type of strategy | Examples of measures |
|---|---|
| **A - Risk and loss acceptance (« doing nothing »)** | 1. Disappearance of some coastal aquifers, wetlands or rain-fed farming areas<br>2. Flooding or erosion of peri-fluvial areas with limited concerns |
| **B - Risk and loss sharing** | 1. Introduction of insurance schemes and financial pooling instruments against hydro-meteorological risk<br>2. Diversification of drinking water supply sources |
| **C - Effect prevention: technology and infrastructure ("Hard")** | • Increasing dam capacity<br>• Increasing inter-basin transfers<br>• Implementing programmes for improving water use efficiency<br>• Developing desalination and wastewater reuse systems<br>• Boosting the efficiency of irrigation systems, drinking water supply networks and sanitation<br>• Rescaling infrastructure and installations (raising the height of dams and dykes, changing river transport infrastructure, etc.)<br>• Constructing flood-resistant buildings |
| **D - Effect prevention: political, regulatory and institutional responses ("Soft")** | • Drought management plans<br>• Financial incentives programme for saving irrigation water<br>• Changes to scaling standards and infrastructure operating rules<br>• Rationing<br>• Standards<br>• Adoption of new types of decision including uncertainty management |
| **E -Changing/ Reorganising uses and activities** | • Reallocation of the resource towards higher added value uses<br>• Introducing water-friendlier or drought resistant crops<br>• Shifting economic activities and housing away from flood zones |
| **F - Research, exploitation of climate information** | • Improving seasonal, annual and ten-year climate forecasting and modelling capacity<br>• Developing tools to assist decision making and improving risk assessm methods at basin and sub-basin level (coupling climate/hydro models)<br>• Defining appropriate vulnerability and adaptation indicators<br>• Setting up early warning systems<br>• Facilitating the production and provision of climate data for decision makers, technical services and the general public<br>• Improving monitoring and warning systems |
| **G - Capacity building and education** | • Broadening decision makers' planning horizons<br>• Building professional technical capacity in the sector as concerns major risk management<br>• Public education and awareness raising |

(Source: amended from Burton I. 1996; European Environment Agency 2007)

- *Reorganising activities and uses on site.* The impact of climate change on the geographical distribution of resources or hazards may prompt the need for land planning policies and the relocation of certain activities and uses to less vulnerable areas. This is the case for certain types of agricultural production such as market gardening which, when the resource becomes scarce, will need to be shifted to regions with more water, or the relocation of housing areas to protect them against more intense and more frequent flooding.
- *Developing the capacity to adapt by improving scientific knowledge and changing behaviour*. The adaptation process may also be furthered by research, the development of information and decision making support systems as well as through education and public information campaigns with a view to prompting behavioural change.

Table 2 provides examples of measures corresponding to each of these strategies. They may entail structural-type adaptation measures (technical measures requiring engineering and physical investment, such as the construction of a dyke, for example) or non-structural ones (political or institutional measures such as amending regulations or introducing insurance schemes against flooding) comprising prevention, resilience, preparation, reaction or recovery measures depending on their level of risk anticipation (UNECE, 2009).

In theory, these various options may be implemented separately, but in practice a combination of approaches drawing on a varied and integrated set of measures is actually preferable. Moreover, the various adaptation measures available to decision makers do not all share the same level of priority or cost. Their implementation thus depends on the timeframe of occurrence and the scale of impact to be managed.

## What implications for water management?

Adaptation does not appear to be completely new as far as water management is concerned. Indeed, most of the measures presented above relate to types of response, which were known and developed prior to the advent of climate change-related issues. It is therefore important to consider the specific nature of climate change and adaptation in relation to existing policies and practices.

The novelty of adaptation lies not so much in the nature of the measures to be implemented as in the way in which decisions regarding these measures are taken in order to take account of a fundamental new fact: a global increase in the frequency and intensity of risk and increased uncertainty regarding its scale as well as its distribution in time and space. This aspect demands a radically different approach to water management, and confronts managers with various new conceptual and operational challenges.

Firstly, current water strategies, policies, infrastructure and uses are based on the premise that hydrological conditions are stable: they presume that current hydro-climatic conditions will be reproduced in the future. The hypothesis of a stable climate is, however, looking increasingly invalid (Milly et al., 2008). Climate change is actually a dynamic, on-going process, which through a statistical change is likely to be reflected in a chronological series, which may adopt various patterns as illustrated by figure 5 (Prefecture of the Lorraine Region, 2008) :

- Case A : No chronological change: phenomenon marked by low frequency periodicity around a stable core trend.
- Case B : Sharp increase in the average or consistency of core trend disrupted, followed by a change in the range and periodicity of variation.
- Case C : Uneventful drift in a chronological series followed after disruption of a consistent core trend by a period of stability.
- Case D : Gradual escalation in temporal variability.

Past climate knowledge is therefore not an adequate reference for qualifying the future climate and guiding management choices. Certain aspects taken hitherto as givens should be revisited and water planning and exploitation measures as well as the rules governing the scale of installations within a non-stable hydrological context should be reassessed. It should nonetheless be borne in mind that any management and adaptation decision should be seen as a transitional stage within a long-term process.

And a further challenge exists- the uncertainty regarding future changes to the climate and their consequences for hydrological and human systems. Despite the reality of the changing water cycle in the Mediterranean and progress in climate modelling which allows the range of plausible hydrological futures to be gradually reduced, major uncertainty continues to surround the rate, extent and consequences of such change, depending on the geographical and time scales considered.

These largely fit into two categories (Newig et al., 2005; Brugnach et al., 2009). The first corresponds to uncertainty of an informational type, resulting

from patchy knowledge regarding the hydrological phenomena being played out and a limited ability to pinpoint the probability, scale and severity of certain types of hazard and risk, mainly due to inadequate data availability or the limitations of the concepts and methods used (Figure 6).

Thus, for certain Mediterranean countries (those on the Northern shores in particular), until 2030 at least it will be difficult from a statistical point of view to distinguish the effects of climate change from the background noise of natural variability and to use recent observations to extrapolate trends within rainfall and hydrological regimes (Hallegatte et al., 2008). Uncertainty of various types- epistemological, stochastic and anthropogenic- similarly abounds regarding climate and socio-economic forecasts and the assessment of the impact on hydrology and water uses, its influence varying according to the timescale under consideration. This uncertainty makes any effort to forecast at regional and local level particularly complex and for the time being rules out the possibility of providing precise enough responses to the operational concerns of managers and planners.

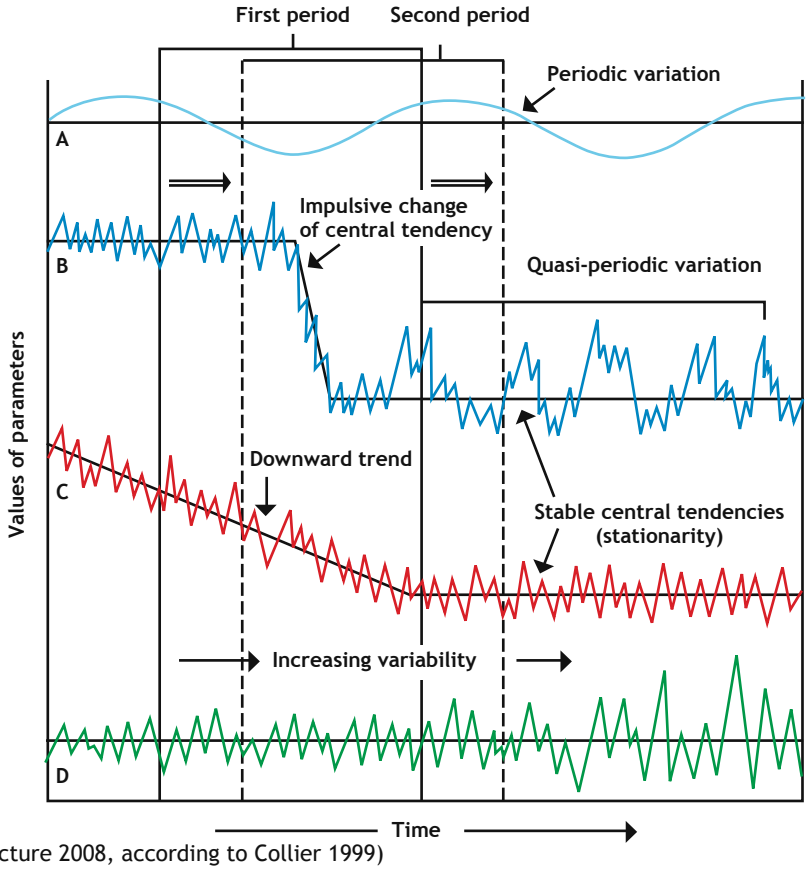
Moreover, not all long term changes to climate and socio-economic features and their combined effect on hydrology and uses can be modelled or their probability established. The current state of tools and knowledge hampers portrayal of the full complexity of interaction between climate and anthropogenic forcing which, in many cases, risks being reflected in non-linear, systemic and random phenomena. Thus climate change and its impact involve a not insignificant dose of unpredictability, which could lead to the emergence of what climatologists term good or bad "surprises".

A second type of uncertainty- this time regulatory- may stem from differences in perception between stakeholders regarding changes to river systems, the nature of the risks being run and their acceptability. These divergent points of view, which reflect different value systems and preferences, may create a certain ambiguity when issues, risks and the means for addressing them are assessed.

Whilst several strategies exist and could be rolled out in order to limit this uncertainty (Figure 6), it is highly unlikely that they can be drastically reduced in the near future.

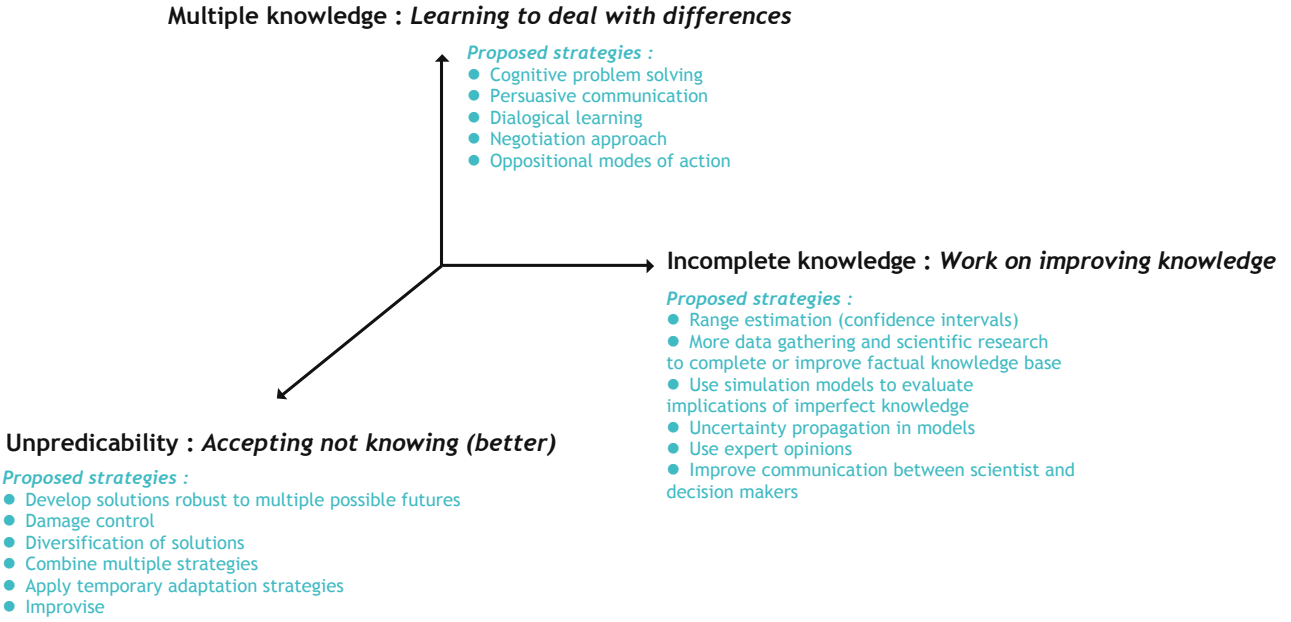
Within this context, the challenge facing water stakeholders does not stop at adapting to a certain type of change, but involves adapting at the same time to the uncertainties linked to such change, whilst ensuring that irreversible choices are kept to a minimum.

Figure 5: Possible patterns of change for a given climate variable




(Source: Lorraine Prefecture 2008, according to Collier 1999)

Figure 6: Uncertainty management strategies




(Source: amended from Brugnach et al., 2009)

This type of reversibility and uncertainty management is all the more crucial for the water sector given the marked inertia which prevails as a result of the predominance of the long if not very long term in sectoral planning timeframes and in the lifespan of investments (De Perthuis et al., 2010). Often the timescales underlying the choice of water strategy and infrastructure equate to those of climate change itself (Figure 7). Consequently, many decisions relating to water, including adaptation, prove particularly sensitive to uncertainty and there is a particularly high risk of "maladaptation" when certain solutions are excessively structured or prove rather inflexible.

Figure 8 shows examples of adaptation and management measures in the water sector, classified according to a rising scale of sensitivity to uncertainty and, finally, the level of risk of not achieving the expected outcome, also known as "regret" (generally expressed in terms of opportunity cost).

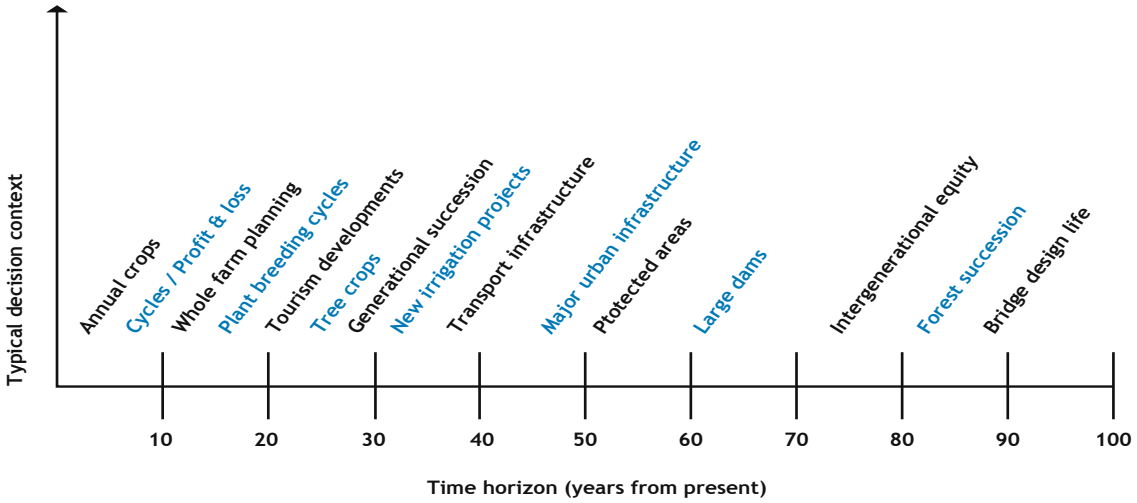
A distinction is drawn between so-called "no-regret", "low-regret" or "high-regret" choices or measures. For the latter category, which corresponds to inert measures with little flexibility in the long term, the consequences of climate change could be :

- Direct where the measure or infrastructure is physically threatened by climate change or its performance seriously affected (sub-optimal performance),
- Or indirect where the measure is likely to trigger increased vulnerability hence "maladaptation" (as, for example, in the case of tax incentives for drilling against a backdrop of major uncertainty as to how aquifer replenishment rates will evolve).

"No-regret" solutions present certain advantages since they allow vulnerability to hydrological change to be reduced whilst producing immediate benefits independent of future developments in the climate and its uncertainties (water demand management measures, for example).

Nevertheless, the choice and appropriateness of management and adaptation approaches should be re-established within a longer timeframe. In fact, some no-regret or low-regret measures which involve pursuing or extending current policies or amount to "makeshift" adaptations (such as water efficiency management or changing the use of existing infrastructure), prove particularly useful in the short term but may well turn out to be inadequate or extremely expensive in the long term, particularly when their purpose is to maintain activities or uses, the continued existence of which may be threatened by climate change (applies in particular to certain irrigated crops). Some countries will almost certainly need to structurally adapt their approach to water in the more or less short term, choosing for example to promote new ways of exploiting and sharing the resource between agriculture and other sectors in the face of acute and chronic scarcity. No-regret or low-regret measures applied in isolation also risk masking the detection of impacts and hampering the adoption of longer-term measures and more substantial behavioural changes.

Figure 7: Planning timeframes and lifespan of various types of policy and investment




(Source: Jones, 2007)

This brings us back to the distinction between adapting to variability and adapting to changes in average hydrological conditions, the latter possibly necessitating a switch or relocation of usage where the conditions for its viability are no longer assured (cf. type E strategy in Table 2). Spatial and temporal hydrological variability management has given rise to a body of techniques and good practices, generally intended to correct the "inequalities" caused by nature (intra and inter-annual regulatory installations, inter-basin transfers, dyke construction...). Also, for a large number of managers, consolidating and extending conventional management practices is a choice and singularly effective adaptation strategy, particularly as many countries have still not adequately adapted to historic climate variability and have a major "adaptation deficit".

This is a perfectly legitimate approach, which makes sense in the short term for the afore-mentioned reasons. However, as is pointed out by the Institute for Sustainable Development and International Relations, IDDRI (2009), "adaptation cannot be limited to variability since the corresponding measures would run the risk of considerably increasing vulnerability (and therefore the cost of damage) in the medium and long term (maladaptation), by only taking account of variations around a mean and not the evolution of that mean". This applies, for example, to certain dams, which have been made higher, or the construction of new infrastructure intended to respond to an increase in inter-annual variability over a given period, without factoring in the decrease in annual rainfall collected over the same period, which climate models deem to be highly likely.

## Towards a change of paradigm?

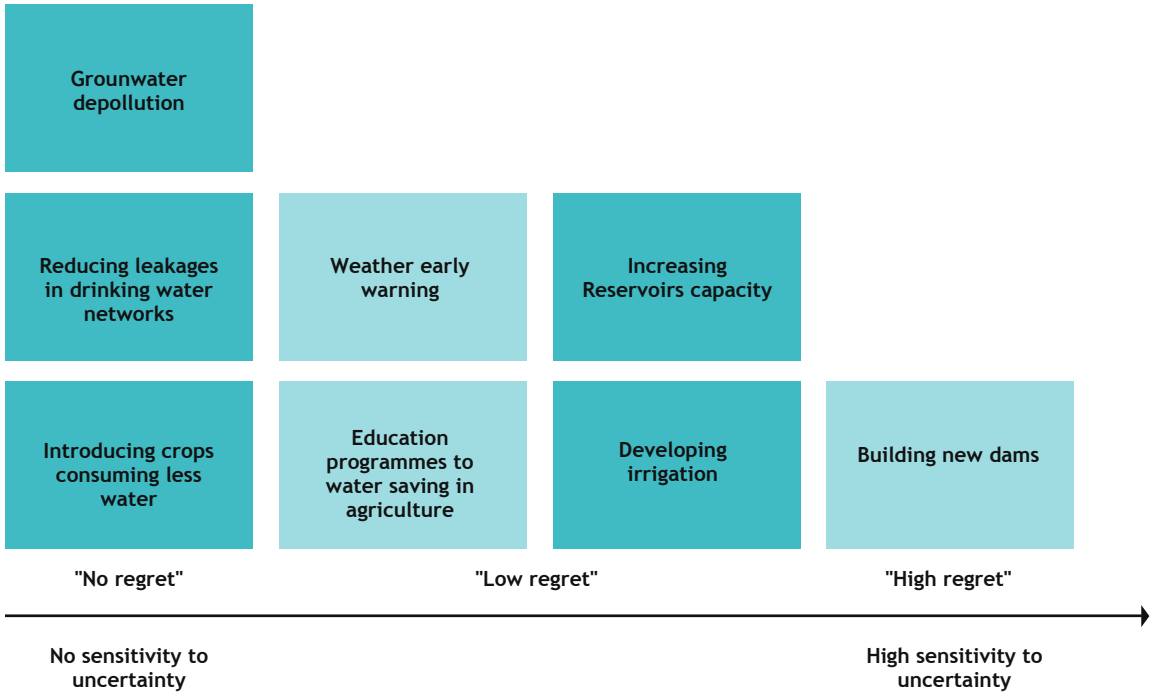
For water stakeholders the concept of adaptation boils down to taking decisions in a non-stationary, dynamic and uncertain universe, which requires a drastic overhaul of current planning and water management paradigms. Yet that is no easy matter. Faced with the complexity of the situation and the difficulty of the task before them, certain decision makers and managers may choose to evade the climate issue or wait for progress in science and climate modelling to shed a more certain light on the future. The limits of the models should not, however, be seen as an obstacle to adaptation (Dessai et al., 2009). Hanging fire could prove to be a risky and costly gamble, since it is likely that change will accelerate and that climate uncertainty will never be completely eradicated. Another, more effective, attitude with greater prospects opens up to managers from the moment they embrace uncertainty and accept it as an integral part of decision making.

Other types of water strategy should be considered, encouraging the introduction of tougher, more resilient policies, measures, uses and mechanisms to protect against extremes. Rather than striving to maintain what already exists (conservation approach) or seeking an optimal type of adaptation for a given climate future (optimisation approach), paths and management choices should be designed which are able to satisfactorily support a broad raft of change within a range of likely hydrological futures (Figure 9). The issue at stake can be summed up in the following two questions: how can "tough" political decisions be taken on the back of "soft" scientific knowledge? How can such decisions be legitimised?

Making the water sector more robust implies encouraging adaptive resource and risk management, in other words management which aims to reduce vulnerability and increase adaptation capacity through a "step by step", flexible and gradual adaptation process based on a "learning by doing" approach and on the implementation of flexible policies and measures which are regularly assessed and corrected as scientific knowledge develops and climatic and socio-economic conditions evolve. This type of water management is based on a certain number of principles for action, such as (according to Pahl-Wostl and Sendzimir, 2005; Hallegatte S., 2009; UNECE, 2009; European Environment Agency, 2009) :

- Giving priority to "bottom-up" approaches for monitoring the vulnerability of water management systems based on the definition of critical thresholds and maximum acceptable risk levels;
- Promoting no-regret/low-regret and win-win measures, in other words measures which reduce vulnerability and generate environmental and social benefits irrespective of how hydrology evolves;
- Systematically applying the precautionary principle in situations of dire uncertainty or ambiguity (unpredictability) regarding a risk;
- Encouraging innovation, social learning and experimentation with new approaches and techniques on a workable scale;
- Promoting long term planning together with an on-going process for revising and improving adaptation strategies, with input from lasting monitoring and improvement mechanisms for climate and hydrological knowledge and regular risk analysis;
- Promoting involvement and dialogue between water stakeholders in order to reduce statutory uncertainty and limit sources of potential conflict as well as possible negative adaptation externalities (taking account of redistributive effects);
- Giving priority to flexible, reversible strategies and measures in order to minimise the risk and cost of maladaptation. This could, for example, imply investing in infrastructure with a shorter lifespan (construction of several low cost hillside dams rather than one very large structure) or factoring greater security margins into their design;
- Not only focusing on technical adaptation solutions: depending on the case, certain institutional or financial instruments may prove more appropriate (for example insurance or flood warning systems rather than heavy flood protection) and much less prone to create inertia and irreversibility.

Figure 8 : Impact of uncertainty on the effectiveness of management and adaptation measures in the water sector




(Amended from the World Bank 2010a)

Adaptive management corresponds to a dynamic perception of adaptation, seeing it as a sequence of graduated interventions and responses, the effective implementation of which will be staggered over time depending on the nature of risks and the rate at which they occur. To be effective, adaptation must draw on relevant measures currently available whilst at the same time promoting long-term innovation. The additional implementation of measures and strategies which are better placed to counter more brutal, more severe and particularly more uncertain changes will mean in particular that management systems and "smarter", flexible technologies which can be tailored to the circumstances will have to be developed, security margins increased in the design and implementation of water strategies, installation sizing and operating rules revised in order to make them more robust and water sources diversified in order to better manage the risk of scarcity.

Against this backdrop, adaptation should be understood in the broad sense of the term and should be based on a varied set of responses which may be classified according to a continuum (Figure 10) running from action intended to reduce non-climatic vulnerability determinants and to increase adaptation capacity ("no-regret" measures), through measures intended to better manage variability and current hydrological risks, to adaptation measures in the strictest sense of the term, i.e. intended to counter impacts directly attributable to climate change and which in the absence of such change would be entirely unjustified.

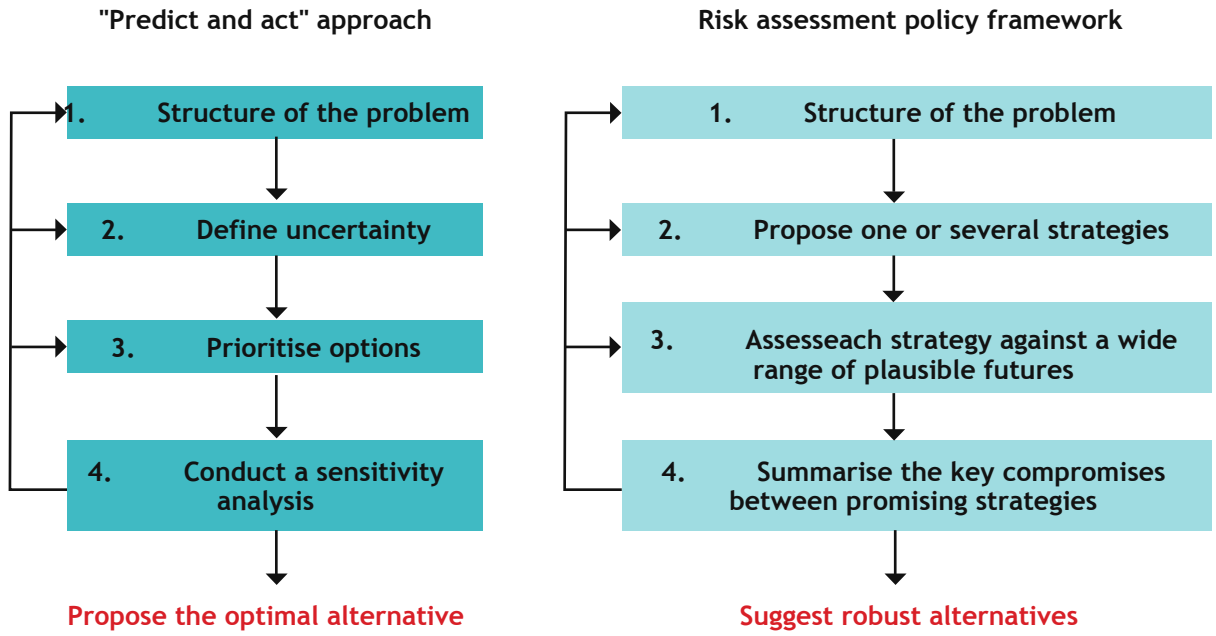
The choice of measure to be deployed will largely depend on the nature, rate and scale of evolution of the risks under consideration over time and space, but also on the scientific knowledge and technological means available within countries. The World Bank proposes three types of complementary strategy in this respect (Le Quesne et al. 2010), (World Bank 2010b) :

- "Shaping strategy", consisting of the immediate implementation of no-regret measures or measures calibrated according to a certain type of risk in the near future (measures "justified by climate change") when the latter is scientifically well established and the information available provides adequate guarantees regarding the likelihood of its occurrence and its consequences;
- "Hedging strategy", consisting of developing certain responses in advance but delaying their deployment until later where uncertainty regarding the risk identified is deemed too great (example of maintaining an unbuildable strip behind certain dykes so that if necessary they can be heightened and consolidated);
- "Signpost strategy", consisting of drawing up a system of indicators and warning thresholds in order to indicate the moment at which a certain type of response should be triggered.

Nevertheless, adaptive management in the water sector cannot simply be boiled down to a change (no matter how effective) in technical or decision-making procedures. Making the sector more resilient to hydro-climatic shock and stress requires a change in the overall water management framework, involving structural reform in the types of planning and design of water policy, governance, institutional cooperation, information management and even sectoral financing mechanisms. The figure below (Figure 11) sets out the main differences between an adaptive management mode and the classical one (Pahl-Wostl et al., 2005). It also indicates the necessary factors for ensuring the transition from one mode to the other.

In most Mediterranean countries, promoting the concept of Integrated Water Resource Management (IWRM) has led to greater recognition of certain inter-dependencies between water issues and the relevance of integrated solutions for managing them. Nevertheless, IWRM alone cannot provide an adequate response to the new hydrological challenges raised by climate change (Pahl-Wostl C., Sendzimir J., 2005). Its principles and tools therefore need to be urgently revisited in respect of climate change issues along with more adaptive management of water and its uses.

Figure 9 : Differences between “optimal” adaptation based on reducing uncertainty and “robust” adaptation based on accepting and taking account of uncertainty and risk




(Lempert et al., 2006)

Figure 10 : The adaptation continuum in the water sector

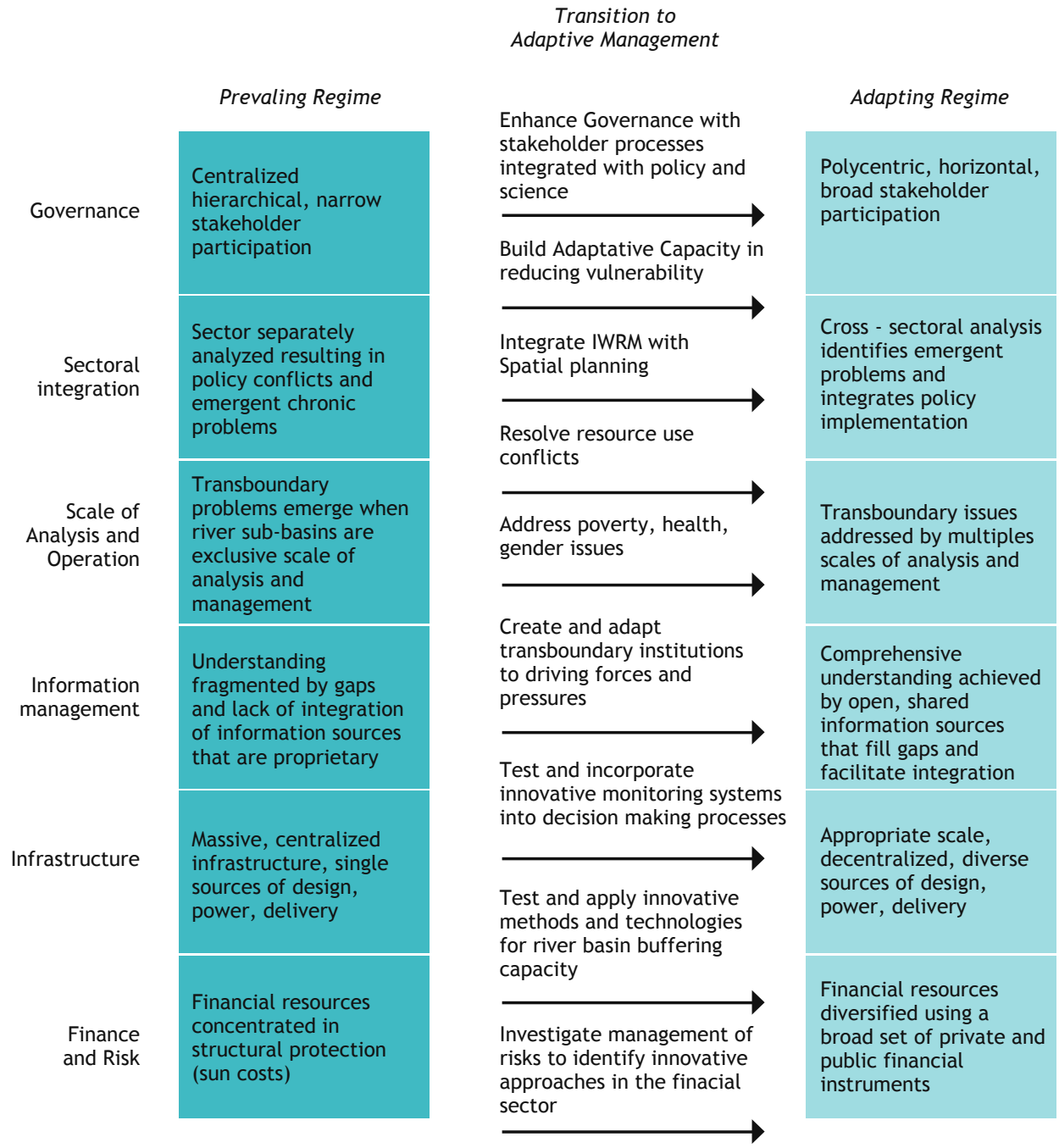
VULNERABILITY → IMPACT

| 1. Eliminating the underlying causes of vulnerability | 2. Developing the capacity to cope | 3. Managing the climate risk | 4. Countering the impact of climate change |
|---|---|---|---|
| Action contributing to human development and enhancing the performance of the water sector. Action which, whilst not taking account of the impact of climate change, helps to reduce its effect on people, users and societies by reducing sources of vulnerability to all types of stress. | Action which still tends to relate to conventional water management and which prepares the ground for action more specifically targeted against climate change. Action focusing on institutional, technical and systems capacity building in particularly vulnerable sectors. | Action to manage and reduce the hydro-climatic risk, producing major benefits under the current climate but differing from conventional water management in that it systematically takes account of climate information in decision-taking and management processes. | Action in specific response to the "additional" effects of climate change, i.e. impacts clearly not attributable to natural variability. Such activity only becomes necessary as a result of climate change and provides few benefits under the current climate. |
| Examples: improving access to drinking water, diversifying livelihood in drought-prone areas, water quality conservation programme, controlled abstraction and development of water law enforcement, etc. | Examples: Conservation and sustainable management of wetlands and flood plains, anti-erosion works for catchment basins, introduction of integrated water management plans by basin, demand management, capacity building for monitoring and resource modelling, etc. | Examples: Inclusion of seasonal forecasting in dam management and resource planning, introduction of flood risk prevention plans and insurance schemes taking account of risk trends, etc. | Examples: relocation of people and activities, abandonment of certain usages, economic area reconversion, development of new technology and expensive infrastructure such as the construction of new dams, alternative water production techniques, etc. |

100 ← Benefits in the absence of climate change → 0

(Adapted from Olhof and Schaer, 2010, McGray and al. 2007)

Figure 11: The conditions for switching to an adaptive water management




(Pahl-Wostl et al. 2005)

Table 3 : Existing or planned national adaptation strategies - Situation until the first semester of 2010

| Country | Name/Acronym | Responsible Institution | Year of adoption | Website |
|---|---|---|---|---|
| *Countries which have adopted a national adaptation strategy* | | | | |
| France | National adaptation strategy (SNA) | Ministry of ecology and sustainable development (MEEDDM/MEDDTL) | 2007 | www.ecologie.gouv.fr /adaptation-au-changement.html |
| | Climate Plan | Ministry of ecology and sustainable development (MEEDDM/MEDDTL) | 2008 | |
| Spain | National plan for adapting to climate change (PNACC) | Ministry for the environment and rural and maritime affairs | 2007 | www.mma.es/secciones /cambio/ancas_tematicas /impactos_cc/pdf/pna_v3.pdf |
| Turkey | National strategy for combating climate change (SNCC) | Ministry of the environment and forests | 2009 | www.iklim.cevreoman.gov.tr /yayinlar.aspx |
| Morocco | National plan for combating global warming (PNRC) | State Secretariat for water and the environment | 2009 | www.gtz.de/de/dokumente /en-climate-results-adaptation.pdf |
| *Countries where a national strategy or action plan in addition to the strategy is in the pipeline* | | | | |
| France | National adaptation plan (PNA) | Ministry of ecology and sustainable development (MEEDDM/MEDDTL) | 2011 | www.developpement-durable.gouv.fr /plan-national-d-adaptation-au, 16726.html |
| Turkey | National action plan against climate change | Ministry of the environment and forests | 2011 | www.iklim.cevreoman.gov.tr /yayinlar.aspx |
| | National strategy for adapting to climate change | Ministry of the environment and forests | 2009 | www.iklim.mdgf-tr.org /index.php?ID=303&LNG=2 |
| Tunisia | National climate change strategy | Ministry for the environment and sustainable development | 2012 | |
| *Countries with no formal strategy but where national priorities have been identified* | | | | |
| Morocco | Chapter on «Vulnerability and Adaptation» in the 2nd National Communication to the UNFCCC | State Secretariat for water and the environment | 2010 | |
| Albania | V&A chapter in the NC | Ministry of the environment | 2009 | |
| Egypt | V&A chapter in the NC | Environment Agency | 2010 | |
| *Countries which have adopted or are preparing a national adaptation strategy specific to the water sector* | | | | |
| Tunisia | National strategy for adapting agriculture and ecosystems to climate change | Ministry of agriculture and water resources | 2007 | Information not available |
| France | Explore 70 Projects | Ministry of ecology and sustainable development (MEEDDM/MEDDTL) | 2012 | Information not available |
| Egypt | National adaptation initiative for the water sector | Ministry for water resources and irrigation | Information not available | Information not available |

# Comparative analysis of adaptation efforts in the water sector : case of 7 Mediterranean countries

This section sets out the results of the cross-analysis conducted on the extent to which adaptation is taken into account in the water sector at the scale of seven Mediterranean countries : France, Spain, Morocco, Tunisia, Egypt, Turkey and Albania. It presents the situation until the first semester of 2010.

## Reference and analysis framework

The analysis is based on the reference framework for adaptive water resource management introduced in the preceding paragraph. Details of the framework are to be found in the annex.

Adaptation does not stop at technical solutions. It also involves a structural transformation process within the water management framework.

Put simply, adaptive water management can be portrayed as a "management system" based on a set of "key functions" which countries must jointly embrace if they wish to effectively adapt to the new hydro-climatic conditions (WRI, 2009). The operation of these various functions is based on a set of management aspects and various types of capacity (technical, institutional, political, informational, etc.) the presence or absence of which will determine how able the water sector is to address change and channel adaptation.

The main functions of this type of adaptive management can be summed up as follows:

**A.** Planning and strategic guidance function (political and strategic framework)

**B.** Coordination and supervisory function (institutional framework and governance)

**C.** Regulation and control function (legislative and regulatory framework)

**D.** Monitoring, information and knowledge management function

**E.** Financing and incentive to adapt function (economic instruments)

**F.** Operational management function for the risks relating to climate change (technical adaptation measures and action)

**G.** Assessment function for the impact of climate change and associated socio-economic risks.

A set of straightforward criteria has been attributed to each of these functional lines in the guise of a check-list of key adaptive management elements, thereby providing a reference framework and an analysis grid. In order to assess the extent to which current water management approaches, policies and instruments take account of adaptation, each criterion has been filled in according to experts' views drawn from targeted interviews with a group of national and regional experts using scores on a scale of 1 to 5 depending on whether the key attributes of adaptive management are present, satisfactory and operational or not. The grid and assessment scale are set out in the annex.

A non-weighted average score was subsequently calculated for each country and line of analysis in order to establish adaptation profiles providing an indicative albeit partial image of how the climate issue has been taken on board within the sample under study ("Benchmarking"). The results of this cross analysis of the various country profiles are reflected in the following paragraphs in the form of a summary radar graph.

Given the limits and constraints of the exercise, these results should be handled with caution and seen as a basic indication. Moreover, rather than producing a value judgment of the state of play within each country, the aim is rather to reflect regional dynamics concerning the inclusion of climate issues in water policy and strategy.

## National adaptation policies and strategies for water

There is no doubt that managing the impact of climate change on water resources requires local responses tailored to the context and vulnerabilities of the areas affected. But establishing an adaptation-friendly political framework at national or regional level ("enabling environment") is also crucial to the development of more resilient water resource and use management. It is at this level that the vision, objectives and means of action are defined, which in return will determine how the sector will evolve and the extent of its vulnerability.

In this respect, the challenge of adaptation largely hinges on including the climate issue in sectoral and sub-sectoral water policy, known in the Anglo-Saxon world as "mainstreaming". Promoting adaptation in

the water sector is a dual-thrust exercise. Given the crosscutting nature of the issue, besides consolidating the presence of climate change in public water policy, water should also start to feature more widely in "climate" policy. The progress analysis for the group of countries within the study takes account of this dual thrust.

## Overview of progress made on the water-related adaptation policy framework within the sample

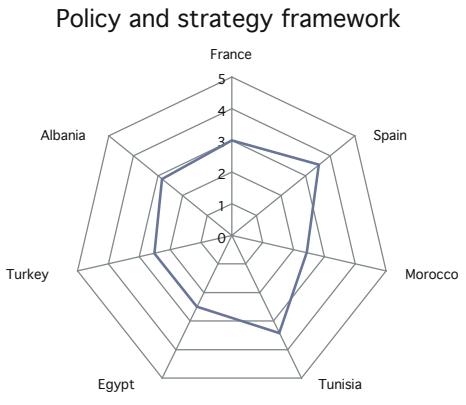
Based on the various assessment criteria defined for functional line A, figure 12 provides a summary of the state of play in the different countries studied.

The results show that there are no major differences between the countries in the sample: overall, progress has tended to be limited to moderate. Of the countries in the sample, for Tunisia, Spain and France water is the focus of climate change-related issues. For the remainder, it would appear that policy started to take the issue on board more recently.

Albania, Turkey, Morocco and Egypt are in rather similar situations. Nevertheless, the results point to shades of difference according to the various dimensions analysed. Thus, there would appear to be less consensus in Egypt regarding the urgency of action in the face of climate change. Conversely, Albania, Turkey and Tunisia seem more explicitly to apply long term thinking when identifying adaptation measures.

Be this as it may, whatever the country, implementation of national strategies and policies in the water sector has so far not been reflected in any noticeable change of practice.

Figure 12: Introduction of adaptation policy frameworks in the 7 countries studied




(1= marginal; 2= limited; 3 = moderate; 4= developed; 5= highly developed)

## An issue largely ignored by water policy

Most of the countries in the sample have started to move down the path of reforming the water sector by adopting strategies and policies aimed at improving the management and economic exploitation of water in agriculture, industry or energy production and at better protecting goods and persons against extreme hydrological events. Despite the relatively long timeframes (15 or 20 years) chosen by these strategies and the increasing attention being paid to adaptation, these strategies are underpinned by a series of issues, amongst which climate change continues to play a relatively minor role.

In the EU Member States, the Water Framework Directive (WFD) promulgated in 2000 makes no explicit mention of climate change. Climate change is consequently not the central theme of the initial management plans produced by France for the period from 2009-2015. That is not to say, however, that it does not feature. Indeed, as is the case for the Rhône-Mediterranean Water Development and Management Master Plan (SDAGE), the risks associated with climate change are taken into account in the assessment of future ground and surface water reserves and the effectiveness of proposed measures is evaluated according to their capacity to boost the resilience of hydro-systems to climate change.

The various strategies, plans and programmes drawn up at national level in the other countries of the group tend to be based on hypotheses of future water availability, taking no account of the expected impact of global warming on hydrological regimes and water demand.

All of these strategies can, however, be deemed to contribute to developing responses in the face of the impact of climate change, by promoting no-regret measures which make for more efficient and sustainable water management and are based on conventional approaches to water.

This inertia may be attributed to various factors, first and foremost inadequate knowledge about impact and the uncertainty surrounding climate forecasts. Decision makers perceive these as hampering action. The case of Egypt is quite revealing on this front, given the difficulties the various studies have encountered in isolating a clear climate signal about how the Nile's water regime is evolving (models predicting highly heterogenic drops in flow ranging between - 90 % and + 20% by 2100). It may also be attributed to other reasons such as the lack of appropriate tools for assessing risk and factoring it into planning and strategic guidance of the sector,

or even the priority given to other short and medium term political and economic issues.

## An emerging political framework

Nevertheless, the analysis of the various countries suggests that overall concerns relating to climate change and its effects on hydrology are tending to climb ever higher up national political agendas. Consensus would appear to be gradually emerging regarding the scale and unavoidable nature of the impact of climate change on the water balance, despite persistent wide differences of opinion on priorities and preferred means of intervention- supply or demand based action for managing the risk of scarcity, hard or soft solutions or the regulating role played by ecosystems. This analysis is confirmed by the interviews conducted. It is also illustrated by countries' growing efforts to adopt multi-sector adaptation strategies and for some, such as France and Spain, by clearly expressed political will.

### *Efforts towards shaping formal adaptation strategies*

Nascent sensitivity about the climate issue is being reflected at national level by somewhat variable progress towards establishing official adaptation strategies.

Table 3 provides a run-down of the various current or planned initiatives. Some countries have made quite some headway in their deliberations on adaptation, with strategic frameworks already in place or in the pipeline, whilst others are still at the stage of identifying problems and defining what priorities to give to their action.

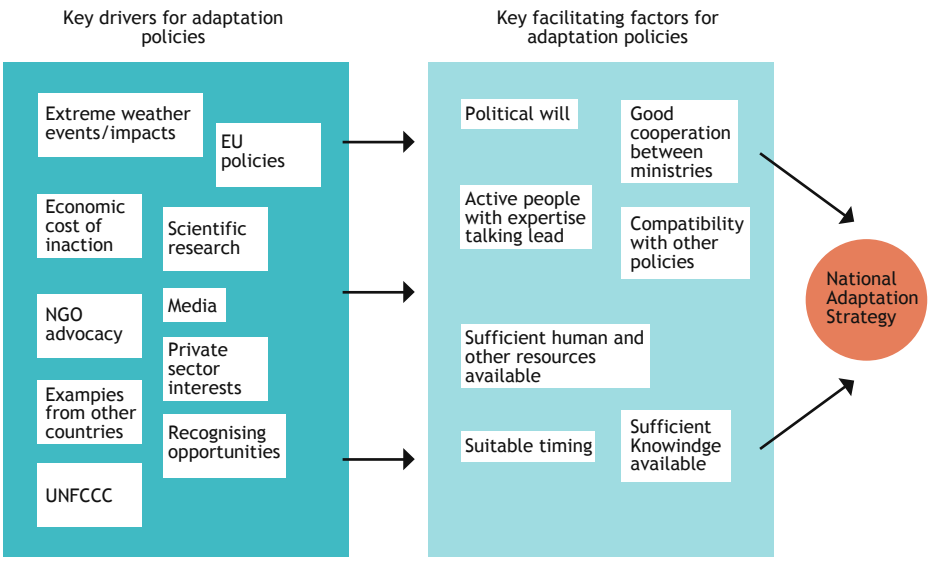
Thus Tunisia, France, Turkey, Spain and Morocco comprise one side of the sample, all of them involved in designing and adopting official adaptation strategies. These are recent processes (less than 3 years old). Depending on the institutions behind them and their prerogatives on water, these initiatives approach adaptation of the water sector from either a multi-sectoral or a sectoral tack, with the former being the most widespread. It generally equates to approaches led by institutions responsible for environmental issues, which woke up to adaptation at a relatively early stage, mainly through their involvement in international climate negotiations. The second type of approach belongs more to administrations directly responsible for water and tends to become established more slowly, testimony to the difficulties with the way in which water stakeholders claim the climate issue as their own. To date only two countries -Tunisia and France- have adopted this type of approach.

The opposite extreme of the sample comprises Egypt and Albania, which have still not adopted strategic adaptation instruments. For these countries, only the general outline and a list of potential measures have been defined and set out in the national Communications to the UNFCCC. More detailed studies are, however, planned in Egypt under the Nile Basin Initiative (NBI).

### *Factors influencing the emergence of adaptation policies*

The differences observed in the development of adaptation policies in the water sector can be attributed to numerous factors of endogenous or exogenous origin (Figure 13).

Figure 13 : Main factors affecting the drafting of adaptation policies for the water sector




(Source: PEER, 2009)

Two elements would appear to play a particularly determining role in the conception and construction of water adaptation policies: severe and recurrent natural disasters or hydrological anomalies and the influence of international or regional climate policy (UNFCCC as well as European policy and Directives for EU member states). Thus in Tunisia, a succession of particularly dry years and the devastating floods of 2003 would appear to have played a major role in triggering the process. Similarly, the UNFCCC negotiations and more specifically the 15th Conference of the Parties (COP-15) in Copenhagen seem to have accelerated the drafting and adoption of National climate strategies and plans in Turkey and Morocco.

In the case of Spain and France, several EU initiatives have helped to promote adaptation in the water sector: the Floods Directive, the EU Strategy on Water Scarcity and Drought as well as the White Paper on adapting to climate change and even measures under the reform of the Common Agricultural Policy. Guidelines and technical notes have been drafted on taking account of climate change issues during implementation of the WFD. All of these are helping to bring the adaptation of water management onto the political agenda, particularly by (European Commission, 2009) :

- Developing resilience to climate change by reducing man-made pressure on hydro-systems and sources of vulnerability,
- Promoting 6 year planning cycles, which allow practices and interventions to be adjusted over time as scientific knowledge advances (adaptive management),
- Encouraging synergy between the various existing policies, particularly in order to:
  - Restore natural hydro-system functions, particularly regarding flow regulation and pollutant treatment,
  - Reduce habitat fragmentation and improve connectivity in order to allow species migration,
  - Move towards a balance between the environment and development.

## Features and content of current policies

A study of the various policy and strategy documents available reveals the following elements.

### *Characterisation of impacts and their cost*

Few of the strategies examined proceed from an in-depth and territorialised assessment of vulnerability, impact and the cost involved. In most countries, studies conducted in this field are still patchy and limited and consequently the thrust and measures advocated in the strategies remain very general and relatively toothless.

### *Timeframes for planning and taking account of uncertainty*

Policy planning timeframes are not always clearly stated or tend not to focus too far ahead (10 to 20 years) to ensure that they remain in sync with decision makers' operational concerns. Few countries are taking an "adaptive" approach to the management of climate change, combining various types of response depending on the probability of impact emerging in the short, medium and long term. Only Turkey and Albania propose to stagger measures over time, although this responds more to an operational concern for programming action and investment than to a "graduated" response strategy taking account of the difficulties involved in forecasting climate and uncertainty. Moreover, the strategies formulated still remain relatively silent on the issue of uncertainty. Indeed, most strategies tend to follow an optimisation approach to adaptation (cf. section 2.4), in other words adaptation to a given climate scenario, which is deemed to constitute a specific future state. Some of the structural measures proposed for addressing short term impact also run the risk of causing more problems 20 years hence ("maladaptation"), particularly where solutions have a long lifespan. This applies in particular to Morocco, Turkey or Egypt, which advocate increasing regulatory and storage capacity for surface water as measures for adapting to scarcity and hydrological variability. Albeit legitimate and justifiable according to the so-called "historical" climate, this type of measure may well trap countries in particularly expensive "hydraulic" approaches by supporting uses or practices condemned in the medium and long term according to certain climate change scenarios.

### *Strategic adaptation priorities expounded in policy*

The priorities most often expressed in the «water» sections of existing strategies and guidance documents can be summed up as follows (in decreasing order of mention by the strategies) :

1. Combating growing water scarcity by reducing the mismatch between supply and demand and ensuring water security through :
   - Supply management,
   - Demand management,
   - Land use planning.

2. Reducing the vulnerability of goods and persons to extreme hydro-meteorological events, particularly through :
   - Protective infrastructure,
   - Establishing prevention plans,
   - Adoption of town planning and building standards,
   - Diversification of water supply sources.

3. Increasing the resilience of water resources by decreasing pressure upon them :
   - Pursuing programmes to combat pollution,
   - Quantitative demand management,

4. Boosting public resilience through awareness raising and preventive information:
   - Education,
   - Awareness raising and communication campaigns.

5. Building adaptation capacity within society as a whole :
   - Research,
   - Awareness raising, information,
   - Education and training.

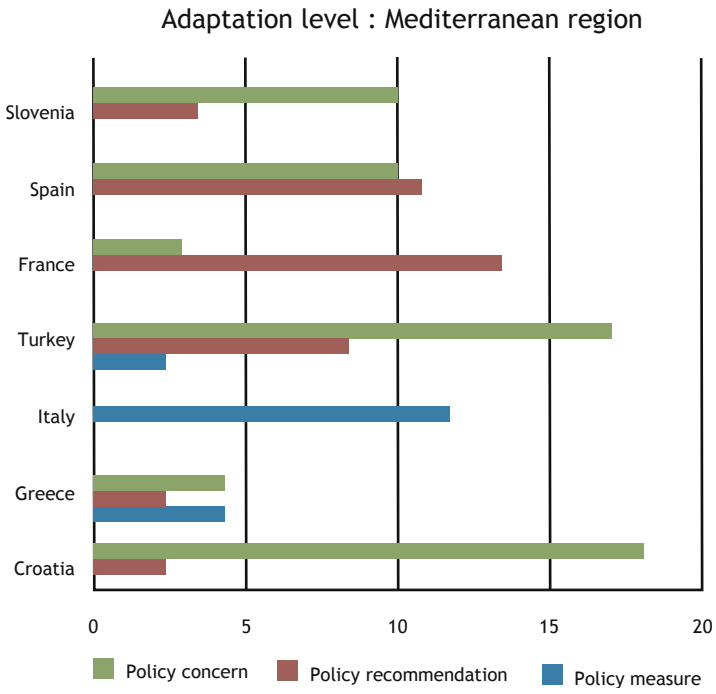
6. Preserving the natural functions of ecosystems and the services rendered towards adaptation :
   - Maintaining wetlands,
   - Combating desertification and erosion.

7. Ensuring the long term robustness of water infrastructure and investment by using methods and tools which allow risk and uncertainty to be taken into account and increase safety margins: amending sizing and operating rules.

Overall, the strategies and policies expounded include a combination of structural and non-structural measures, the former tending to dominate in the SEMCs. They also draw to a large extent on no-regret strategies, since they advocate the consolidation of current policy as an initial adaptation measure. In certain cases, however, such as in France, they also include additional measures in the form of greater consideration of future risk and uncertainty as well as reducing the vulnerability of goods, persons and uses.

In the vast majority of cases the themes covered include satisfying the need for agricultural and urban water by mobilising conventional as well as non-conventional sources, making more rational and sparing use of resources and protecting goods and persons against floods. France, Morocco and Turkey's Strategies look particularly well-balanced in terms of the objectives established and themes covered.

Figure 14: Progress towards adaptation in Mediterranean Europe




(Source: Massey E., Bergsma E. 2008)

The interactions between physical and biological phenomena and their role in determining the resilience capacity of hydro-systems and thus the uses dependent upon them are still very much a minor issue in most non-EU countries, where water, energy and food security issues predominate. Thus technical solutions continue to be relied upon rather than promoting approaches based on resilience and the adaptive capacity of the natural environment or the ones that question production and consumption patterns.

### *Dominant paradigms*

Coming back to the adaptation paradigms presented in Table 2, the analysis suggests that the majority of strategy approaches and options chosen by the countries under study relate to the following:

- Type C and D : "Preventing effects through technical and institutional measures",
- Type F : "Research and improving climate knowledge",
- Type G : "Information, education and training",
- Type B : "Risk and loss sharing".

"Living with water" approaches, which correspond to type A strategies ("Accepting risk and loss") are less politically visible than the so-called "hard" ones. They would appear, however, to be attracting the interest of increasing numbers of managers who are realising the limits of some resource developments. Conversely, there are still few examples of action targeting the long term impact of climate change and requiring a far-reaching overhaul of practice or the revisiting of current water policy and management means (type E strategies: "Changing/switching activities and uses"). This can be attributed to two main reasons. Firstly, climate change is only just beginning to produce an effect and, as far as rainfall regimes are concerned, it is still very difficult to isolate long-term development trends from the "background noise" of natural variability. In addition, such approaches call for responses which managers perceive as having a very high economic, social and political cost (in the short term) in view of the level of uncertainty surrounding forecasts.

A further paradigm to emerge at international level consists of "exploiting" opportunities linked to climate change. These opportunities are particularly limited in the Mediterranean region, as a consequence of which climate change tends to be described in strategies as bothersome and a threat to be combated.

### *Taking account of the transboundary dimension*

No evidence has emerged from the analysis so far of national adaptation policies taking account to any great extent of aspects relating to shared waters. It is therefore difficult to assess the extent to which riparian states consult on this issue. One exception is the case of the Nile basin, where the NBI has seen the launch of the drafting process for an adaptation strategy to be shared by all the riparian states. It will be based on 6 pillars:

- Inclusion of adaptation measures in Nile basin development initiatives
- Setting up of innovative financing mechanisms to support the sustainable management of water resources,
- Introduction of economic tools, notably including a private investment programme for water management,
- Support for research, knowledge management and capacity building,
- Building bridges between the scientific community and decision-making circles,
- Improving access to climate data and information.

The strategy will be linked to a programme of action in order to provide riparian states with technical and financial support in these various fields and to ensure that efforts put in throughout the Nile basin are better coordinated.

In the absence of a multilateral agreement on the Nile (currently under negotiation), this initiative resembles a study programme on climate change emanating from the NBI Secretariat more than a transboundary strategy with a genuine legal basis and management instruments. It nonetheless represents a major stride towards greater account being taken of these issues in the future Nile Treaty.

### *Monitoring and policy assessment mechanisms*

Any adaptive water management strategy must be flexible and reversible in order to best manage uncertainty. This implies the availability of monitoring and assessment tools and indicators, which will allow measures to be adjusted in line with effective changes in hydrological conditions, progress in climate science and analysis of the effects of the policies and measures themselves. These elements are lacking in most strategies. Although some strategies include monitoring and assessment provisions (France, Spain, Turkey and Tunisia), they aim first and foremost at ensuring that the measures advocated are correctly implemented rather than focusing on their effectiveness in order to revise or abandon them where necessary in view of changes within the hydrological context.

### *Inadequate implementation running up against several obstacles*

It is also important to consider the extent to which adaptation policies set out at national level are actually put into effect.

A study conducted by the Amsterdam Environmental Studies Institute (Massey and Bergsma, 2008) based on the analysis of various official sources (Communications to the UNFCCC, National Strategies, official reports, etc.) endeavoured to assess the adaptation progress made in 29 European countries by sorting adaptation steps taken by these countries into 3 categories (from the most general to the most specific) :

Category 1 : policy concerns,

Category 2 : policy recommendations,

Category 3 : measures specifically implemented.

The relative importance of each of these categories within the national policies expounded provides an indication of the extent to which the policies in question have been completed and rendered operational. Figure 14 includes the results for France, Spain and Turkey.

The results show that the vast majority of steps announced by these countries fall into categories 1 and 2, in other words they are rather general, essentially declaratory and relatively non-binding. Whilst reflecting the situation in 2007 and not restricted to the water sector alone, the trends revealed by this analysis are still valid today and provide a relatively good reflection of the situation noted in the other countries in the sample.

Indeed, the various interviews conducted amongst national experts all confirm that for the time being the strategies announced are still only being implemented to a limited extent, if at all. None of the adaptation options and measures proposed by the countries have as yet led to significant changes in water policy or in paradigms and the dominant modes of resource management. The reforms are intended either to support measures aimed at coping with pressure of non-climate origin on the resource, or to correct the influence the climate has had on human activity over the past 20 years.

The case of the Tunisian Strategy, adopted in 2007, is a clear example of how difficult it is to move from intentions alone to specific political reforms. Although reference is regularly made to the Strategy's most robust principles and messages (particularly on the need to switch from a mobilisation approach to one based on efficiency and best use of water), effective implementation of many of the measures proposed is still pending. Some of these measures touch particularly upon eminently political issues such as sharing the resource between uses and areas, or more generally the future of the country's hydro-agricultural development model.

It is possible that as water management adaptation policies are implemented, political and institutional challenges could well prove greater than challenges linked to technical innovation or access to technology. Table 4 (below) shows how different factors influence adaptation implementation conditions, acting either as brakes, or as assets and opportunities.

## Adapting the institutional framework

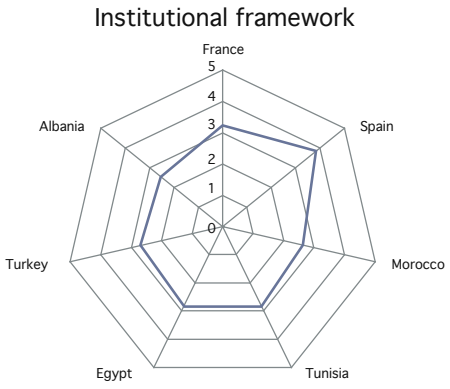
Governance and institutional arrangements tailored to the issues and specific features of climate change need to be designed: organisation of powers and responsibilities between sectors and territorial levels, ability to draft and implement policies and to settle disputes. Adaptation boosts the relevance of promoting transparent, fair and flexible rules, procedures and means of interaction between institutions.

Figure 15 shows that the level of development of institutional adaptation elements in the water sector varies quite widely within the sample. France and particularly Spain appear to be better equipped and more advanced than their neighbours to the South and East of the Mediterranean.

### *In terms of guidance and inter-sectoral coordination*

In most of the countries studied, organising bodies and coordination mechanisms for adaptation policy already exist or are in the pipeline, usually on an inter-sectoral basis.

Figure 15: Setting up of an institutional adaptation framework in the water sector




(1 = marginal; 2= limited; 3 = moderate; 4 = developed; 5 = highly developed)

Their efficiency varies widely from one country to another, however. Spain has set up an overhauled institutional framework for implementing its adaptation policy within the various sectors concerned, including water (cf. Figure 16). It centres on an Office for Climate Change, responsible for ensuring the implementation of the National Adaptation Plan in the relevant sectors. Focal points have also been appointed within each sector administration to facilitate coordination and implementation of the plan.

In theory, adaptation is guided at sectoral level by national inter-ministerial coordination bodies with decision-making and arbitration powers such as in Morocco, Spain and more recently Tunisia with the creation of the National Water Council, or playing an essentially advisory role like the National Water Committee in France. The most emblematic structure is certainly the Higher Council for Water and Climate (CSEC) in Morocco.

However, the case of Morocco clearly demonstrates the problems encountered. A study conducted by the World Bank and the Moroccan government (World Bank, 2004) indicates amongst others that in the absence of a clear roadmap and high level political backing, the consultation and coordination bodies set up risk running out of steam, preventing them from promoting and embracing an open debate between stakeholders and opening the way for strategic decisions on issues such as adaptation of water demand or resource sharing between economic activities.

Moreover, although these countries are undertaking substantial reforms in order to improve water governance, responsibilities are still fragmented or overlap, sometimes giving rise to conflict, inertia or even an institutional vacuum. This state of affairs hampers the capacity of existing institutions to respond and pre-empt. It is a recurrent theme running throughout the strategies examined, all of which recommend an administrative shake-up in the water sector as a key factor in adaptation, in order to reduce the dispersal of competence and encourage greater decentralisation of power.

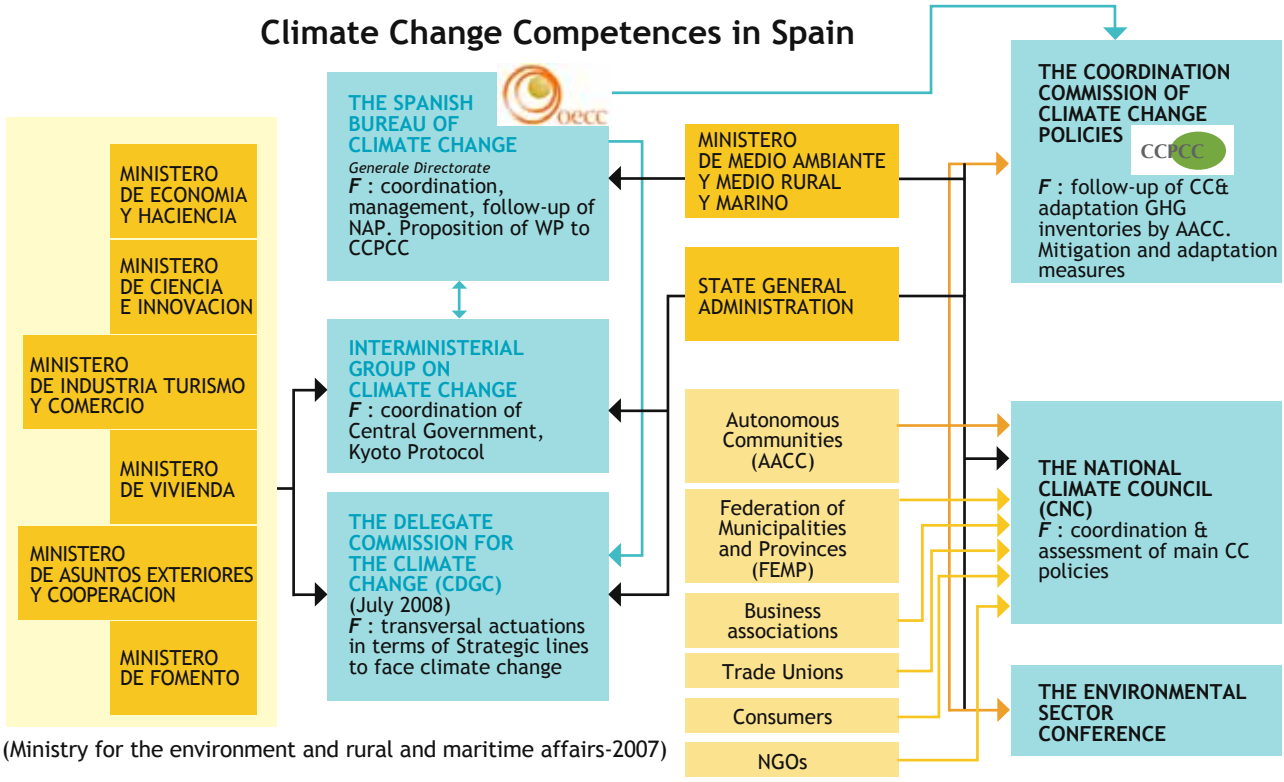
A further obstacle lies in the difficulty of setting up strategic and technical units devoted to climate issues within administrations responsible for water. To date, adaptation was dealt with by numerous different departments, sometimes with contradictory objectives and approaches. This hampered coordination with other sectors. The situation is compounded by a cruel shortage of technical capacity for grasping the complexity of the issues raised by climate change for planning and resource management. Although institutional capacity building needs have been clearly identified, thanks in particular to the diagnoses established in the National Communications, they remain largely unmet.

Table 4: SWOT Analysis of National Adaptation Strategies

| | Factors making a significant contribution towards meeting NAS objectives | Factors hampering the achievement of NAS objectives |
|---|---|---|
| Internal factors linked to NAS emergence and development conditions | (STRENGTHS)<br>● Targeted research programmes<br>● Planning of the implementation, monitoring and financing of adaptation<br>● Organisation of coordination between sectors and levels of administration | (WEAKNESSES)<br>● Inadequate institutional coordination<br>● Inadequate stakeholder involvement and commitment<br>● Poor definition of roles and responsibilities devolved to the various territorial levels<br>● Inadequate account taken of local know-how and context |
| Factors linked to future institutional developments external to the NASs | (OPPORTUNITIES)<br>● Rapid growth and increased exchange of knowledge on adaptation<br>● Lessons learned from integration and multi-level governance in fields other than climate | (THREATS)<br>● Inter-institutional and inter-territorial conflict<br>● Inadequate financial and technical resources<br>● Inadequate mobilisation of public opinion<br>● Political attention diverted to other more immediate concerns |

(Source: PEER 2009)

Figure 16 : Institutional coordination of the National Adaptation Plan in Spain




(Ministry for the environment and rural and maritime affairs-2007)

## *In terms of cooperation between territorial levels*

The role granted to the local level (areas, catchment basins, urban conurbations, etc.) in adapting the water sector varies widely from one country to another, mainly depending on the degree to which water management is centralised. However, since adaptation requires responses tailored to local contexts and needs, catchment basins and local areas are increasingly being recognised as the appropriate level at which to organise and implement adaptation policy. Countries continue to face several challenges. The attribution of roles and the terms governing cooperation between the different territorial levels remain to be clarified and extension of the territorial subsidiarity principle to the adaptation of the water sector and its institutionalisation must still be developed. The challenge lies in avoiding inconsistency and additional cost in policy implementation, organising activities throughout the area depending on how average resources evolve year on year, but also in order to improve the handling of natural disasters relating to water. This requires coordinated action by central and local authorities before, during and after a crisis. Moreover, management bodies and local authorities often find it very difficult to access national and international funding, whilst their local roots mean that they are highly aware of needs and priorities. Finally, adaptation policies still tend to be defined at national level and risk turning into prescriptive procedures leaving little leeway for local stakeholders to design and embrace solutions that join up with local reality.

Certain institutional measures are underway in the countries, such as in France where the Grenelle II law has been adopted, requiring the regions and communities with over 50 000 inhabitants to adopt regional climate-air-energy schemes (SRCAE) and territorial climate-energy plans (PCET) by 2012. These local climate policy planning documents are required to include a section on “adaptation” and should provide an opportunity to clarify how responsibilities are organised and how they join up between the various territorial levels. The same applies to the inclusion of adaptation in catchment basin management plans, which should be effective for EU member states as of 2015 (WFD).

## *In terms of consultation and public and local stakeholder participation*

An adaptation strategy demands transparency regarding climate data, uncertainty and risks involved, as well as requiring the recognition of diverging interests between stakeholders and the juggling of equity issues and power struggles between potential winners and losers, particularly regarding the level of risk and cost they are willing to accept both individually and collectively (Magnan et al., 2009).

A rather marked lack of symmetry exists between the EU countries and their neighbours on the Southern and Eastern banks. Numerous consultation and participation mechanisms have been developed or are being institutionalised for the former, at national as well as local level (example of the Grenelle Colleges in France, the Adaptation Forum in Spain, basin committees, local water commissions, direct consultation processes, etc.). Their efficiency has not yet been assessed. For the other countries, despite encouraging progress adaptation remains the business of specialists and experts. Opportunities for users and the various stakeholders from civil society and the private sector to feed into the debate and decision-making remain limited. However, the resilience of water management systems largely lies in the ability of these stakeholders to adapt their practices and identify and collectively implement robust, active solutions.

## Legislative and regulatory measures

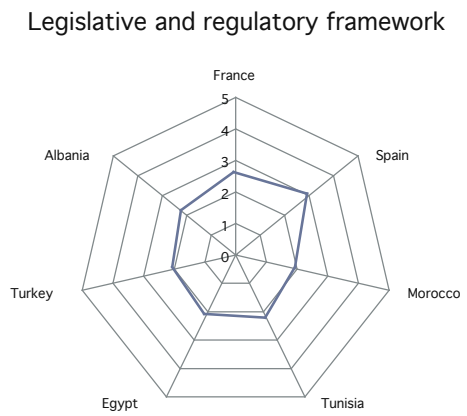
The development of an effective legislative and regulatory framework is a good indicator of States' political will and commitment to adaptation.

The scant progress made in this field is mainly to be seen in the EU countries (Figure 17).

The state of play on this front is addressed according to three dimensions in the analysis framework:

- Adapting national legislative frameworks,
- Modifying water regulations (rights, permits and authorisation),
- Mainstreaming adaptation in transboundary treaties and their legal provisions.

Figure 17: Introduction of a legislative and regulatory framework for adaptation in the water sector




(1 = marginal; 2= limited; 3 = moderate; 4 = developed; 5 = highly developed)

## Legislative developments at national level

Whilst most of the national adaptation strategies analysed recognise the need to update the legal framework for water management, only France and Spain have taken steps in this direction.

Advances are of recent date in France:

- The Law on water and aquatic environments adopted on 30 December 2006 takes account of adaptation to climate change in water resource management.
- The Grenelle I and II laws (finally adopted on 30/06/2010) foresee :
- Transposition of the EU framework directive on the risk of flooding into French law. Floodable areas and flood risks must be mapped in all areas with a high risk of flooding. The floods directive stipulates that the maps should be regularly updated (every 6 years) and take account of the effects of climate change.
- The setting up of green and blue networks through amendments to the Town Planning Code and the drawing up of regional ecological coherence schemes by 2012,
- The requirement incumbent upon departments, urban communities and conurbations as well as municipalities and groups of municipalities with over 50 000 inhabitants to adopt territorial climate-energy plans by 31 December 2012. These documents are supposed to ensure the rollout of NAP measures at territorial level.

Spain has also amended its legislation following the adoption of its national water plan in 2007. These amendments focus largely on the need to include climate change in environmental impact assessments for water projects and the introduction of drought management plans.

The remaining countries have so far not taken any steps directly motivated by climate issues to update their legislation. An initiative is, however, underway in Tunisia where an initial stocktaking of the current legal framework has been carried out with a view to identifying and assessing the contribution made by each piece of legislation to adaptation to climate change, including texts on water. Some recent legislative headway made within the more general framework of upgrading the water sector can be seen to be nudging towards adaptation by introducing effective "no regret" measures. Such is the case, for example in Morocco and Tunisia where the water code and policy have been consolidated.

As is highlighted by the Tunisian strategy, one of the first adaptation measures in the water field consists of effectively applying the legislation in force as well as regulations on use. The manner in which laws are implemented varies widely from one country to another, particularly in non-EU states (Kaufmann & al., 2009). Several obstacles hamper the implementation of legislation in these countries:

- The lack of decrees opening the way for implementation of legislative provisions;
- Weak procedures relating to abstraction requests, controls and sanctions in case of infringement;
- Inadequate policing powers and prerogatives granted to water authorities;
- The lack of human and financial resources to conduct control and monitoring under the water policy;
- Corrupt practices.

Scant information has been collected regarding adaptation of water management regulation. However, a review of the literature and consultation with experts on the issue would appear to indicate that adaptation still brings little influence to bear on the rules and regulations governing water management and use.

Efforts are, however, underway in the EU member states, particularly as regards consolidating the legal code on flood risk prevention and delimiting areas which may not be built on and their easements. The revision of standards and legal provisions on the sizing and construction of water infrastructure (dams, dykes, canals, etc.) also ranks high up in national thinking. In France, preparatory studies for the drawing up of the national adaptation plan have led to the initial lines of regulatory development being identified, some of which directly concern water.

### *International agreements on transboundary basins*

As far as Mediterranean transboundary basins are concerned, none of the agreements existing within the group of countries analysed include any provisions clearly driven by climate change. Concerted variability management mechanisms exist for Spain (Albufera Convention with Portugal) and France (Rhine, Meuse), but they have been drawn up according to a hypothesis of hydrological stability. Moreover, a recent study highlighted the mismatch between the possibilities offered by the water modelling tools available and the precision required by most of the water sharing rules in international agreements (UNECE 2009). Nevertheless, initiatives intended to render rules on resource sharing between riparian countries more flexible in the face of growing intra and inter-annual variability are underway in certain non-Mediterranean basins and deserve to be flagged up in this respect. Thus in 2008, Spain and Portugal introduced a provision in the Albufeira agreements to allow the flow of 4 shared rivers (Minho, Douro, Tejo and Guardiana) to be permanently adjusted depending on rainfall changes for various time intervals (monthly, weekly and daily) allowing account to be taken of intra-annual variability.

A further example of an initiative intended to respond to these issues is the Nile Basin adaptation strategy currently on the drawing board (cf. 3.2, p.18). It follows up a decision taken by the Nile Basin Committee in 2008, and as yet has no legal scope since a multi-partite agreement is currently being negotiated. It nonetheless helps ensure that climate change and effective response mechanisms are an integral part of the future agreement.

## Economic adaptation tools

The various studies conducted at international level have shown that, generally speaking, even modest investment in adaptation would lead to a significant reduction in cost compared with non-action. This holds particularly true for the water sector. At global level, annual adaptation costs for the sector are estimated at between 9 and 11 billion dollars for 2030, 85 % of which concern developing countries alone (UNFCCC 2007). Albeit still relatively unrefined and limited from a methodological point of view, these assessments provide orders of magnitude which point to the fact that major financial efforts will be needed in the water sector, requiring current funding to be redirected and innovative mechanisms used to tap into additional resources.

Adaptation costs are as much linked to the growing vulnerability (exposure and sensitivity) of people, goods and economic activity as to an increase in hazards. In the case of flood risk, the former factor could well predominate over the next decades, particularly in the SEMCs due to booming urban growth and associated real estate pressure, which is forcing the least well-off to move into the most exposed areas (flood plains, unstable hillsides...). Growing vulnerability thus legitimises the sharing of adaptation costs and justifies the use of public and private tools and sources of finance.

Several types of economic and financial tools for adapting management of the resource and the water sector exist, including most notably (OECD, 2008) :

- International and national public aid and funding programmes;
- Mechanisms based on the provision of a price signal, such as price setting for water;
- Risk pooling and sharing schemes, such as insurance against hydro-meteorological risks (drought, floods, etc.);
- Market mechanisms such as trading in water rights or payment for ecosystem services (PES);
- Private investment, particularly through public-private partnerships (PPPs);
- Regulatory or tax incentives (such as the conditionality of some aid, the introduction of quotas or tax exemptions for investments).

These various instruments are often flagged up in the adaptation debate. They are considered to be more effective than technical measures deemed to be more expensive and less flexible. Well-designed and adapted to countries' economic, technical and social conditions, they may play an effective role towards adaptation, notably by mobilising the necessary resources for the most vulnerable groups, correcting market bias and the inadequacies of purely private and spontaneous adaptation, by creating the incentives needed to drive more efficient resource allocation or encouraging the adoption of preventive behaviour in the face of growing risk and uncertainty.

## Limited development of tools for adaptation purposes

Despite the region's marked vulnerability, the study of the situation in the various countries shows that little progress has as yet been made towards developing economic instruments for adaptation in general and the water sector in particular (Figure 18).

In fact, the many instruments created under national water funding and management policies (such as water pricing in agriculture or flood insurance schemes) were introduced independent of climate change and are not directly focused on adaptation. Moreover, the implementation and performance of these tools tend to be sub-optimal if not basically inadequate in the SEMCs (the case, for example, with water pricing or insurance schemes against natural risks). This limits the capacity of existing mechanisms to address the impact and additional cost of climate change, as emerges from an analysis of the situation, prospects and implementation conditions for three of these tools : public financing mechanisms, insurance schemes and water pricing policies.

### *Public financing mechanisms*

Most economists believe that public money may legitimately be used to fund adaptation to climate change, even though it essentially generates private benefits. According to the UNFCCC (UNFCCC, 2007), introducing privately financed adaptation systems may well prove inadequate, particularly in developing countries, given the dearth of information available about the future, the difficulties faced by private operators in understanding the long term, their limited investment capacity and even for reasons of equity and efficiency (De Perthuis et al., 2010). For the water sector, a common good by its very nature, public financing has a crucial role to play in developing new infrastructure or maintaining what already exists, supporting basic research facilitating the production and circulation of climate information (seasonal forecasts, climate projections, risk analysis, etc.), promoting the adoption of new technology (in irrigation, for example) or investing in prevention measures and guaranteeing that individuals and companies are compensated in case of natural disaster. This type of financing may come in different shapes (subsidy and financial support programmes, assistance and investment funds...) and fall under national or international mechanisms.

As far as the countries in the sample are concerned, public financing specifically dedicated to adaptation is limited to supra-national assistance funds: European funds for the EU member states and multilateral or bilateral international aid for the SEMCs: Adaptation

Funds under the Global Environment Fund (GEF), World Bank, EU, French Global Environment Fund (FFEM), etc.

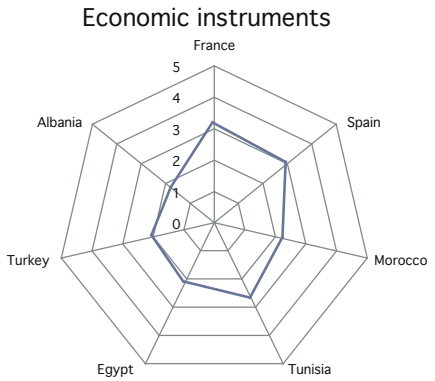
As for the SEMCs, the predominance of international aid can largely be attributed to their limited financial capacity but also to the position of these countries within UNFCCC negotiations on responsibility for financing adaptation at international level. The SEMCs and indeed developing countries in general, consider that, industrialised countries being the main cause of climate change, the cost of adaptation and its funding should therefore be incumbent upon them according to the "polluter pays" principle. Albeit legitimate and now widely accepted by developed countries, the principle of international solidarity and the relevant financial mechanisms are hampered by several operational constraints which considerably limit funding for adaptation in the water sector.

National and international resources are inadequate and/or insufficiently mobilised. In the latter case, the problem stems more from poor channelling of public funds than from any shortage, thereby limiting countries' absorption capacity.

As far as UNFCCC funds managed by the GEF are concerned, the notion of additionality has often been the main criterion governing the eligibility of funding requests. This concept raises a problem, since it renders project design and justification particularly irksome whilst de facto excluding "no regret" measures, which, albeit not the sole component, often comprise an essential prerequisite for any adaptation policy. A further constraint lies in the fact that these various funds see water as a sector rather than the main vector through which the impact of climate change emerges and increasingly affects the other sectors of the economy (agriculture, tourism, health, etc.). Water consequently often finds itself in competition with other sectors for access to what are already highly inadequate resources. Finally, these funds usually allocate resources following a "project" approach, which very often leads to aid being scattered and interventions fragmented. Programme-based approaches continue to receive inadequate backing from these funds, despite their numerous benefits (long term strategic vision, consistent policies and reforms, predictability of financing, effectiveness and impact of increased investment, etc.).

For countries to the North of the Mediterranean just as for those to the South and East, the introduction of national financing mechanisms now looks unavoidable. As has been highlighted by the preparatory studies for the French Adaptation Plan, whilst requiring new types of financing, this will also mean striving to minimise additional funding needs

Figure 18: Introduction of economic instruments for adapting the water sector




(1= marginal; 2= limited; 3 = moderate; 4= developed; 5= highly developed)

against a backdrop of economic crisis and public spending cuts. Current funding can in this context make a major contribution to adaptation policy by redirecting, conditioning and optimising in order to take better account of the impact of climate change and avoid the risk of "maladaptation".

Three elements essential to the introduction and effectiveness of public (and private) funding mechanisms at national level should also be recalled. The first concerns the need to better grasp financial needs for adapting the water sector. This is achieved by assessing in precise enough terms the cost of impact and measures to address it as well as their sectoral, geographical but also social and temporal distribution. Yet available assessments are mainly the fruit of global or regional studies applying highly divergent hypotheses and methodologies, thus limiting their operational scope at national level. The second refers to the imperative need to increase the absorption capacity of stakeholders in the sector, which remains low in the SEMCs. This can be achieved in particular through ambitious technical and human capacity building policies as well as by improving institutional governance in the sector. Finally, the third element argues in favour of territorial authorities becoming more involved in financing policy. Under the decentralisation process currently underway in several Mediterranean countries, these authorities are indeed seeing their prerogatives and means to intervene gradually expand in the water field.

*Insurance and risk transfer schemes*

Insurance and re-insurance mechanisms may also play a major role in adaptation. In the event of extreme hydrological events (drought, floods, etc.), they allow risk to be pooled by sharing the cost of damage between a large group of potential beneficiaries or by transferring the risk to national or

international markets in the case of certain innovatory insurance products (climate drift, indexed insurance, disaster bonds...). Moreover, by attributing a price to risk, the growth of insurance may also help to make it more specific and encourage the adoption of more preventive behaviour. In fact, when insurance/re-insurance premiums and excesses depend on the level of risk exposure, they also provide subscribers with a price signal and encourage them to adopt measures to reduce the vulnerability of goods and assets.

In the various countries studied, insurance schemes covering existing natural risks tend to be a mix of part private, part public, comprising a classical insurance scheme for risk deemed to be insurable, topped up by a public compensation scheme for natural disasters based on national solidarity and intended to cover non-insurable damage and, in certain cases such as France, to guarantee re-insurance.

In countries outside the EU, public insurance schemes account for a large part of natural risk coverage. The private insurance market is relatively undeveloped, as for example in Morocco and Albania, which still have no mandatory insurance scheme for this type of risk. Growth of the insurance market in these countries is hampered by:

- Institutional constraints and the absence of an appropriate regulatory framework (as for example the requirement to insure against certain types of risk or activity);
- The unattractiveness of the market due to limited possibilities for households to contribute and sometimes inadequate demand bearing in mind the scale of direct State intervention through national solidarity;
- The lack of effective regulation limiting the exposure of goods and persons and allowing potential damage to be kept to levels eligible for compensation and which can therefore be covered by insurance companies.

Nonetheless, efforts are currently underway in several countries to try and remove these obstacles. Morocco, for example, is studying a bill on disaster risk and Albania is expected to gain access to an insurance scheme against natural risk and disaster thanks to World Bank aid, mainly through the disaster insurance fund set up throughout the countries of South-Eastern Europe.

However developed the insurance scheme, climate change is expected to bring major influence to bear on how the sector evolves and on the role played by the public authorities. Firstly, increased hazard occurrence and intensity (particularly low probability/high impact hazards) but also socio-economic vulnerability should drive a significant rise in the cost of damage and therefore compensation, resulting in a growing need for capital amongst insurers and re-assurers to protect themselves against the risk of bankruptcy. Also, the highly uncertain and non-static nature of the climate risks overtaking the actuarial analysis approaches and tools generally used to determine risk and calculate premiums (OECD, 2008). From the insurance companies' point of view, these elements are making insurance activity riskier than it used to be. This is likely to be reflected in higher insurance premiums or even the refusal to cover certain types of risk which have become too tricky to assess. In the long term this trend could prove prohibitive for the smallest stakeholders and challenge the fairness of the system. Public intervention may prove necessary in order to maintain risks and their cost at insurable and generally affordable levels, through financing steps to reduce vulnerability (prevention), for example, or by dealing with large-scale natural events and disasters through national solidarity and re-insurance.

### *Water pricing policy*

One of the aims of adaptation in the Mediterranean is to promote the rational and sustainable use of resources- currently becoming scarce in several countries- and ensure maximum efficiency in their allocation and economic exploitation. Water pricing may create major leverage in this respect. With an appropriate pricing structure, the price of water may help signal the scarcity of the resource and encourage savings and control of demand in those regions most severely affected by diminished rainfall.

Water pricing is now becoming quite widespread in Mediterranean countries, particularly in the farming sector, which accounts for over 80 % of total water demand in the SEMCs and two thirds of potential water savings in the Mediterranean region. It tends to pursue the dual aim of covering virtually the total cost of distribution to users and, to a lesser extent, reducing demand (Thivet and Blinda, 2009). Whilst the former aspect predominates in rising water prices, the latter is becoming increasingly widespread, not only in EU member states but also in countries such as Morocco, Turkey and particularly Tunisia, which in recent years has embarked on an incentive-based tariff scheme. Generally speaking, there is no major difference between pricing for adaptation purposes and conventional water pricing, save that it is intended to consolidate the price signal and the incentive effect of pricing by complementing the existing tariff structure in such a way as to take account of the exposure of each sector of consumption (agriculture, individuals, industry, tourism...) to climate variations.

In Tunisia, the adaptation strategy for agriculture intends to follow this model to introduce "climatic" water pricing to be tacked onto current prices and which would be adjustable in order to reflect the effect of climate change on rainfall variability and spatio-temporal trends. In the other countries studied, pricing is also presented as a preferred economic tool for adapting demand (particularly in agriculture) and maintaining the supply/demand balance.

It was not possible to conduct a detailed review of the other types of instrument within the framework of this study. Certain aspects emerge, however, from the country group analysis:

Water rights exchanges and trading in abstraction permits are virtually non-existent in any formal manner. They have, however, been proposed under the Tunisian adaptation strategy through the introduction of a "blue" certificate trading exchange in some pilot irrigated areas. Politically this remains a highly sensitive tool, the effectiveness of which is contested (Barraqué, 2002).

Operational Payment for Ecosystem Services (PES) schemes towards adaptation are non-existent. France and Tunisia, however, are proposing to explore this avenue in order to put to effective use the services rendered by ecosystems and their role as natural infrastructures for adaptation.

Public-private partnerships are planned in several countries, particularly regarding the adaptation of urban water infrastructure, reuse of treated wastewater or desalination. In return, the effects of certain adaptation measures such as, for example, desalination, on climate change, would have to be assessed and taken into account. Current thinking joins up with the framework of agreements for delegating certain water and sanitation services to private operators. Thus, under the World Bank-financed project on "Adapting North African coastal towns to climate change" studies and consultations are underway in Casablanca and Rabat in partnership with the LYDEC and REDAL, the delegated water service managers, aimed at assessing the adaptation needs of water and sanitation infrastructure, identifying the nature and volume of investment required and, where necessary, studying ways to take account of these new constraints in current service delegation contracts.

## Instruments to be used under certain conditions

The various financial tools presented are important adaptation levers. Account should be taken during their implementation, however, of certain conditions and limits to ensure that they are effective and socially equitable.

If poorly gauged, public adaptation funding mechanisms and insurance products entail a risk of "moral hazard" or even maladaptation. Indeed, the fact that the State finances certain activities or provides compensation for damage caused by natural disasters could prompt stakeholders to maintain goods and uses which are highly vulnerable to hydrological extremes rather than investing in preventive measures intended to curb or eliminate this vulnerability (see type A, B, and C strategies in Table 2). In the same vein, an insurance scheme based on uniform premiums and failing to reflect the level of risk entailed may give rise to a «perverse incentive» and tempt clients either not to amend or even to increase their risk-taking compared with a situation where they would be totally liable for the negative consequences of a disaster (OECD, 2008). This scenario tends to dominate in those countries studied where premiums are not currently modulated according to the risk of natural disaster. Thus States face the challenge of introducing balanced systems guaranteeing access for as many people as possible to effective insurance and compensation whilst ensuring that the cost of such cover produces an attractive enough price signal likely to prompt the adoption of responsible preventive behaviour. Several countries are already considering such approaches, particularly France, where a recent report by the Ministry for the Environment (MEEDDM, 2009) shows the feasibility of solutions marrying national solidarity and premium modulation to reflect the level of risk.

Pricing for adaptation purposes faces the same implementation constraints as conventional pricing. The feasibility and success of such instruments depend on technical, political, economic and social considerations. In agriculture, for example, the effect of pricing on irrigation water demand remains a complex issue dependent on several factors such as the presence or absence of alternative and free water sources (such as groundwater), the irrigation techniques used, the significance of the cost of water compared with profits produced by crops and price features: initial price level, scale of price increase and roll-out provisions over time (Thivet and Blinda, 2009). In addition, the social implications of pricing should not be lost sight of when this type of tool is being set up, since user acceptability will largely

depend upon them. As such, household income and that of economic operators, particularly the weakest amongst them, should be correctly taken into account within the price structure revision as well as in its implementing provisions. This may necessitate the introduction of social pricing provisions, compensation (relief from other taxes and levies) or equalisation mechanisms. Moreover, pricing cannot provide a panacea for managing the quantitative impact of climate change, particularly in cases of severe, one-off or chronic deficit, where the incentive effect of the price instrument may not suffice. In order to ensure that demand is adequately regulated under all circumstances, pricing needs to be supplemented by other types of measures, particularly the use of standards and regulations (water restrictions during droughts, quota allocation, controlled abstraction and water law enforcement, etc.).

## Information and knowledge management systems

Given the scale and complexity of hydrological change, water management needs more than ever to see an improvement in the manner in which development and investment decisions are taken. This can be achieved by improving the inclusion, circulation and use of meteorological information (climate surveillance, radar and satellite observation, hydrological measures) as well as through the development of climate products and services tailored to managers' and users' needs. This is indeed one of the flagship recommendations from the 3rd World Climate Conference (WCC) convened in September 2009 by the World Meteorological Organisation (WMO).

The capacity to generate and use information and knowledge about extreme events and climate change in the relatively long term is a determining factor in adaptation and contributes directly to increasing the resilience of water management systems.

The issues at stake for water stakeholders could thus be summed up as follows : providing relevant information to directly involved users at the right moment, whilst clarifying the level of uncertainty.

Addressing these issues means :

- Adopting monitoring, surveillance and forecasting systems which will allow trends in meteorological and hydrological parameters to be tracked in real time and also short, medium and long term forecasts and warnings to be produced as the climate evolves and science progresses;
- Having the tools to analyse the data produced and to generate information to assist decision-making (making it available and circulating it amongst target groups in operational format).
- Codifying, managing and circulating information on impact and adaptation in order to build on past experience and facilitate switches of practice and, finally, the adaptive management of the sector.

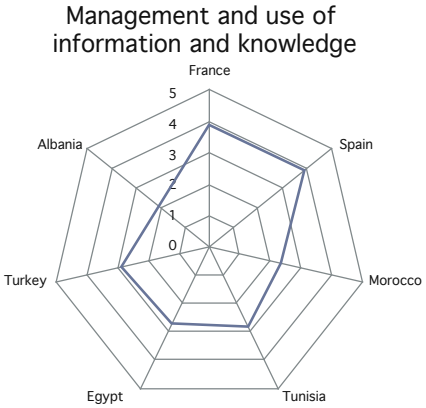
An analysis of the 7 countries selected reveals wide variation as far as these 3 criteria are concerned (Figure 19).

Regarding the first aspect, whilst France and Spain have highly developed observation capacity and hydrological and meteorological monitoring and alert networks (supplemented by several European mechanisms), the development of monitoring and surveillance means in the remaining countries is inadequate if not in decline. The situation is particularly alarming in Albania, where the hydro-meteorological monitoring system has been obsolete since the nineties.

Aware of the importance of climate information in implementing adaptation, countries tend to apply relatively substantial updating steps, by setting up regional and national surveillance and warning systems for example. Several of the countries studied are also becoming increasingly involved in international or regional initiatives to build monitoring and warning capacity.

For the remaining two criteria, countries are increasingly recognising the need to ensure a better interface between scientific and decision-making circles. Several initiatives are underway, aimed for example at developing climate products and services

Figure 19 : Setting up of systems for the production, management and use of information and knowledge about the climate and adaptation




(1 = marginal; 2= limited; 3 = moderate; 4 = developed; 5 = highly developed)

targeting the needs of final users, providing access to regionalised scenarios, such as the DRIAS[1] project in France, or promoting the exchange of climate data and good adaptation practices between territorial and sector stakeholders.

Despite the progress already made, there is still major room for improvement, particularly on the following fronts :

- Monitoring and measurement networks are inadequately maintained and financed and only partially cover the particularly vulnerable areas at national level ("blind spots" still abound, in the oasis regions in Southern Morocco for example);
- Surveillance, early warning and drought and flood response systems have major shortcomings in the SEMCs and could be improved in the EU countries, as was shown in France by the devastating floods which struck part of the Var region in June 2010. Despite its marked vulnerability, this area is still not covered by the national flood forecasting and warning system (SCHAPI) (Solletty, 2010);
- Climate modelling capacity is still limited at regional and local level, particularly for the long term;
- Research towards furthering climate knowledge and modelling tools and addressing uncertainty should be more widely supported, particularly in the SEMCs and in the fields of 10-year forecasting, downscaling tools or frequency analysis of hazards under uncertain conditions;
- Coupling and interfacing methods between climate and hydraulic/hydrological models should be optimised and widely circulated;
- Remote sensing and satellite analysis methods are still not widely used to study the impact of climate change on hydrology;
- Tools to support decision making in the evaluation of hydrological risk and the adaptation of water planning remain relatively undeveloped. Agencies responsible for managing the resource are rather poorly equipped on this front both to the North and to the South. Hydro-meteorological risk and «hot spot» mapping at national level is highly inadequate across the board despite the relevance of this type of tool for guiding adaptation efforts;
- A degree of mismatch continues to exist between supply and demand of climate information. The data produced by researchers and climatologists (regional model production, seasonal forecasts, 10-year climate forecasting, etc.) does not take adequate account of final users' operational needs. In addition, the latter are not sufficiently aware of the value added provided by the results/outcome of climate research and modelling studies. Dialogue and cooperation should be encouraged between upstream and downstream in the information chain;
- As far as institutional information and knowledge sharing mechanisms are concerned, progress remains limited and must pick up speed. Moreover, the production and provision of climate data is sometimes seen by meteorological agencies as a paying service, which may hamper their accessibility and input to decision making. Thought needs to be given to the status of climate information and means for recovering the cost of its production.
- Countries do not make adequate use of data produced by international agencies. Despite the WMO's efforts, regional cooperation in this field is in need of consolidation.
- The human and technical means needed to manage and anticipate change and extreme climate events are inadequate; most of the time, the institutions concerned operate in a vacuum and suffer from a lack of training for the production and use of climate information as well as inadequate specific technical capacity in this field.

1. Project intented to make available regionalised climate scenarios established by French climate modelling laboratories.

## Technical adaptation measures

Besides the analysis of the political, legislative and institutional aspects, the implementation of technical adaptation measures was also briefly reviewed, based on a wide range of structural and non-structural measures. They fall into two main categories :

- Planning and territorial management tools for adaptation
- Technical measures concerning :
  - The management of water scarcity and the risk of drought
  - Management of the flood risk

### *Planning and territorial management tools for adaptation*

Integrated water planning tools are tending to be developed in the Mediterranean at the level of the various water management units (catchment basins, groundwater), administrative areas (regions, provinces, communes) or local communities (villages and local associations) and are increasingly seen by administrators as preferred instruments for promoting adaptation and rendering it operational at local level. They are based on the use of climate and hydrological scenarios for assessing and factoring in the impact of climate change and the corresponding adaptation measures within prospective analysis and land use planning exercises focusing on medium and long term resource management and usage.

Various initiatives underway on the planning front are intended to make catchment basin water development and management plans or groundwater agreements more resistant to climate change, following an approach known as "climate-proofing". Recent provisions on implementation of the Water Framework Directive have made it mandatory for the impact of climate change to be taken into account in EU member states. For the first round of planning from 2008-2015, the European Commission has introduced a "climate-check" procedure on programmes of measures included in management plans in order to assess how sensitive they are to the impact of climate change and the risk of maladaptation. The second and third rounds will require the inclusion of an in-depth assessment of the climatic impact on resources, uses and the security of property and persons in management plans and the corresponding adaptation measures. Flood and drought risk management plans are also being developed, prompted by the Floods Directive in EU member states and under various pilot initiatives, particularly in Morocco.

1. http://www.iisd.org/cristaltool/

In the same way, with the spread of administrative decentralisation policies, strategic and territorial adaptation planning tools are starting to be introduced at the various levels of territorial governance. Spatial planning plays a determining role in water use and vulnerability to risk. Thus taking account of the hydrological impact of climate change in territorial planning documents is proving to be a particularly crucial adaptation measure. At intra-national level, some local and regional authorities are signing up to adaptation, as is happening in France through regional climate-air-energy schemes (SRCAE), in Spain through its Regional Climate Plans and in Morocco through the Territorial Anti Global Warming Plans (PTRC). Promising experiences are also emerging at municipal level. As such, the World Bank's project on the "Adaptation of coastal towns in North Africa" is backing the development of adaptation and natural risk preparedness plans within the municipalities of Casablanca, Tunis and Alexandria. In France, communities of over 50,000 inhabitants are now required to draught Territorial Climate-Energy Plans (PCETs). At community and village level, tools such as "CRISTAL[1]" are leading to the emergence of community adaptation plans, with the first experiences emerging in Morocco and Turkey under UNDP-backed projects.

This range of mechanisms is of tremendous relevance to adaptation and water management, leading notably to improved organisation and greater consistency within territorial action and providing an appropriate framework for consultation and user accountability as well as the definition of mutually accepted adaptation objectives.

To become genuinely effective, however, these tools must guarantee a balance between mitigation and adaptation policies and enjoy a broad enough legal scope in the face of other territorial and urban planning documents.

### *Technical adaptation measures*

The following table sets out a typology of the main technical adaptation measures for the various water use sectors

Two main types of adaptation options exist:

- Water stress and drought management measures,
- Flood risk management measures.

A third category, bridging the first two, concerns infrastructure adaptation measures.

Implementation of the various adaptation measures was briefly assessed (cf. Assessment grid in Annex 3)

Table 5: Examples of adaptation measures and technologies available in the water sector

| Type of use | | Supply side | Demand side |
|---|---|---|---|
| **Municipal/domestic** | | 1. Increasing reservoir capacity (hard technology)<br>2. Desalination (hard technology)<br>3. Inter-basin transfers (hard technology)<br>4. Amending the system's operating rules (« soft » technology) | 5. Increasing the use of « grey » water, facilitated for example by the use of enhanced filtration systems (hard technology)<br>6. Reducing loss from distribution systems (hard technology)<br>7. Decentralised wastewater treatment (hard technology)<br>8. Seasonal forecasting (« soft » technology)<br>9. Water quality standards with a legal basis («soft technology »)<br>10. Water demand management (« soft » technology) |
| **Industrial and cooling of thermal power stations** | | 1. Use of lower quality water (« soft » technology) | 2. Increasing the efficiency of water use and its recycling (hard technology) |
| **Hydroelectricity** | | 11. Increasing reservoir capacity (hard technology) | 12. Increasing turbine efficiency (hard technology)<br>13. Encouraging energy efficiency (« soft » technology)<br>14. Energy demand management (« soft » technology) |
| **Navigation** | | 15. Constructing dams and tide gates (hard technology)<br>16. Alternative transport (hard technology) | 17. Changing vessel dimensions (hard technology) and frequency (« soft » technology) |
| **Curbing pollution** | | 18. Improving treatment systems (hard technology)<br>19. Reusing and revamping (hard technology) | 20. Reducing the volume of effluent to be treated (« soft » technology)<br>21. Promoting alternatives to the use of chemical products (« soft technology ») |
| **Flood management** | | • Increasing protection against floods, e.g. dykes, reservoirs (hard technology)<br>• Protecting and restoring wetlands (« soft » technology) | • Improving flood warnings and their circulation (« soft » technology)<br>• Controlling the development of flood plains (« soft » technology) |
| **Agriculture** | **Rain-fed** | • Improving soil conservation, e.g. nutrient replacement (hard technology)<br>• Improving forecasting (« soft » technology) | • Improving crop tolerance to drought (hard technology) |
| | **Irrigated** | A. Alternative ploughing practices (« soft » technology)<br>B. Rainwater collection (hard technology) | C. Increasing the efficiency of irrigation, e.g. localised irrigation (hard technology)<br>D. Changing irrigation water pricing (« soft » technology)<br>E. Improving crop tolerance to drought (hard technology)<br>F. Switching cropping plans (« soft » technology) |

(UNFCCC, 2006

using a procedure combining the views of an expert (based on interviews conducted with a group of national experts) with a study of the literature existing for each country. This approach presents certain limitations (small sample of people questioned, bias stemming from the type of document used...), hence the results of this exercise should be treated with caution and taken as essentially indicative.

The vast majority of technical measures available to managers predate climate change. Some of them, however, may be new in some countries and catchment basins, justifying giving consideration to a wide range of measures. Since most of these are already well-known from a technical point of view they will not be presented in detail hereafter. Discussion will focus instead on the extent to which they have been implemented.

### *Water stress and drought management measures*

The various water stress management measures were grouped into 2 categories:

- Adapting water demand,
- Increasing water supply.

As is shown by Figure 20 below, implementation of the various technical measures for managing water scarcity and the lack of water vary from one country to another. Marked asymmetry exists between EU and non-EU countries regarding the use of demand-side as compared with supply-side adaptation measures.

In most non-EU countries the preponderance of strategies intended to increase supply using conventional water can be clearly observed (construction of new dams, raising the height of existing installations, inter-basin transfers...). Morocco's 2030 National Water Strategy, for example, plans to continue tapping into fresh conventional water resources (1.7 billion m3) by constructing 59 large dams and a thousand small dams per year over the next twenty years. It also proposes transfers between water-surplus and water-deficient basins along a North-South axis to the tune of 800 Mm3 per year drawn from the Sebou and the Loukkos-Laou (State Secretariat for water and the environment, 2010).

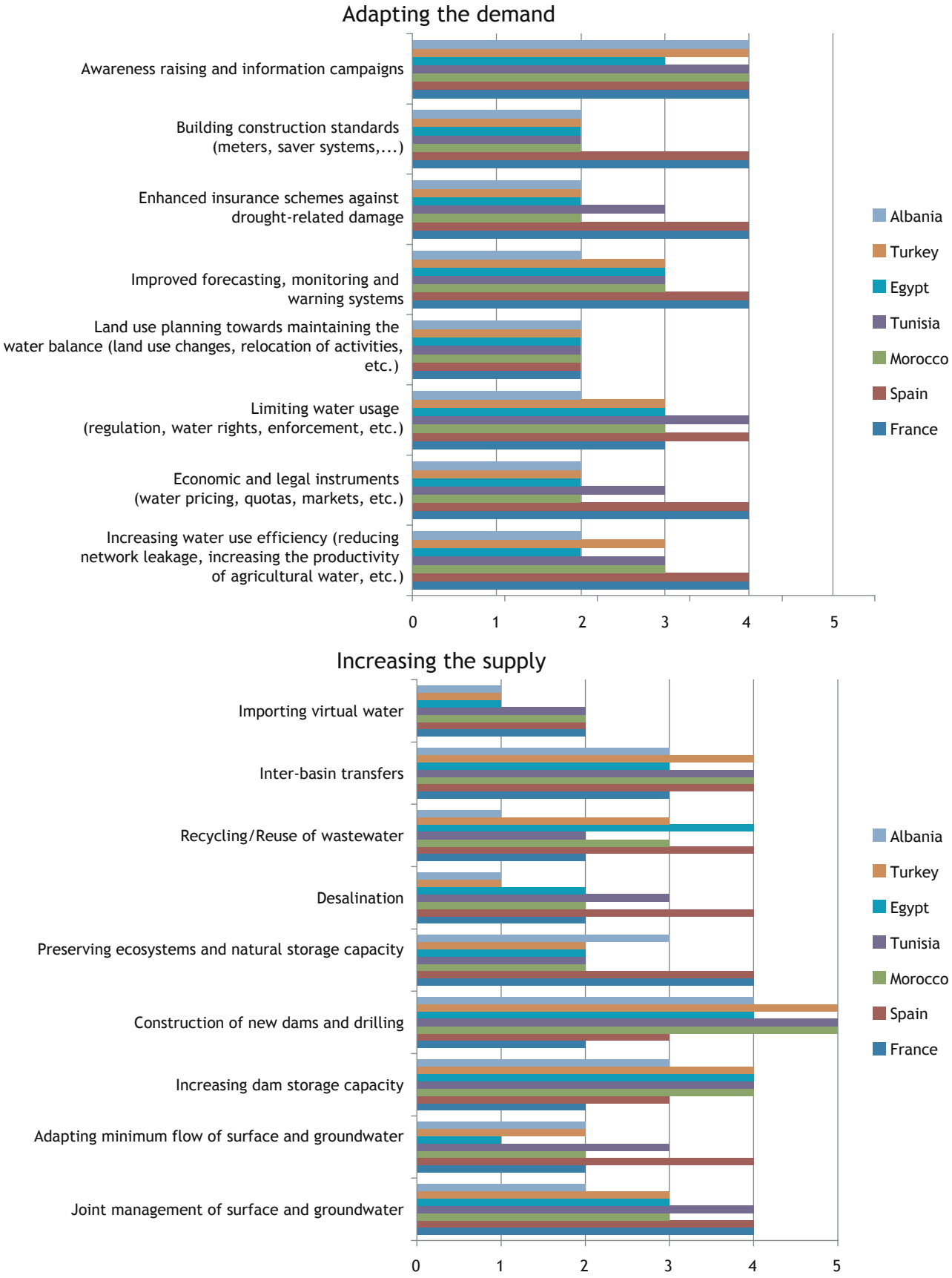
Over the next decades, however, exploitation of new renewable natural water resources in some countries will hit a physical limit (for example 95% mobilisation by 2016 in Tunisia), potentially triggering a structural imbalance between supply and demand. Moreover, with this type of strategy presenting a particularly high risk of maladaptation in view of expected trends in variability and average water conditions and the uncertainty surrounding them, its effectiveness should be questioned. The mobilisation of alternative resources and thrifty water management in particular is therefore brought into sharp focus.

As far as the mobilisation of non-conventional water is concerned, the analysis points to highly variable levels of development. The use of alternative techniques is a clearly established objective in the countries to the South and East, with the emphasis on increasing water production capacity through desalination and the reuse of treated wastewater. The use of other alternative techniques was not assessed. Rainfall collection, for example, still appears to be limited and tends to be reserved for very specific uses and contexts (small-scale irrigation in areas of rain-fed agriculture). Countries do not explicitly promote strategies or measures for the importation of virtual water, even though many countries are actually net importers of virtual water (Fernandez and Thivet, 2007). The Tunisian adaptation strategy is the only one to have adopted imports of virtual water as a long term flagship adaptation measure.

Developing conventional and alternative resources from desalination in particular may well prove to be a costly strategy in the long term and one which is harmful to the environment. Controlling the growth in demand and needs and seeking water savings in the agricultural and domestic as well as energy sectors may allow a certain volume of available water to be tapped into, which may compensate to an extent for the forecast deficit. Thus, before any new resources and infrastructure are developed, priority should be given to demand management and increased water use efficiency. Some headway has been made by the countries in this respect, but as far as non-EU states are concerned there is still plenty of scope for developing measures such as the drafting of efficiency standards, the introduction of insurance schemes, use of economic instruments or even boosting the efficiency of water supply networks and infrastructure.

As far as the adaptation of low flow targets and crisis thresholds for surface and groundwater is concerned, few countries have as yet started to move in this direction, possibly with the exception of Spain, which under its drought management plans and the WFD has defined thresholds and shortage management measures at national level. In the remaining countries, intervention on minimum flow has been identified, with some of them already working on the issue (particularly in France in the Adour-Garonne and Rhône-Mediterranean basins and Corsica, as well as in Turkey), although nothing is operational as yet. Implementation of this type

Figure 20 : Implementation of various measures for adapting to water stress and drought in the countries studied




(1 : Non-existent and not planned ; 2 : planned but not yet in place; 3 : currently being drawn up and/or implementation still limited ; 4 : in place and implementation advanced ; 5 : in place and implementation highly advanced)

of measure is a delicate matter for many countries, raising as it does the issue of water sharing between environmental and economic uses (agricultural in particular), triggering intense debate between users. Indeed, with even lower water levels and depending on the priorities set, target flows may be revised either upwards or downwards, with contrasting effects on the state of aquatic environments and water quality. In EU countries, the WFD's targets are forcing France and Spain to consider increasing low water flow. For the remaining countries, economic uses have clearly been given priority, and efforts to define minimum flows within a context of climate change are few and far between, particularly since methods for defining and monitoring these objectives have still not completely stabilised or become adapted to the local water context.

The analysis also suggests that countries with a sound and effective institutional framework more readily embrace demand management. Conversely, countries less advanced from an institutional and regulatory point of view would appear to lean more towards technical supply management measures. Technology thus appears to provide a more immediate solution to compensate for shortcomings within a context of sub-optimal governance of the sector.

Water savings and efficiency measures may, moreover, well prove inadequate in the medium and long term, given the current and forecast tension surrounding the resource. Water will have to be redistributed and better shared between uses and areas, particularly between agriculture and other economic activities. However, little headway appears to have been made to date on the implementation of this type of response, at least not outside one-off shortage situations (seasonal drought, for example, with the introduction of restrictions and reallocation in support of drinking water provision). Both the Tunisian and French strategies make explicit reference to this type of approach, but for the time being its political and economic cost would appear to be hampering its implementation within a context of major uncertainty as to how resources will evolve within the various zones.

Finally, the role of ecosystems as natural adaptation infrastructure for storing and regulating water transfers appears to have been given little consideration within non-EU countries.

### *Prevention and flood risk management measures*

Figure 21 sets out the results of the assessment conducted for this type of measure.

Infrastructural-type protection measures (dykes...) would appear to take precedence over preventive measures, particularly in non-EU countries. Very few flood risk prevention plans have been implemented in these countries, and little progress has been made in the development and application of measures to limit urbanisation in at-risk areas. Morocco is alone in having developed a pilot Risk Prevention Plan Approach, which it intends to generalise to all of its vulnerable areas under its National Flood Prevention Plan.

This is a problematic issue and shows just how inadequately risk management has been taken on board in urban planning documents and regulations. Moreover, adaptation targeting the longer term impact of climate change- through measures such as the strategic withdrawal of human settlements and activities located on the coastline in order to avoid the risk of submersion and coastal erosion- is still in the very early stages with the exception of France and Egypt, which has started to consider the subject in the Nile delta.

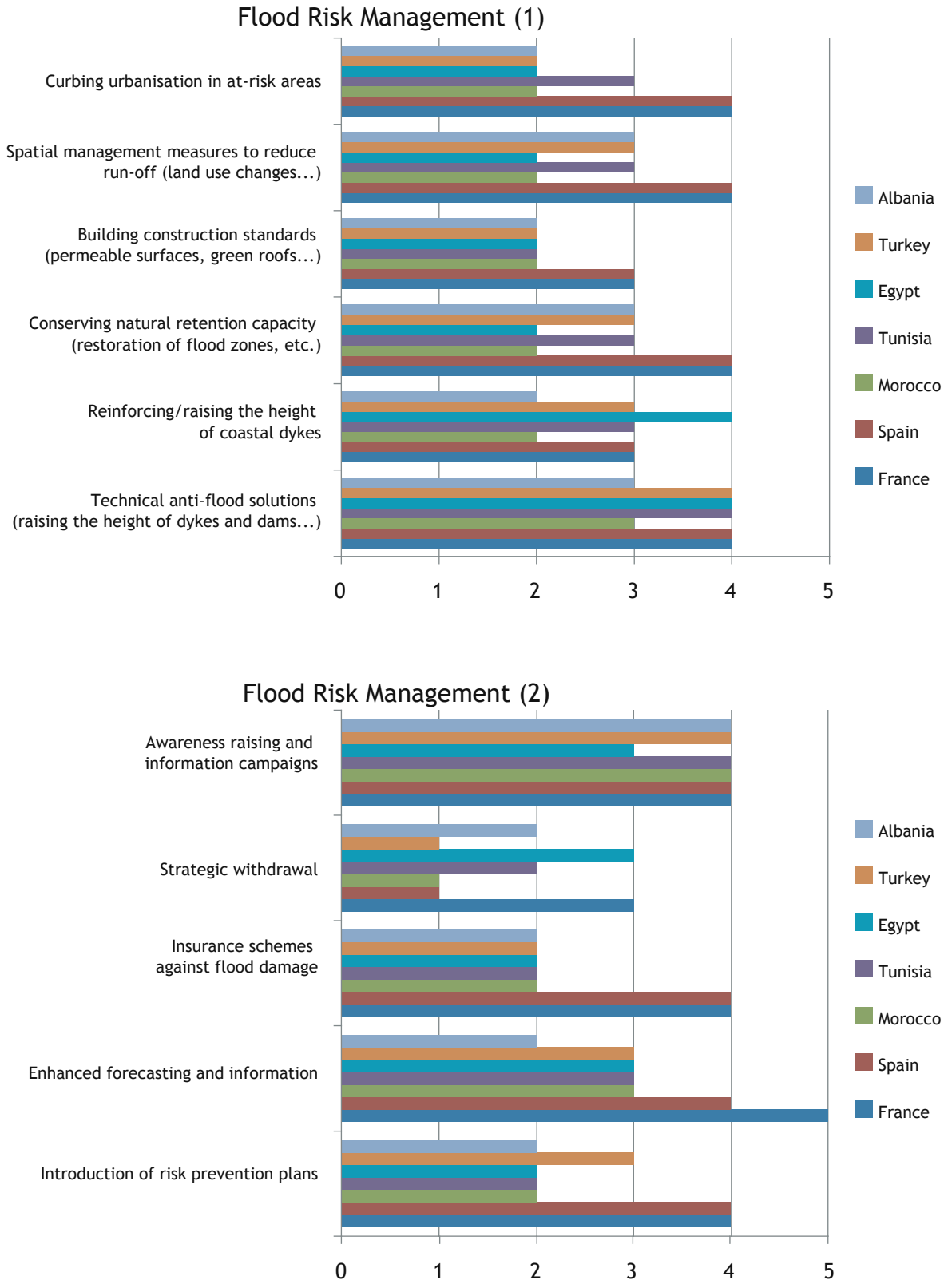
Countries are widely involved in improving monitoring, vigilance and warning tools, largely supported by international assistance and the WMO (numerous examples and projects in Morocco, Tunisia, Turkey and Albania).

Insurance schemes are still lacking and face several types of obstacle (see section 3.5).

On the other hand, public awareness raising and information efforts are being widely made across the sample.

As with water scarcity management, the role played by ecosystems and wetlands in reducing the flood risk has still not been widely enough recognised, particularly within non-EU countries. Approaches aimed at accommodating the natural elements rather than striving to protect against them using «hard» protective techniques have proven their limits from both an environmental and a financial point of view, regardless of climate change. Few programmes for the restoration and conservation of this "natural infrastructure" are actually implemented with a view to adaptation. It is high time that the role played by ecosystems as climate "shock absorbers" was taken into account and this dimension taken fully on board within adaptation and natural disaster prevention policy.

Figure 21 : Implementation of the various measures for adapting to the risk of flooding in the countries studied




(1 : Non-existent and not planned ; 2 : planned but not yet in place; 3 : currently being drawn up and/or implementation still limited ; 4 : in place and implementation advanced ; 5 : in place and implementation highly advanced)

Table 6: Typology of the extent to which adaptation is taken into account in the water sector

| Stages | Extent to which adaptation is taken into account | Country |
|---|---|---|
| 1 | • The need for adaptation is recognised by a group of pioneers within the sector<br>• There are few studies on the impact of climate change or adapting to such change<br>• Whilst certain adaptation measures have been identified, they have still not been implemented<br>• Predominance of conventional water management policies and practices, no tangible signs of reform towards adaptation | |
| 2 | • Stakeholders in the sector recognise to an extent the need to adapt water policy; awareness starting to emerge at political level<br>• Knowledge about the impact of climate change on resources and uses is essentially indicative and mainly at national level<br>• Certain adaptation measures have been defined and projects designed for implementation; some are underway<br>• Predominance of conventional water management policies and practices, some encouraging signs towards adaptation | **Albania**<br>**Egypt**<br>**Morocco**<br>**Turkey**<br>**Tunisia**<br>**Spain**<br>**France** |
| 3 | • Existence of marked political will and commitment to adaptation in the water sector<br>• Sound awareness of the impact of climate change, given the uncertainty<br>• Adaptation measures have been defined and provisions made for implementing them; some of them are already underway in priority areas<br>• Some notable progress has been made regarding the development of water management policies and practices | |
| 4 | • In-depth and territorialised assessments of climatic impact and risks are available<br>• The impact of climate change and the means for adapting thereto are systematically taken into account in water-related planning and decision-taking processes<br>• Adaptation strategies and action plans have been drawn up at all levels of water management; their inclusion in national and local water policies is underway<br>• Adaptation measures are being implemented in all priority areas and water management policies and practices are being seriously overhauled<br>• Inter-sectoral cooperation on adaptation measures is being introduced | |
| 5 | • Adaptation strategies and action plans are available and operational at all levels of water management<br>• Adaptation objectives, principles, instruments and measures are sustainably integrated in the political, institutional and legal frameworks<br>• A sound monitoring and assessment process has been set up in order to evaluate progress made on each of the measures and to regularly update the objectives pursued<br>• Inter-sectoral cooperation and adaptation governance are fully established and functional | |

(Source : adapted from the Finnish Ministry of Agriculture and Forests, 2009)

## Trial typology according to the extent to which adaptation is taken into account

On the basis of what has just been said, the following typology may be proposed in order to reflect the extent to which adaptation is taken into account and rendered operational in the water sector (Table 6). The countries included in the study are as a whole at stage n°2 as described below.

## Conclusions

Adaptation to climate change in the Mediterranean appears to be an emerging water management issue, but one which has so far not seen much operational rollout, despite limited breakthroughs mainly in EU member states. The countries studied are basically at the stage of improving their knowledge of hydrological impact and identifying appropriate adaptation measures. Apart from a handful of pilot projects and experiments mainly with the backing of international cooperation, in most countries the impact of climate change is still not being factored into water management policies and practices.

The types of response being proposed essentially relate to "no regret" measures or fall under a "catch-up" approach. They support the objective of reducing current pressure on water and its vulnerability, which even without the effect of climate change is already deemed to be problematic. Decision makers still lay little store by the management of climate uncertainty and its implications for decision-making in the water sector. This state of affairs harbours the serious risk of "maladaptation" given the region's marked vulnerability to the impact of climate change on water demand, resources and flow.

So what leverage can be brought to bear in order to remove the obstacles hampering the development of adaptation to climate change policies in the water sector in the Mediterranean, particularly in the southern and eastern rim countries? In this connection it is important to recall several crucial points.

*All too often, the risks relating to climate change still tend to be perceived as purely long term problems,* particularly in view of food and energy security issues and economic development, which largely determine current water strategies. The relations between climate and development issues in these countries will need to be better portrayed and quantified if adaptation to climate change is to be encouraged.

*Inter-sectoral cooperation on adaptation still does not go far enough.* Adaptation strategies tend to be drafted by Environmental Departments, which, albeit highly involved in UNFCCC negotiations, in most cases are not directly responsible for water. Institutional "power relations" often pan out in favour of administrations responsible for water, which tend to be recalcitrant about embracing a process outside their prerogatives and remit. Moreover, where inter-sectoral coordination tools do actually exist, they are still struggling to play the role of a catalyst and promoter of adaptation in the various sectors...

*There is little involvement of the local level and water stakeholders:* despite the development of the IWRM concept and catchment basin-level management, water management and administration remains largely centralised in the Mediterranean countries (with the exception of Spain and France). This type of model limits possibilities for designing and experimenting with more subsidiary management approaches at catchment basin or local area level, where new approaches can be tested whilst keeping transaction costs down and subsequently constituting a lever for extension to national level. The fact that adaptation is by essence a contextual process makes territorial water governance based on local institutions with beefed-up powers and on full user participation even more pressing and essential.

*Financial, technical and human capacities fail to match up to the issues at stake.* The water sector is already facing a certain number of structural constraints (organisational, know-how, financial, knowledge...), which seriously cramp its performance and reduce its capacity to adapt to future change. Funding for adaptation therefore competes with other short and medium term issues. Efforts to cooperate towards upgrading the sector therefore need to be cranked up in order to take the additional cost of adaptation on board.

*Current water management and policies do not adequately take on board the spatial and temporal uncertainty relating to climate and hydrological developments.* They rely on "command and control" approaches based on the hypothesis of climate and water cycle stability. Managing uncertainty requires a change of paradigm and the promotion of appropriate decision-taking tools and methods for uncertain situations (switch from a deterministic to a probabilistic approach, greater expert and stakeholder participation, application of adaptive management principles, combination of preventive and precautionary regimes in shaping collective decisions, etc.).

*The efficiency and robustness of existing institutional mechanisms and techniques are widely trusted to cope with future change* : the "bit more of the same" approach, which consists of believing that with a

little tweaking here and there the systems already in place will manage to stand up to future climate change and shocks is relatively widespread amongst water administrators. In the short term, this type of approach looks acceptable and even desirable given the increased variability and uncertainty about the climate signal which will mark decades to come. Within this context, priority should be given to no regret measures seeking to make the water sector less vulnerable to a set of current pressures (including to variability and hydrological extremes). In the medium and long term, however, the risk of maladaptation is inherent to this type of approach. This is the case, for example, with the construction of new dams for 3 and even 5 year inter-annual regulation purposes. If alternative approaches are to be promoted it is crucial that the cost of maladaptation should be quantified and decision making improved in the face of uncertainty.

*Priority lies with "hard solutions",* to the detriment of non-structural responses such as legal and economic instruments and the role of "natural infrastructure", which can be played by ecosystems and the services they provide. In order for these non-structural responses to be promoted, their efficiency compared with that of structural ones would have to be assessed under an uncertain future.

## Conclusions and recommendations

Several recommendations emerge at the end of this study.

The uncertainty surrounding impact and risk assessment should not be seen as hampering action. On the contrary, it should encourage the emergence of a dual approach : "no regret" action and adaptation as such.

Climate change is bolstering the need for reform in the water sector which the Mediterranean Action Plan (MAP) has been promoting for fifteen years or so in terms of managing the imbalance between supply and demand, water and river network quality degradation and even the vulnerability of goods and persons to flooding. Such reforms amount to "no regret" actions and constitute a preliminary to adaptation policy.

Adaptation also requires innovation in order to shape alternative futures in the water sector, which will enhance the management of a non-stable climate and uncertainty. Promotion of such innovation towards its inclusion on the regional political agenda for adaptation to climate change may be achieved by circulating and implementing messages developed within international fora: Recommendations from the 5th World Water Forum[1], Roadmap for the Mediterranean contribution to the 5th WWF[2], Nairobi Principles on Water and Climate[3], Guidelines from the United Nations Economic Commission for Europe (UNECE)[4], the International Union for the Conservation of Nature's (IUCN) resilience framework[5], the Alliance for water and climate's contribution to the UNFCCC[6], etc. Some of the thrust of sectoral agricultural or water policies will also need to be revisited.

What is at stake is the switch from a reactive attitude to crisis to a proactive one, drawing on a battery of tools including: impact modelling, vulnerability assessment, prospective analysis tools, strategic environmental assessment... In this respect, the development of hydro-climatic products and services targeting the needs of planners and managers is a priority, although the limits of these tools must also always be borne in mind.

The risk of maladaptation in the water field can be avoided through the development and promotion of uncertainty management tools for decision-making on investment and development matters. This will involve:

a) Setting up and consolidating expert bodies and debate fora on uncertainty management,

b) Improving communication and consultation regarding risk and uncertainty,

c) Allocating means for the development of methods and tools for making decisions in an uncertain environment, particularly as far as economic calculations are concerned ("Robust Decision Making"; Wilby and Dessai, 2010)

d) Promoting manager training in these new approaches.

It is important that the efficiency of alternatives to core, investment-heavy solutions should be investigated, such as institutional ones (standards, regulation), economic ones (insurance, taxes, pricing...) and natural infrastructure (services rendered by ecosystems).

1. http://content.worldwaterforum5.org/files/PoliticalProcess/Istanbul%20Water%20Guide.pdf

2. http://content.worldwaterforum5.org/files/RegionalDocuments/Mediterranean%20regional%20document.pdf

3. http://www.landwaterdialogue.um.dk/node/211

4. http://www.unece.org/env/water/publications/documents/Guidance_water_climate.pdf

5. http://cmsdata.iucn.org/downloads/water_and_climate_change_adaptation_briefing_1.pdf

6. http://www.waterclimatecoalition.org/index.php/activities/170-consultation-activities-towardscop15-building-the-case.html

A comparative assessment of the cost of adaptation at a late or early stage should also be promoted, linked in particular to rational anticipation, the choice of "no regret" measures, making up for adaptation shortfalls, retargeting public and private investment, the progressiveness, flexibility and reversibility of action, use of the precautionary principle, etc. An assessment of the cost of gradual and adaptive management taking account of the capacity of management systems to react and of progress in scientific knowledge will also be necessary.

Efforts to mainstream the adaptation of water management must also go hand in hand with a change in attitude aimed at taking a cross-cutting, integrated approach to water management and making it the focus of the various sectoral adaptation policies (tourism, agriculture, health, etc.), since water is the main vector in the Mediterranean through which the impact of climate change will be felt by people and socio-economic sectors. In other words, by guaranteeing water security, the adaptation of water management helps consolidate the resilience of Mediterranean economies and societies as a whole to a changing climate.

If this is to be achieved, new modes of governance will need to be designed, tested and promoted at all levels of decision making. Similarly, territorial prospective analysis exercises could be conducted in order to encourage integrated, subsidiary approaches and their promotion at regional level.

Finally, regional cooperation has a key role to play in:

- Drawing on and developing research on modelling, the sharing and circulation of information and data: hydro-meteorological observation, seasonal forecasting, the setting up of rapid alert systems on risk and the circulation of warnings...;
- Coordination particularly regarding the organisation of regional solidarity in case of major crisis, drumming up the funding required for adaptation, information sharing and the development of regional climate services, addressing transboundary issues and strategic consideration of better use of resources at basin level;
- Capacity building and the sharing of experience, tools and technology towards resilient resource and risk management;
- Networking and the pooling of expertise in order to facilitate the drawing up of public adaptation policies and support for them.

# Annex : Analysis and Benchmarking Grid

## Context and objective

Establishing an inventory of adaptation to climate change within the Mediterranean water sector is a complex matter, mainly because of the variety of national situations, the heterogeneous nature of data available and the widely scattered sources of information.

What is proposed here is the construction of a reference framework and analysis grid common to all the countries studied, which pursues the following objectives:

- Helping to rapidly establish an inventory of national adaptation systems in the water sector in order to identify their strengths and weaknesses as well as scope for progress;
- Proposing a standard assessment nomenclature for the various countries studied, based on a reference framework ("platform"), the aim being to highlight common points and divergence whilst allowing information to be pooled and a regional level typology to be established;
- Taking a "snapshot" and comparing the state of play within the different countries in terms of the various axes in the reference framework, following a benchmarking approach.

This type of tool is also relevant in that it manages to combine various sources of information by calling up information gleaned from experts as well as information from work, studies and research conducted in the region. In the long term, this approach may be instrumental in documenting the situation at regional level and facilitating the creation of dialogue between regional players about the strengths and weaknesses of adaptation policy in the water sector at national level as well as the type of action to be taken.

The framework presented below is clearly a first attempt and makes no claim to be either exhaustive or final. It is first and foremost a pilot approach which could be tried out and furthered by the Plan Bleu and its partners in order to render it more efficient and useful.

## Reference framework

The effects of global warming on hydrology in the Mediterranean countries are leading to the emergence of several environmental, social and economic challenges and require a global, integrated response from States and managers. Dwindling resources, greater variability and hydro-meteorological extremes, rising uncertainty and heightened risk of competition for resources between the most vulnerable areas and sectors argue in favour of a systemic approach to the problem, which sees adaptation first and foremost as an issue relating to development and society going well beyond the water sector alone, rather than as a purely environmental or technical matter.

Within this context, the concept of adaptive water resource management provides a relevant theoretical and operational framework for addressing the impact of climate change on water resources. Applied to the water sector, adaptive management requires a structural transformation process in order to develop the ability and capacity to adapt to change, which is still difficult to predict and qualify with any degree of certainty. It must draw on a range of responses and complementary levers for action in fields as varied as research and development on the modelling and forecasting of the impact of climate change on water, planning and resource allocation methods, climate information management (production and end use), the development of climate-compatible water technology and infrastructure (as, for example, the global management of surface and groundwater, wastewater recycling, use of rainwater...), the shaping of economic and financial instruments (insurance, subsidy mechanisms, pricing policy...), or even in terms of legal and institutional reform (revision of legislative policy and framework, institutional governance, decision making processes...).

For Mediterranean countries, this will involve creating and developing adaptation capacity in these different fields in order to construct a genuine "adaptation system[1]", which in the long term is able to ensure the coherence, effectiveness and permanence of the approach and resilience measures applied in the water sector.

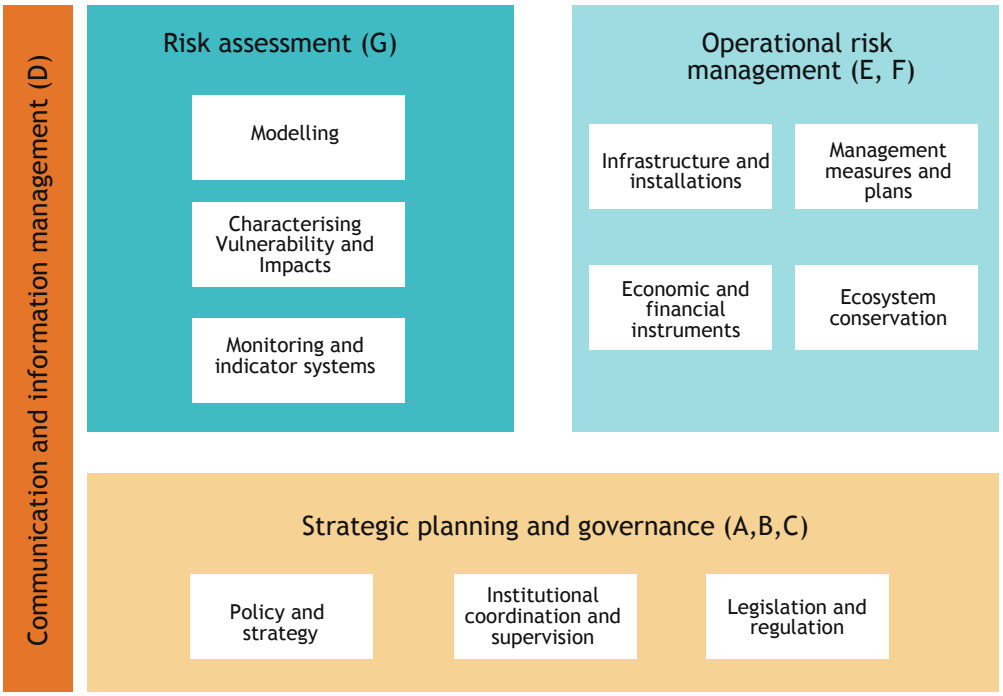
This type of ''adaptive system'' is based on technical and non-technical institutional procedures, rules and structures which, whilst assuming various guises depending on the national context, form a set of basic functions which countries will be required to implement jointly if they wish to effectively adapt to the new hydro-climatic conditions and forestall water-related crises.

For the aims of the study, a typology based on 6 main categories of functions is proposed (Figure 22):

1. World ressources Institute. *The National Capacity Framework : Key Institutional Functions for a Changing Climate.* November 2009

- Planning and strategic guidance function (political and strategic framework): public strategic and political adaptation vision; setting of priorities and objectives at national level using strategies, plans and programmes, etc.
- Coordination and supervisory function (institutional framework and governance): sharing of powers and competence between the various stakeholders (State services, regulatory bodies, authorities, private operators, civil society organisations, etc.) and the different levels of governance; type of decision-making and coordination; public consultation and participation procedures, etc.
- Regulation and control function (legislative and regulatory framework) : type of national, local and international legislation and regulation governing water management and adaptation practices, including transboundary agreements and treaties;
- Surveillance, information and knowledge management function: tools and mechanisms for observing, monitoring, forecasting and warning about the state of the resource and the impact of climate change; etc.
- Financing and incentive to adapt function (economic instruments) : pricing systems; tax and financial instruments; public-private partnerships;
- Operational management function for the risks relating to climate change (technical adaptation action and measures) : management plans for water and extreme events (floods, drought); infrastructure development and management, action to reduce water demand, development of alternative techniques, construction of physical protective measures, etc.
- Assessment function for the impact of climate change and associated socio-economic risks: state of knowledge regarding vulnerability and risks to resources and uses and associated costs; modelling and assessment capacity for processes and impact; methods to assist risk and uncertainty assessment;

Figure 22 : Functional diagram of an “adaptation system” for the water sector



## Analysis grid

For each of the 6 functional axes chosen, a series of criteria have been proposed by way of a check-list of key adaptation elements, which can be used to assess the state of play in the various countries studied. These criteria are presented hereafter in the form of evaluative questions or, in the case of function F, as a list of technical adaptation measures. The analyses grid is not presented in this report but it can be obtained asking Plan Bleu. The criteria and measures used here are partly based on those developed by the United Nations Economic Commission for Europe as part of a questionnaire-based survey conducted in 2009 with the aim of drawing up the Methodological Guide to Water and Adaptation published in 2010 (http://www.unece.org/env/water/water_climate_activ.htm).

Given the time constraints, these are not intended to be exhaustive, and have opted to address a limited number of aspects. The intention is therefore to add to and refine both the list and the quality of the criteria.

The various criteria may be filled in for each country using a scoring method from 1 - 5, which in a semi-qualitative way will reflect how far the country has progressed and plot it in terms of the various axes and elements in the reference framework. The scores obtained either through a survey or from experts' comments, will provide an indication of existing capacity and the level of preparedness of each country regarding the adaptation of water management. The scores obtained for each of the criteria can then be aggregated (with or without weighting) in order to reach an average score for each functional axis. The results may be plotted on a graph in order to facilitate comparison between countries for the purpose of regional benchmarking.

# Glossary

| | |
|---|---|
| DRIAS | Project entitled « Donner accès aux scénarios climatiques Régionalisés français pour l'Impact et l'Adaptation de nos Sociétés et environnements (France) |
| EU | European Union |
| FFEM | French Fund for the Global Environment (Fonds français pour l'environnement mondial) |
| GEF | Global Environment Fund |
| GHG | GreenHouse Gas |
| IDDRI | Institute for sustainable development and international relations (Institut du développement durable et des relations internationales) |
| IPCC | Intergovernmental Panel on Climate Change |
| IUCN | International Union for the Conservation of Nature |
| IWRM | Integrated Water Resources Management |
| MEEDDM/MEDDTL | Ministry of ecology and sustainable development (France) |
| NAP | National Adaptation Plan |
| NAS | National Adaptation Strategy |
| NBI | Nile Basin Initiative |
| PCET | Territorial Climate-Energy Plan (France) |
| PES | Payments for Ecosystem Services |
| RTW | Reuse of Treated Wastewater |
| SEMCs | Southern and Eastern Mediterranean Countries |
| SRCAE | Regional Climate-Air-Energy Scheme (France) |
| UNDP | United Nations Development Programme |
| UNECE | United Nations Economic Commission for Europe |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| WFD | European Union's Water Framework Directive |
| WMO | World Meteorological Organisation |
| WRI | World Resources Institute |

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