WATER, WETLANDS AND CLIMATE CHANGE

Building Linkages for their Integrated Management

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Mediterranean Water Resources Planning and Climate Change Adaptation

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Preface

The Global Water Partnership (GWP), the Dialogue on Water and Climate Change, and IUCN - The World Conservation Union, have joined forces to facilitate an exchange of views on the common challenges faced by Mediterranean societies in adapting to climate change.

Scientific consensus is that climate change will have a pervasive influence on the future demand, supply and quality of fresh water resources in the Mediterranean, and add pressure to water and environment resources, and coastal systems in the region currently under stress. All sectors of the economy, environment and society may be vulnerable to one degree or another, to greater hydrological variability, more frequent flood and drought extremes, and to the longer-term effects of gradual mean temperature and sea level rise.

Under Article 4 of the UN Framework Convention on Climate Change (UNFCCC-1992), it was agreed that all Parties would develop short, medium, and long-term strategies for climate change mitigation and adaptation in a phased manner, taking into account the different socio-economic contexts. A number of Mediterranean countries have already taken preliminary steps to identify strategies and integrate responses to climate change in their current water resource management policies and activities. Other counties have yet to initiate processes to enable steps to moderate significant vulnerabilities, or to benefit from the opportunities associated with climate change.

This document is one of twelve country base-line studies and thematic papers prepared as background material for a Roundtable meeting in Athens, Greece in December 2002 on the linkages between climate change, water and wetlands resource management in the Mediterranean region. While the primary aim is to exchange views, perspectives and experience on possible directions and priorities for climate change adaptation planning, the discussion would also explore opportunities to enhance synergy in responses to the UNFCCC and Ramsar Conventions.

Eight country base-line studies were prepared for:

- Cyprus
- France
- Greece
- Italy
- Morocco
- Spain
- Tunisia
- Turkey

The four crosscutting thematic papers are:

- Mediterranean Water Resource Planning and Climate Change Adaptation
- National Approaches to Drought Preparation in the Mediterranean
- Adaptation Strategies for Improved Flood Management in the Mediterranean
- Biophysical and Socio-Economic Impacts of Climate Change on Water and Wetlands in the Mediterranean

Electronic copies of the reports and papers noted above may be downloaded from the web page of The IUCN Centre for Mediterranean Cooperation at www.uicnmed.org. Project funding for this initiative was provided by the Global Dialogue on Water and Climate Change. The IUCN Centre for Mediterranean Cooperation receives core funding from the Spanish Ministry for Environment and the Junta of Andalucia.

Summary

Over the past decade, climate change has emerged as a major global and regional development issue alongside sustainable development, environment conservation and biodiversity protection. Water is a common denominator. In fact, current thinking is to view responses to climate change as an integral part of decision-making on sustainable water resources management (e.g. concerning land-water-environment interactions). Responses to climate change would also be integrated with national economic, social and regional development planning, and harmonized with other resource and environmental management activities at both policy and practical levels.

Since ratification of the UNFCCC (1992), which called for all Parties to implement measures for both mitigation and adaptation to climate change, the National Communications of Annex 1 and non-Annex developing countries from the Mediterranean, as elsewhere, have largely focused on GHG emission reduction measures. The mitigation actions will be reinforced by the commitments made under the Kyoto Protocol (1995) – though Kyoto itself is yet to be ratified. However, as provided for under Article 4 of the UNFCCC, attention is now shifting to adaptation. Here, most scientists now agree that climate change is inevitable and that we are probably in the early stages of more accelerated change. Thus instead of being a secondary, longer-term consideration, "planned" adaptation requires more immediate attention. This concern was reflected in the recent Ministerial Declaration from the Conference of Parties to the UNFCCC (COP-8) held in New Delhi (Nov 2002).

IPCC's Third Assessment Report (2001) provides a comprehensive assessment of climate change impacts, vulnerability and adaptation using global and cross-regional scale climate models. Though the science, and thinking that it embodies is constantly evolving, it sketched out a broad framework for undertaking impact and vulnerability assessments, and identified generic adaptation measures (e.g. policy, technology and institutional responses) appropriate in different regions, situations and sectors of the economy. By analogy, the IPCC work provides directional guidance for how Mediterranean countries may proceed in this area. The UNFCCC Secretariat has also prepared generic guidelines for National Adaptation Programmes of Action (NAPAs), which the COP-7 (2001) adopted, though as yet, only a few counties have started to prepare NAPAs.

In the Mediterranean, it is recognized that measures are needed both to improve the capacity to adjust to today's hydrological variability and extremes (floods and droughts) in dynamic circumstances (e.g. with current demographic, economic, land-use and regional development pressures), and to reduce the significant vulnerabilities of society, the economy and the environment to future effects on the horizon. In the Mediterranean context also, adaptation means that special effort is needed to help the poorest communities or groups in the region, who typically have limited resources, less capacity to adapt, and are consequently the most vulnerable of all in society.

This paper examines some implications of climate change for water resource planning in the Mediterranean and steps to produce adaptation plans. It is presented in three parts:

Part 1: Climate change: influences on water resource systems and their management
Part 2: Climate sensitive water resource planning approaches and methods
Part 3: Climate adaptation in the water resources sector- toward a framework

The first part profiles the current Mediterranean water resource situation and highlights the projected first-order impacts of climate change on hydrological systems in the region, and second-order impacts on water-dependent sectors, such as irrigation and water supply. Adaptation planning is then placed in the context of overall water resource planning. Here it is simply argued that Agenda 21 (1992), and the Dublin Principles (1992) and integrated water management (IWRM) approaches, provide the wider conceptual framework for adaptation planning. Moreover, adaptation planning processes, and plans – that are necessary as discrete, separate activities initially to help focus attention and mobilize public debate and consensus on adaptation measures - would not be seen in isolation, but rather

integrated with, and inform existing water resource planning and management activities. In the Mediterranean this often means EU Water Framework Directives which are binding on EU countries and inspirational for others in the region. Investing in adaptation to climate change would essentially be the same as investing in sustainable development – with high social and economic returns.

The second part of the paper looks more closely at a selection of seven water resource planning issues, tools and methodologies. It shows how these need to be systematically reviewed in light of climate change, and revised accordingly. In fact, resources managers in the Mediterranean increasingly recognize that the region's water resource systems have been largely planned, designed, and are today managed on the basis of past hydrological conditions. Because of this, the "re-tooling" of planning procedures, and the re-planning and adjustment the water resource system may become a defining feature of water resource planning in coming years. Certainly, many infrastructure components (from dams and flood control structures to urban stormwater systems) need to be adapted initially, and thereafter on a dynamic basis. Risk assessments and life-cycle analysis approaches, for example, would enable planners to better account for increased uncertainty, and cope with unforeseen issues that may arise such as critical thresholds for responses to climate change and non-linear responses in interdependent human and natural systems.

The third section of the paper considers some wider issues and steps to establish national adaptation planning processes, and those more specifically for water resources. This reflects the guidance provided by the IPCC and UNFCCC Secretariat, as well as insights from work by Mediterranean countries and European Union countries on this theme.

- ***Adaptation may require departures from conventional water resource planning practices***

Broadly, adaptation would be a continuous process, where complementary elements of an effective water resources management system would be developed and strengthened concurrently. This may involve small adjustments, evolutionary changes, or more radical reorientations in current water resource planning practices. For instance, depending on progress already made incorporating IWRM approaches in planning systems, the steps might include: more clearly separating responsibilities for overall water resource planning (e.g. concerned with water availability, quality, access and allocation) from sector-specific service delivery activities; moving from supply to demand-oriented planning in service provision; shifting from reactive to anticipatory planning; using participatory approaches and applying the subsidiary principle (the institutional principle of the Dublin Principles) that involves taking decisions at the lowest appropriate level; and, broadly becoming more strategic, interactive, innovative and dynamic in developing solutions to water problems.

- ***Strategic Orientations: building "climate headroom" into water resource systems and their management to improve adaptation capacity***

A major strategic aim in adaptation is to increase the flexibility in the water resources system and how it is managed. This would create flexibility for societies to manage risks, and avoid the more painful social, economic and environmental dislocations that result when sudden changes in direction are forced upon them. Three broader strategic orientations or strategies to achieve this are: (1) reducing the risk associated with hydrological variability and to extreme events; (2) closing the demand-supply gap in water resources; and, (3) balancing human and nature needs.

The relative emphasis placed on each strategy and the interactive mix of measures (policy, institutional, non-structural and structural) for each strategy would be determined by assessing vulnerabilities in relation to current management practice and scenarios for climate change. The table below illustrates the type of measures that might be associated with each strategy.

Strategies and Measures to Build in "climate headroom" into water resource systems and their management	
Strategies and Strategic Orientations	**Representative Responses / Measures**
Reducing the risk to hydrological variability, and extreme events	• Reinforcing/introducing flood and drought preparedness programmes • Retrofit existing infrastructure for safety and performance in more variable and extreme conditions (e.g. enlarging or lowering dam spillways; removal / setback/ raising of flood embankments); • decision-support systems to optimise operations of water infrastructure (e.g. reservoir operating strategies in advance of floods and in drought cycles); • catchment management to improve water retention and infiltration, regulate intensified runoff, reduce erosion (more frequent storms, torrential downpours); • Sustainable management of urban stormwater (e.g. steps to increase infiltration and increase the capacity of storm water systems).
Closing the demand-supply gap in water resources	• Adjusting water allocation policies to higher value uses; • Introducing greater flexibility to allocate between competing demands and matching water quality with demand: • Balancing demand-supply for off-steam water uses with: - Demand side measures (end-use technologies, recycling and conservation) - Supply side measures (conventional and non-conventional sources) • Optimising existing water regulation infrastructure (operations and retrofit) to most efficient uses and ongoing changes in water allocation priorities; • Conjunctive use surface and ground water and their management.
Balancing human And nature needs	• Introducing policies that recognize environment needs in water allocation; • Continuous update of water quality (surface and ground water) linked to hydraulic variability (river flow conditions and current pollution levels); • Recognizing and sustaining ecological services from rivers and wetlands (e.g. for ground water recharge and water purification); • Adapting minimum environmental flow provisions (surface and groundwater) to the hydroperiod of wetlands.

- ***Mediterranean countries face common challenges adapting water resource systems to climate change; these are greatest where the demand-supply gap is increasing and deeper structural changes in demand will be needed***

In all Mediterranean countries there is a common need to adjust to variability and extremes and balance human and nature needs. For example, all countries need to invest in more and better hydrometric monitoring and warning systems, and link these with planning measures and operating strategies for infrastructure (e.g. updating hazard classifications and land zoning, drought indexing and operating strategies of reservoirs). There is also a common need to prepare for gradual sea level rise and the effects it will have along the 46,000 km of rapidly developing coastal zones of the Mediterranean Sea, by creating incentives or requirements to move people and structures out of vulnerable areas (e.g. defend, or phased strategic retreat, eliminating maladaptive practices).

The urgency to focus the demand-supply gap closing measures is clearly greatest in countries, or basins, where water demand now exceeds or threatens to outstrip sustainable levels of supply, and traditional supply strategies alone can no longer physically meet growing needs. This will require much greater attention to water allocation policies and measures to increase the flexibility of the system to physically allocate water to different uses. And much more effective use of pricing and other economic instruments for demand management and recycling of water to relieve pressure on systems, and reduce economic loss while longer-term structural shifts in demand and use of non-conventional supply technologies are achieved. Here, supply measures are likely to be more costly than demand-side measures, even before environmental impacts (market and non-market factors) are taken into account.

However, beyond demand management, more innovative policies and philosophies toward water use would be needed for systems at their hydrological limits. This would include: strategically rethinking the matching water quality to end-use demands; sequencing of water withdrawals in the basin to optimise recycling and water quality; and managing the interaction of surface and ground water resources for optimal storage, also taking into account increased evaporative losses in hotter, dryer climates. More fundamental transformations in how water is viewed in development decisions would also be needed. For example, water supply would have to become an explicit factor in all major land use, regional development, and industrial and municipal development decisions, or provisions made for non-conventional supply to be factored into the development costs.

- ***National processes would provide directional guidance for sector-based measures***

It is now widely accepted that a national process and plan is needed to coordinate responses to climate change across sectors, and to harmonize planning in the different sub-sectors, and at different levels of water resource management. In fact, there may be a hierarchy of plans (or guidance papers, procedures, etc.) at the national, sectoral, basin and municipal or local levels that correspond to how the various responsibilities for planning and decision-making on water resource management are allocated within the country.

The UNFCCC/IPCC nevertheless stress that cost-effective strategies and measures for adaptation must be identified and implemented nationally and locally, engaging policy-makers and resource managers at all levels of government, and involving water users, the private sector, civil society and non-government organizations. This would be best achieved in overlapping "top down" and "bottom up" processes. The strategies and measures need to take into account important social and economic implications, and would be implemented on a stage-by-stage basis, in a priorized way.

- ***While measures would be needed on a number of fronts, Low-Cost or "Least Regrets" Measures are important starting point***

Adaptation measures that would improve the performance of water resource systems in today's climate conditions, whose further delay could increase vulnerability, or lead to increased costs at a later stage, are sometimes referred to as "win-win", or "least-regret" measures. They would be effective and sensible as resource management measures and have high social and economic returns, even in the absence of significant climate change effects. These are illustrated in the table that follows. Generally, these are regarded as an important starting point.

- ***Institutional Mechanisms are In Place for Initial Stages of Adaptation Planning***

In most Mediterranean countries institutional coordination mechanisms are already in place for climate mitigation planning, and these can be used in the initial stages of national adaptation planning. These include the focal points for UNFCCC or IPCC responses and Ramsar, as well as interdepartmental panels or groups, and income cases Commissions that governments have established to study and coordinate responses to these issues. Here the means of identifying and implementing measures in actions programmes would be based on principles of dialogue and partnership between government, business, civil society and water users at all three levels. The business as usual approaches will not be adequate, as the future will be unlike the past.

The larger issue is that climate change is a reality. The longer that adaptation is left unattended, the more costly and disruptive it will be for society and the environment to make the necessary adjustments.

Representative "Least Regret" Measures – Water Resources Sector

Cost Aspects	Representative Measures
Low-cost Measures	**Adapting to hydrological variability and extreme events** - Flood zoning, land use controls discouraging development in high-risk areas; - Optimising operation of reservoirs for flood responses in conjunction with flood warning systems; - Introduction of climate change considerations in infrastructure design standards (safety and flexible performance)
	Closing the demand-supply gap - Raising public awareness of water scarcity / costs of new supply - Removing perverse subsidies for excessive water use - Demand-side management measures (water-efficient devices) - Tariff restructuring (progressive step tariff, marginal pricing and lifeline rates for equity) - Introducing / enforcing groundwater extraction licenses and fees
	Balancing human and nature needs - Introducing environmental flows policies (low cost in some situations) - Incorporating buffer zones in designated areas for wetland migration - Improved protection and management of existing designated conservation areas
Moderate cost Measures to those requiring more significant up-front investment in infrastructure or institutional capacity	**Adapting to hydrological variability and extreme events** - Investment in hydrometric monitoring and early warning systems; - Watershed management (soil stabilization and erosion control) - Dams safety and retrofit of infrastructure for improved safety and performance under higher hydrological variability and extremes
	Closing the demand-supply gap - Reinforcing/introducing drought preparedness programmes - Addressing water supply leakage reduction in priority areas - More aggressive demand management, coupled with restrictions, and incentives encourage/required structural shifts in demand
	Balancing human and nature needs - Strengthening environmental flows policies for a range of conditions and linking to drought measures - Operating/Retrofitting infrastructure to improve water quality - Restoring and maintaining watersheds (e.g. vegetation) and wetlands as an integrated strategy for managing water quality and quantity.

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1. CLIMATE CHANGE: INFLUENCES ON WATER RESOURCES IN THE MEDITERRANEAN AND THEIR MANAGEMENT

1.1 The Mediterranean water resources context

The Mediterranean region has always experienced contrasting climate extremes, where floods and water scarcity have co-existed. Human and natural systems in the region have adapted autonomously to gradual changes in climate over time - less successfully to the more abrupt, or sudden changes.[1] In the present day, freshwater resources in the Mediterranean are under increasing pressure in terms of both water quantity and quality. Chronically so in the south and east Mediterranean (SEMC) counties where water utilization is now approaching hydrological limits.

Multiple pressures are not only restricted to arid and semi-arid SEMC countries. Northern Mediterranean counties with higher, more regular rainfall also face climate-induced natural hazards, flooding, and water shortages in basins susceptible to drought. As a consequence, human and natural systems sensitive to water availability and water quality are increasingly stressed, or coming under threat. Growing water-stress poses a threat to economic development, human livelihoods and welfare in some areas, particularly among the poorest and most vulnerable living in arid rural areas, or in urban centres with poor access to water and sanitation services.

Climate variability of course is only one of many factors influencing water resources management and service provision in the Mediterranean. The evidence, nonetheless, appears overwhelming that climate change will bring additional pressure to systems that are already under stress, or fragile – through pervasive changes in the hydrological cycle, extending to changes in land-water interactions and natural processes in watersheds, river basins and wetlands. The prospect of a gradual rise in mean annual temperatures and sea levels, also provides notice of the need to moderate the longer-term threats of climate change, including the potential vulnerabilities of populations, infrastructure and economic activities along 46,000 km of rapidly developing coastal zones of the Mediterranean Sea.

Both in response to the current and future climate variability, government, non-government and civil society interests across the region have increasingly called for action to speed the transition from the conventional water management approaches that dominated much of the 20th century, to practices more appropriate in today's circumstances. Broadly, these new approaches are embodied the Mediterranean version of Agenda 21 (1992) for sustainable water resource development endorsed by the Mediterranean Council of Ministers in 1993, and contained the Dublin Principles (1992) for integrated water resource management (IWRM).

But in many ways, the debate emerging over Mediterranean "water futures" is less about whether sustainable approaches are necessary, than about how to achieve them in practice – through reorientation of policies and water allocation priorities, and by the realignment of planning methodologies, operational practices and institutional arrangements to these new priorities.

- **Demand-supply circumstances vary greatly across the Mediterranean**

Much has been written about the status and outlook for water resources and their management in the Mediterranean in the decade since Agenda 21. Table 1-1 shows that broader variations in water resource availability across the region, corresponds to three geographic groupings.

[1] The population of the Mediterranean region is currently about 430 million. Patterns of land use, urbanization and economic activity have largely been influenced by the prevailing climate conditions. The water resource situation across countries in the region is highly diverse, set against contrasting levels of economic development, cultures, and traditions of governance.

Table 1-1 Water Resource Endowment Across Mediterranean Countries

Geographic Location	Water Resource (Availability) Status
The North or greater Europe Portugal, Spain, France and Monaco, Italy, Bosnia-Herzegovina, Croatia, Slovenia, F.R. of Yugoslavia, Albania, Greece **The East** Turkey, Cyprus, Syria, Lebanon, Israel, Palestinian territories of Gaza and the West Bank, Jordan **The South:** Egypt, Libya, Tunisia, Algeria, Morocco, Malta	Group 1: Mainly northern European countries rich in water (above 3000 m3/year/cap) where total water demand is stable, or even decreasing, without quantity shortage problems (except for short periods of time, or drought cycles for localized areas), but having to face water quality degradation and meet the increasing needs of environmental protection and restoration. Group 2: Western Mediterranean and Middle East countries, with overall excess resources (1000 to 3000 m3/year/cap), but where demands are more or less increasing, more sensitive to short term or structural shortages, in certain areas. Group 3: Countries from North Africa, the Middle East, or islands where the resources are limited (less than 1000 m3/year/cap) that are already overexploited or are becoming so (whether demands can be high or low, with likely future aggravation where demographic growth is strong.
Source: PlanBleu[i]	

Countries in the north Mediterranean receive about 72% of regional precipitation, compared to 23% for countries in the east, and 5% for countries in the south. On the demand-side, irrigation accounts for near 72% of all fresh water withdrawals across the region, though it is a higher proportion in some countries (e.g. Maghreb countries, including Morocco 92%, and Tunisia 86%). Municipal demand is about 15% of consumptive use on average. While these generalized data mask key variations between countries and individual basins within countries, the overall trend is toward larger withdrawals, particularly in the SEMC areas either to support demographic and economic growth at current water-use efficiency levels, or to meet growing (and unrestrained) irrigation demands.

The present water economy and patterns of water use is unsustainable in many countries

The report published by PlanBleu in 2000, "Mediterranean Vision on Water, Population and the Environment for the 21st Century" provided a relatively comprehensive assessment of current and projected water demand-supply balances across the region[2]. Scenario analysis concluded the present water economy was partly, or wholly unsustainable in many countries in the Mediterranean, and under demand-supply trends and policies (the Conventional Mediterranean Scenario), environmental degradation related to poor water quality and wetland loss would accelerate.

To achieve balanced demand-supply (the Sustainable Mediterranean scenario), concerted action would be required on many fronts: demand-management, as well as complementary actions to mobilize additional conventional and non-conventional supply sources to close the demand-supply gap. In countries where demand already exceeds, or threatens to outstrip sustainable levels of supply, more fundamental transformations in how water is viewed in development decisions would be needed. For example, water supply would have to become an explicit factor in all major land use, regional development, and industrial and municipal development decisions. This approach backed by other policies (e.g. tax incentives, or measures to improve the availability of supply and end-use technologies, such using water-recycling systems) would be needed to promote the deeper, structural changes in demand that are required. In situations where demand-reductions have reached their limits,

[2] Three scenarios were developed: (1) The "Conventional Mediterranean", where current demand trends continue at a moderate rate; (2) The "Mediterranean in Crisis", where current demand trends accelerated, and (3) The "Sustainable Mediterranean", where determined policies for sustainable water management are introduced.

and water supply could no longer be guaranteed, the cost of alternative supply (non-conventional supply) would have to be factored into development decisions. A number of islands have already moved to this threshold, such as Malta, where a third of the island's supply is now provided by desalination of sea water, at roughly three times the cost of limited conventional supply (precipitation and artificial or natural storage), and Cyprus, where over 10% of needs are now met by desalination.

The broader conclusions about current fresh water demand-supply trends in the Mediterranean are reinforced by the "sustainability" indicators developed by GWP network in collaboration with government agencies in the region.[ii] Here, indicators suggest that eight of the 12 SEMC countries now use more than 50 per cent of their renewable water resources annually (surface and ground water sources). In Plan Blue's current trends scenario, by the year 2025, eight of these 12 countries would consume more than 100 per cent of their renewable water supply.

A gradual shift from irrigation to municipal water supply, but limited evidence of progress in demand management

Annex A provides additional statistics on water availability and use in the region. The trends, as characterized with a few macro indicators, is that:

- Total water use (m3/ year per capita)– shows a reducing trend in some Mediterranean countries classified as water stressed, but overall it is rising in most others;
- household use (litres/day per capita) – shows an increasing trend in all but a few countries (e.g. France and Egypt, with Spain rising the fastest);
- total surface irrigated area (Mha) – shows a steady increasing trend over a long period with levelling in a few countries;
- the renewable water resource exploitation index (proportional reliance on total estimated annual surface and groundwater supply) in most Mediterranean countries is higher than 10%, indicating local pressure in specific basins; in a number of SEMC countries indicators above 50% reveal high pressure, and the need for fully rationalising management of water uses and demands.

Figures 1-1 and 1-2 below, illustrate 25-year (and longer) trends in total water use and household use in various Mediterranean countries

Figure 1-1: Total Water Use

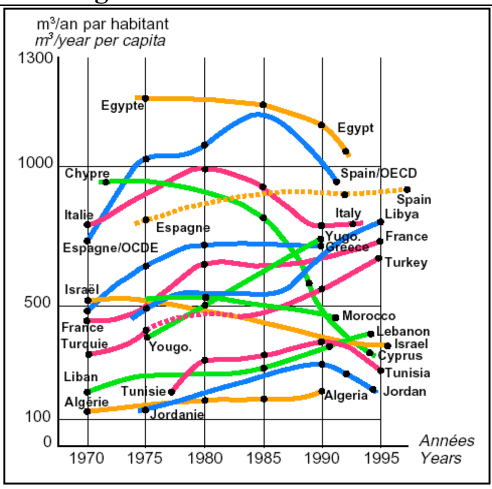
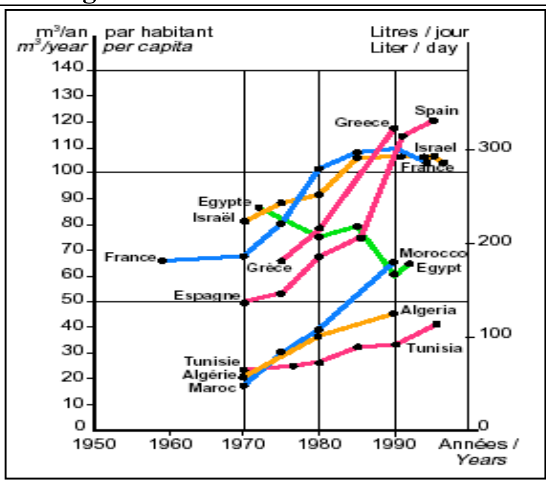


Figure 1-2: Household Water Use



Source: Reprinted with permission of PlanBleu

Data suggest a gradual shift away from irrigation toward municipal water uses (incorporating household, commercial and industrial demand) in countries experiencing water shortages. However, these shifts have less to do with water-efficient practices and technology becoming the norm in agriculture, than reactive responses (e.g. supply restrictions, changing crops). Figure 1-2, above, also indicates that limited progress has been achieved (up to 1995) in demand management in the household sector – again in terms of a macro picture. Drinking water is the first priority in water allocation policies in most Mediterranean countries, except for Egypt (which emphasizes irrigation), and Turkey that has no explicit sector allocation policy[iii]. Agriculture is the second priority in water allocation policies in most Mediterranean countries. Except for the proposed amendments to water priorities in France, at present no Mediterranean country explicitly identifies the environment sector as a priority in its water allocation policy.

1.2 Climate change impact and vulnerability

The IPCC's Third Assessment Report (2001) reconfirmed the scientific consensus that the gradual elevation in mean temperatures, associated changes in hydrological variability, and longer-term sea level rise is a reality. The ACACIA Project Report (2000) prepared for European Commission's 3rd Communication to the UNFCCC, reinforced the IPCC's interpretation of the possible effects on water resource systems in the Mediterranean and southern Europe.[iv]

Broadly, a warmer climate would influence the demand and supply for water, water quality and the frequency, spatial distribution and intensity drought and flood hazards. All sectors of the economy, environment and society may be vulnerable to one degree or another, and need to assess the key vulnerabilities, and where necessary, increase adaptation capacity. The significance and cost of reducing the potentially more serious vulnerabilities will, however, depend to a considerable extent on non-climate drivers of environmental change, patterns of socio-economic development and policy evolution – and the timing of the adaptation responses. Generally, where vulnerability is indicated, the earlier the adjustment, the lower the cost of adaptation over the longer-term.

- **Climate change will increase hydrological variability and extremes**

The picture building for Mediterranean is more unpredictable (e.g. irregular seasonal, and year-to-year changes) and extreme events outside the bounds of recorded climate variation. "First order" impacts will be felt on the different components of the hydrological cycle (i.e. the closed system of ocean water evaporation, precipitation over land, surface runoff, interception and infiltration, evaporation and evapotranspiration, and river and underground flow through the watercourse back to oceans and seas). Changes in hydrological cycle will be interactive, and affect water balances and water quality in a given watershed, in a given time period. These changes will subsequently feed through as factors in secondary impacts on water-dependent sectors and systems (e.g. on irrigation and water supply systems, coastal systems, and ecosystem functions). Current hydrological variations and extremes (floods, droughts, storms and incidence of torrential downpour) would be amplified.

Table 1-2 illustrates some expected first order impacts on Mediterranean water resource systems. The region would warm at a rate of between (0.1ºC/decade and 0.4ºC/decade), twice that of northern Europe. Projections point to more precipitation in the winter and less in summer over the region as a whole, while mean annual precipitation is expected to decline south of 45° N. The general tendency would be that northern parts of the Mediterranean would be come wetter, and the southern parts drier. The IPCC nonetheless acknowledges that the regional averages - that are themselves bracketed by (low, medium and high) degrees of certainty - also mask important basin, sub-basin and temporal problems with distribution. The analysis is directional and indicative of the trends only because the general circulation models used to assess global and regional variations do not have sufficient resolution and accuracy as yet to assess local effects, or changes in a particular basin, (the interactive influences of the Sahara, Atlantic and Mediterranean are also particularly difficult to model),

Table 1-2

Projected First Order Impacts Of Climate Change on Mediterranean Hydrological Systems[v]

Aspect	Representative Impacts
More variability and extreme weather events: • More frequent and intense storms • Increased number of days of heavy rainfall events and torrential downpours • More frequent and longer lasting droughts spells • Greater seasonal and year-to-year variation in precipitation, especially in semi-arid areas in the southern and eastern portions of the region	• Higher surface runoff with less chance for infiltration • Increased variability in river flows through the year • More frequent and higher floods, especially over northern parts of the Mediterranean basin • Increased erosion from intense storms and sediment in runoff (in conjunction with effects of drought making soils erosion-prone) • Lower groundwater recharge rates associated with drought
Wetter winters and dryer summers • More precipitation in winter, less in summer over the Mediterranean region as a whole, with variability in basins • Earlier snowmelt (e.g. shifting to Jan, Feb, Mar) • More winter precipitation falling as rain (in mountainous and colder climate regions)	• Shift in normal season of peak flows in rivers from spring to winter, especially in basins with mountains in the upper catchments • runoff in a particular basin may increase or decrease on average, but the seasonal distribution will change • Lower groundwater recharge rates where infiltration is less, and in dry summers • Less efficient rainwater infiltration feeding inland and coastal water tables and fragmentation of fresh water aquifers
Hotter summers and heat waves • Warming trend greater in summer than in winter • Hotter and longer summers, • Heat waves becoming the norm.	• Increased soil evaporation, plant evapotranspiration • Dryer and more erosion-prone soils • Acceleration of desertification effects • Multiple impacts such as increasing water needs in human, agriculture and natural systems

Recent IPCC analysis suggests that globally, average sea levels may rise another 0.15 to 0.95 m by the year 2100, with a best guess of about 0.50 meters. Changes in the mean level of the Mediterranean Sea appear to be even harder for the models to predict, even with low or moderate certainty[vi]. Here, much of the 46,000 km of Mediterranean coastal zone, characterized by rapidly intensifying land use and economic development (urbanization, tourism and agriculture) would be exposed to sea level change effects, including permanent flooding, storm surges and salinization of coastal groundwater and estuaries. About 145 million inhabitants, or roughly one third of the population of the Mediterranean now reside in these coastal zones, and island groups will be affected by sea level change (directly and indirectly).

Initially changes in extreme precipitation and temporal and spatial distribution are likely to have a greater immediate impact on water resources systems than the gradual, small changes in the mean annual rainfall amount and temperature, perhaps with the exception of increased evaporation in arid areas.

- **Water resource systems already stresses will be most vulnerable**

Water resource systems in different countries would also exhibit different degrees of vulnerability to increased climate variability. Some natural vulnerability is inherent from factors such as location, hydrogeology, soil quality and other physiographic characteristics of the basin. Additional vulnerability is induced by the water resource management system (infrastructure and practices) that has evolved over time, and through associated patterns of land use in the catchment, development in flood prone or lowland coastal areas, and the proportion of water-intensive economic activities, such as irrigated agriculture in the overall economy. Nonetheless, sensitivity to increased climate variability would be greatest in water resource systems where natural supply and use are closely matched (e.g., in Eastern and Southern Mediterranean countries, and particularly, much of the semi-arid and arid North Africa). At the same time, in systems that are already under demand-supply stress, or due to water-quality problems - climatic changes may impose new and greater stresses than those already anticipated because of non-linearity of interactive natural processes and critical thresholds in biophysical systems.

Generally, well-managed water resources systems, where there is greater flexibility to respond to expected (or unexpected) changes in hydrological variability would, by definition, be less vulnerable to climate change. But there are different interpretations about what "well managed" means, and how the vulnerability of human and natural systems is balanced.

- **Water demand will be influenced by temperature changes: water quality will be affected by changing runoff, flow conditions and temperature**

Longer-term temperature rises will influence water demand and need to be taken into account in demand forecasts. While industrial and household water demand is sensitive to temperature in certain circumstances, agriculture demand (evapotranspiration) and natural evaporation will be most critically affected as conditions become hotter and drier. Temperature-related increases in the rates of evaporation from natural water bodies (lakes, ponds and rivers), and from artificial water bodies (impoundments and reservoirs), from soils and runoff will also impact on water demand-supply balances. At present, evaporation from surface water bodies alone is estimated to be about 5% of available water supply, and higher in arid and semi-arid regions[vii]. In arid and semi arid regions potential evapotranspiration (ETp) will exceed annual precipitation, and precipitation/ETp ratios may fall as low as 0.25, presenting implications for how both evaporation and storage is managed[viii].

In some basins the potential for higher flows in rivers in winter may improve water quality. Most studies suggest that on balance, surface and groundwater quality would be adversely affected, particularly where it is already under multiple threats, and degraded[ix]. Lower flows (either from climate change or increased abstraction, or both) coupled with increasing volumes of effluent discharges into watercourses from growing populations, agriculture activity (pesticides and fertilizers) and industrial activities will serve to increase concentrations of water pollution. Morocco, for example projects that the tonnage of urban discharge (nitrates, phosphates, and other organic wastes) will increase by a factor of 2.5 to 3 between 1990 and 2020[x]. More intense precipitation and frequent torrential downpours would also increase the amount of agricultural and urban pollutants washed into streams and lakes. Here, heavy rainfall is primarily responsible for soil erosion, leaching of agricultural chemicals, and runoff of urban and livestock wastes and nutrients into water bodies. Lower flows in rivers as they enter the Mediterranean, coupled with sea level rise would accelerate saltwater intrusion into estuaries and coastal aquifers.

- **Watershed degradation and desertification processes would intensify**

Changes to soil and land resources are highly dependent on geographical factors and human-use factors (agriculture intensity, livestock grazing practices, urbanization) and may be moderated by increased precipitation in some areas. Where climate change effectively lowers precipitation and increases periods of drought, land degradation processes, soil erosion and salinization would nonetheless increase. In southern Mediterranean areas in particular, soil quality is likely to deteriorate under warmer and drier conditions, leading to loss of soil function, and acceleration of desertification processes. The major impact on water resource management would be changes, mainly increases, in sediment yield affecting the performance of water resource infrastructure.

Table 1-3

Influence of Climate Change on Water Demand, Quality and Watershed Conditions

Affected Aspect	Representative Impacts **(Potential primary and secondary impacts)**	
Water Demand	Increases consumptive water-use in key sectors including agriculture, domestic/commercial demand and (non-consumptive) thermoelectric/industrial cooling water demand.	
	• Warmer average temperatures and hotter and dryer extremes	• increased evaporation from water bodies reducing the available supply • increased evapotranspiration from crops and natural vegetation • reduced efficiency of water cooling systems (industrial and thermoelectric) • increased household and commercial water use (indirect and direct)
Water quantity	Some improvement in water quality with more frequent high flows in winter. Generally, though river and ground water quality adversely affected by combination of factors.	
	• Pollution from intensified runoff in catchments and from urban areas	• Increased leaching of agricultural chemicals into groundwater • increased urban and livestock wastes discharging into streams, rivers and lakes
	• Lower rivers flows, particularly in summer	• higher pollutant concentrations in rivers • increased ground water contamination • increased saltwater intrusion into rivers and coastal aquifers (combine with sea-level rise)
	• increased temperature	• increases in lake and ground water salinity levels due to higher evaporation rates • lower dissolved oxygen levels in water due to higher water temperatures • increased incidence of eutropification of lakes and water bodies
	• sea changes	• changes in temperature, salinity, organic matter content, concentration in CO2, nitrates and phosphates
Watersheds conditions	Generally hotter and dryer summers, more frequent and prolonged droughts, coupled with sudden intense rainfall events would exacerbate existing erosion and desertification processes	
	• higher temperatures	• dryer soils and salinization (particularly summer and long droughts) • higher incidence of wind-blown soil erosion • changes in land-use that may be maladaptive
	• intensified rainfall events	• higher sediment content in runoff • higher erosion from storm events

- **Instream and offstream water uses will be affected, in positive and adverse ways**

Changes in river flows, and water quality would affect the various instream uses (e.g. hydropower, navigation, waste assimilation, and ecosystem services), and offstream uses of water (e.g. withdrawals for irrigation and water supply) - in both positive and negative ways. The effects would be basin specific. For example, with more frequent floods instream uses such as hydro generation and navigation functions may be increase for short periods, or they may be curtailed for safety reasons or measures such as drawdown of reservoirs in advance of floods. With lower flows in summer and extended drought cycles there would be adverse effects, such as reduced power generation, restricted periods for navigation and various ecosystem threats. Wetlands and many ecosystem processes will benefit from floods, constrained mainly by water regulation infrastructure effects (e.g. flood-nutrient cycles that may be restricted by dams). Off-stream uses would similarly be affected by reductions in water withdrawals and there would be pressure to ration water, or allocate it to higher-value uses.

- **Any infrastructure designed and operated for past hydrological conditions will need to be adapted**

The increased climate variability and extremes will have a major influence on the management of water regulation infrastructure, as much of the infrastructure in place today is designed and operated for past hydrological conditions. Therefore, measures to adapt the existing stock of water infrastructure, or design new infrastructure to more flexibly function under a wider range of future hydrological conditions would be needed. This applies to everything from large dams and reservoirs to urban stormwater drainage systems. It is a task that would require the attention of water resource planners in all sectors, and all levels, working with multi-disciplinary teams, and in some instances require significant investment.

In general the need for refurbishment, retrofit, modification, relocation, removal – or change in operation of existing water resources infrastructure will need to be assessed on a case-by-case basis – against number of water management objectives and criteria, including economic, environment, safety and risk-cost factors. The aim would be ensure the safe operation (e.g. in higher floods) and improve the performance and flexibility of operation, in the context of the overall water management approach and changing allocation policy. Risk assessment and other performance assessments against climate change parameters specified by the government (usually scenarios translated to performance-based or risk-based criteria) would be appropriately applied to all water management infrastructure (e.g. dams, water transfer schemes, flood embankments, water supply and irrigation intakes, municipal storm water management systems and wastewater outlets, water treatment plants, thermo-electric cooling systems, etc.), as well as public and privately owned infrastructure and buildings in exposed flood plains or coastal areas subject to storm surges and eventual sea rise (e.g. river crossing bridges, roads and other building structures).

There are, for example, over 4,000 large dams in the Mediterranean (see Annex A for the list by country), and many thousands more of smaller embankment dams for irrigation and water supply that will need attention, particularly as regard to sediment management and ensuring spillways and other physical structures and outlet works are adequate to pass larger floods, and also to improve environmental performance, as discussed in part 2 of the paper. Sediment, in particular, reservoir sedimentation increasingly referred to, as the "hidden problem" – that is hidden by water and exacerbated by climate change and desertification – is becoming a major issue. In its 2002 State of the Environment Report, the United Nations Environment Programme (UNEP) singled it out as a significant, emerging issue for many regions of the world, where sediment reduces storage capacity, reducing the reliability of water supply and power generation, and reducing flood control effectiveness.[xi]

- **Wetlands and freshwater ecosystems systems would have to adapt "autonomously" and are most vulnerable**

Climate change will act in conjunction with a range of other non-climate pressures, many of which may pose far greater concern for aquatic ecosystems and wetlands in the short to medium term[3xii]. These pressures include human activities that have severely modified many aquatic ecosystems with actions such as river diversion, draining of wetlands for other land uses, groundwater pumping and water pollution. Cumulatively, these alterations fragment the aquatic landscape and increase vulnerability to the additional stress associated with climate change, and serve to limit autonomous adaptation.[4]

From a water resource planning perspective, the important issue is that wetlands habitat and processes are critically dependent on their hydrological functions, specifically, the nature and variability of the hydroperiod and the number and severity of extreme events. Healthy ecosystems are fundamentally dependent on receiving appropriate amounts of water, of a certain quality, at certain times – either as river flows, groundwater, or a combination. And while ecosystems may be resilient to normal climate

[3] Wetlands, as defined by the RAMSAR Convention, include coastal/marine habitats, inland habitats such as lakes and marshes whether saline or fresh, temporary or permanent, and high altitude and latitude habitats such as bogs and fens.
[4] Human society depends on these natural systems to provide a range of goods and services that include primary productivity and inputs supporting food webs, yielding fish for commercial and recreational purposes, while decomposition and biological uptakes remove organic materials and nutrients and purify water. Wetlands also important as carbon sinks and thus play are role in mitigation of climate change.

variations, the extremes, particularly drought coupled with human responses to these same extremes, pose the main threat.

Possible adverse impacts of climate change on wetlands broadly include[xiii]:

- altered hydrologic characteristics from changes in seasonal patterns of precipitation and runoff;
- further deterioration of water quality from climate-human induced effects, such as: higher pollution concentrations in rivers and groundwater aquifers (riparian zones) in low flow periods; low dissolved oxygen levels in downstream releases of water from deep reservoirs compounded by changes in temperature and flow regimes[5][xiv]; altered amounts and patterns of suspended sediment loadings, and oxidation of organic sediments;
- increased water temperature and altered evapotranspiration affecting productivity of natural processes (from temperature rise);
- physical effects of change in river morphology and wave energy in lakes and costal areas (increased storms), and
- Rising sea levels that potentially inundate coastal wetlands and lead to their loss by salinity and inability to "retreat", particularly due to blockage by human land use.

As discussed in part 2 of this paper, environmental flows are critically important not to further stress managed wetland systems, or move them beyond critical thresholds.

1.3 Conventional and emerging water resource planning approaches

- **Conventional approaches have been largely supply-oriented, and focused on structural means of controlling hydrological variability**

A long-standing goal of water resource planning in the Mediterranean, as elsewhere, has been to meet the demand for reliable water supply, no matter how that demand changed. Conventional wisdom has been to control, or dampen out hydrological variability in rivers to match human needs for use of water resources, and to regulate and store water flows for later abstraction during dry periods, and make it possible to convert flood plains to other uses. In response to variability that could not be regulated (higher floods and droughts) a broadly reactive, emergency-response approach was adopted.

During the 20th century a standard set of planning approaches evolved where channelisation of rivers, dams, reservoirs, canals, embankments, diversions and river training became the primary tools for water resource development. Step-wise development of flow regulation structures and reservoirs to provide a large excess surface storage capacity was seen the best strategic approach to reduce sensitivity to climate fluctuation, including seasonal, and in some cases year-to-year variations. Inter-basin transfer schemes emerged to move water from surplus and deficit basins. Viewed with the benefit of hindsight, the focus was on surface water resources. Irrigation managers and farmers were largely left (though in not all cases) to developed ground water supplies. Except in a few countries, there was little direct government control, involvement or planning for ground water recharge, apart from local initiatives or demonstration programs.

- **Integrated approaches are more appropriate to respond to increased climate variability and sustainable development**

In the past few decades, a convergence of many factors has broadened water management approaches. Some Mediterranean countries, have now moved quite far to embrace a more comprehensive set of policies and strategies for improved management of existing supplies and facilities, to move toward

[5] Emerging research indicates a number of interactive effects of water regulation on ecological processes such as changes lake levels, mixing regimes, dissolved oxygen concentrations, water residence times, water clarity, thermocline depth and productivity, and altered nutrient exchanges.

demand management and recycling, and also to shift toward more integrated approaches to land-water management, and reflect these in institutional arrangements.

The changes have been more rapid in those countries with financial resources – or where water demand has outpaced available supply. In these situations, planning practice has either followed (or in some countries informed) changes in water management policy and practice.

Planning is in transition from "programme" to "process" oriented approaches that enables more flexible and adaptive responses to changing circumstances and growing complexity. While countries are moving at different paces, these changes include widening participation of water users and stakeholders in water management activities, as well as other dimensions, as broadly illustrated in Table 1-5.

Table 1-5 Characteristics of the Shift from Conventional to Integrated Planning Approaches

Conventional Planning (a " programme" approach)	Integrated Planning (a "process" approach)
Tends to react to perceived problems as they arise	Tends to be more anticipatory and preventive
Assumes continued sector/sub-sector development to meet projected needs (targets and programming)	Aims to be responsive to changing external environment and internal sector/sub-sector capacities (foresight)
Focuses on activities, predominantly those implemented by government entities	Focuses on goals, objectives and results, attained by government, private and co-operative entities
Tends to be agency-based, separate and partial (each agency prepares its own plan)	Aims to be comprehensive and integrated in scope (synthesis of all plans)
Emphasizes structural solutions	Aims for balanced integration of both structural and non-structural solutions
Tends to be compiled within agency planning departments (secretive and top-down)	Involves government, non-government and the general public in an open dialogue to set goals and select actions (participatory and bottom-up)
Tends towards fixed schedules and target-setting (rigid)	Represents a dynamic/recurring reiterative process (flexible)
Often fails to address inter-agency and inter-jurisdictional issues	Emphasizes communication, cooperation, co-ordination and feedback
Tends to repeat the past (repetitive)	Strengthens teamwork (partnerships) and provides new learning opportunities
Generates data and formal statistical records rather than interpreting and evaluating information	Requires information, monitoring, evaluation and reporting to support the reiterative process towards expected results
Source: Adapted from WCD and Strategic Options For the Water Sector, (T.A. 2817-PRC), Asia Development Bank, 1999.	

On top of these transitions, a key challenge emerging with climate change is incorporating greater uncertainty and hydrological variability into water resources planning and management. Despite the optimism of many water managers that existing systems will be adequate to deal with the risks and uncertainty imposed by climate change, the IPCC, the GWP and World Commission on Dams (WCD) all consider that in many countries (not only the Mediterranean), current policies affecting water use, management, and development are often unresponsive, or not sufficiently responsive to changing conditions, or the rate of change. In the absence of changes in approach, the costs of these inefficiencies most likely will rise as water becomes scarcer and demand-supply conditions change.

- **Mediterranean Agenda 21 and the Dublin Principles represent a turning point in water management and planning**

The Mediterranean version of Agenda 21 (1993) and the Dublin Principles on integrated water management (IWRM, 1992) joined up many of the perspectives on rethinking the approach to water management at that time, and now provide the "compass" to set the new course for water management and planning in the Mediterranean. To a large degree, these principles are reflected in National legislation, policies and directives of most countries in the region, either explicitly or implicitly. Water resources management, and more specifically IWRM approaches as reaffirmed in the 2002 World Summit in Johannesburg, is a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP). Three fundamental principles of IWRM, also known as the Dublin principles are characterized in Box 1-2.

Box 1-2
Dublin Principles (1992)

Economic good principle - water is a scarce resource, and greater use needs to be made of incentives and economic principles in improving allocation and enhancing water quality.

Ecological principle - independent management of water by different water-using sectors is not appropriate, the river basin must become the unit of analysis, land and water need to be managed together, and much greater attention needs to be paid to the environment

Institutional principle - water resources management is best done when all stakeholders participate, including the state, the private sector and civil society; that women need to be included; and that resource management should respect the principle of subsidiary, with actions taken at the lowest appropriate level

While the principles help set water resource planning activities in a wider framework of sustainable development, climate adaptation planning in the water resource sector would follow the same pathway.

In Practice: Bringing climate adaptation planning into planning transitions

Again, the challenge is less with principles and more a question of how to operationalize them. Broader consensus is that an integrated package of structural and non-structural water management tools is needed to reconcile different and changing water uses and demands, and offers greater flexibility than conventional water resources management to cope with the additional stresses of greater climate variability.

Infrastructure investments need to be complemented by non-structural investments, where they were not adequately considered before (e.g. investments in watershed management, flood management, land use planning and hydrological monitoring and information and systems management). Policy interventions such as tariff measures have not proved robust enough, or sufficient on their own, to influence demand and close the demand-supply gap. Other reinforcing policy measures such as awareness building, incentives, and removal of barriers to market adoption of water-efficient end-use technologies and practices have to be brought into the equation - if demand management is to be a realistic and viable alternative to take pressure off supply development and the rising costs of supply. Otherwise, allocation decisions will increasingly be required by government, which may mean the temporary or irreversible curtailment of certain economic activities, or sacrifice of ecosystem services.

Three separate functional orientations of IWRM and planning are needed

To better position for the transitions in water resource planning, a clear separation between three related, but nevertheless distinct functional orientations (and sometimes competing functions) in needed. These are: (1) overall water resource management; (2) water service provision in the different sectors (irrigation, water supply etc.); and, (3) activities around the development and management of infrastructure.

Table 1-6 provides a further illustration of separate functions and relationships.

Table 1-6 Illustration of Three Separate Functional Orientations of IWRM

Function	Orientation
Overall Water Resource Management	Concerned with overall policies, strategies and measures for water availability (water balances), water quality, water accessibility, water rights, and water allocation across sectors: Integrating: e.g. - Land-water planning and management - Water rights and access policies (groundwater and surface water) - Watershed and catchment management programmes - Flood and drought preparedness and responses, linkages to programmes to combat desertification - Basin-wide hydrological monitoring systems/networks - Integrating with environment protection, restoration, maintenance of ecosystem services, environmentally sensitive water allocation - Coastal development interactions with water resources - New supply development
Sector-specific Water Service Provision	Concerned with achieving demand-supply balance in specific sectors for given water allocation, and access: e.g. - off-stream uses: or withdrawals for irrigation, municipal, industrial water demands - instream uses: such as hydropower, recreation and navigation, environment) - implementing new demand and new supply measures
Water Infrastructure Development and Management	Concerned with the unique role of water regulation infrastructure in both resource management and service provision: e.g. - life-cycle management - integrated (and multi purpose operation) under water resource management policies - supply efficiency (bulk conveyance and delivery systems)

Of these three functional orientations, overall water management is a newest “domain” introduced largely in the past decade (or since the 1980’s in some countries), and which grew out of Agenda 21 and the Dublin, principles.

It reflects the increasing move to strengthen river basin organizations and is approach is reflected in the EU Water Framework Directives and the basin perspectives. The functions now organized under this umbrella (water availability, quality, rights, access, and allocation, etc.) were previously handled by separate policy groups (e.g. environment policy or legislation), or under sector-specific ministries and activities (e.g. often in different branches of the Ministry responsible for the dominant water use, such as irrigation), which previously contributed to fragmented planning. It is in this domain that most multi-disciplinary stakeholder dialogue is focused today. This is understandable due to the policy dimensions, concern with strategic selection of options, and the need to address cross-sector and crosscutting issues.

Previously in conventional water planning and management there were primarily two functions (water infrastructure development and management - then synonymous with water resource management, and sector-based services provision). Climate change considerations would need to be introduced in each of the three functional orientations simultaneously, and in a coherent way and involve different sets of planners from national to municipal levels.

- **No universal blueprint for the planning systems, institutional arrangements and allocation of responsibilities for introducing IWRM and associated climate adaptation measures**

The GWP has indicated there is no universal blueprint on how the principles for IWRM can best be put into practice and integrated across functions and sectors. Similarly in the recent COP 8 meetings under the UNFCCC process it was noted there is no single, best approach or methodology for how climate change adaptation would be integrated in national, basin and local planning systems. Even for specific analytical questions, such as assessing the relative merit of potential adaptation measures, there is a need to have flexibility in methods so that they can be implemented and be relevant to local conditions.

As the GWP indicated, "The nature, character and intensity of water problems, human resources, institutional capacities, the relative strengths and characteristics of the public and private sectors, the cultural setting, natural conditions and many other factors differ greatly between countries and regions. Practical implementation of approaches derived from common principles must reflect such variations in local conditions and thus will necessarily take a variety of forms.[xv]"

Despite the application being context specific there are nevertheless common approaches. Part 3 of this paper explores some of the broader frameworks for national adaptation processes based on the IPCC approaches, UNFCCC guidance, and the general IWRP framework. Here, Annex B provides the generic guidelines for the preparation of water are referred to as National Adaptation Programmes of Action (NAPAs), approved by the Conference of parties to the UNFCCC are COP-7 (2001 decision 28/CP.7).

2. CLIMATE SENSITIVE WATER RESOUCES PLANNING APPROACHES AND METHODS

2.1 Adapting existing planning tools to climate change

Water resources planning methods, tools and standards need to be continuously adapted, as appropriate, to take account of the significant direct and indirect effects of climate change. The methods and tools range from simple "rules of thumb" to more complex analytical procedures and computer-based simulation models that incorporate many assumptions about climate, and natural responses of physical and ecological systems to climate variation.

To illustrate what may be involved, seven selected topics in water resource planning are considered from this perspective. These are:

- Hydrological forecasting: Extremes and means
- Infrastructure design and operating strategies: Adapting to greater hydrological variability, and increasing operational flexibility
- Sediment management: Addressing a growing "hidden" problem exacerbated by climate change
- Environmental flow methodologies: Sustaining aquatic and wetlands systems and increasing their capacity to successfully adapt
- Decision support systems: Optimising solutions to complex problems
- Risk assessment and management: A wider perspective to take account of all issues and stakeholder perspectives
- Scenario-based analysis: Decision-making under uncertainty

The points here may be extended by analogy to other planning topics. It also is important to note there is no single "conventional" planning practice. Approaches and design procedures used by water resource planners often vary between sectors within countries and between countries, such as structural design, safety and water quality standards.

Underlying this also is the changing role of the water resource planner and engineer - from that of functioning in a hierarchical decision-making process to involvement in multi-disciplinary planning teams advising decision-making processes which involve stakeholders, public hearings and consultation meetings. These new roles require new sets of tools, skills and ways of presenting information to different groups. And similar to ongoing efforts to bring sustainable development principles explicitly into mainstream water resources planning, climate adaptation work draws on a wide range of physical, biological, and social science disciplines. As a consequence, new planning methods and tools are constantly being introduced which complement the exiting set of tools. These new approaches invariably build on recent advance in information technology, data processing and computer modelling, and employ multi-disciplinary approaches that address complex interactions between natural and human systems.

2.2 Hydrological forecasting: extremes and means

Most conventional forecasting methods involve the analysis and projection of historical trends to predict future conditions. That is, they assume the future will be the same as the past. Indeed, conventional thinking is that the longer the time series of hydrological records (e.g. precipitation and streamflow records) the better, and the more accurate the forecasts on which to base planning.

Forecasts, based on past climate patterns and related responses of the hydrological system influence a range of decisions in the development and management of the water resource system, such as whether structural flood defenses are feasible, what level of protection they would afford, and if selected - factors such as their, location, height and design. Similarly, unit hydrographs developed from statistical relationships between observed rainfall and runoff in a watershed are used to estimate inflows to reservoirs and calculate storage, or route simulated floods of various types through a river reach, or a dams, and predict the outflow hydrograph from a watershed. Structural and non-structural options are then evaluated against these simulations for "with" and "without" project effects.

Extremes: flood frequency and PMF analysis and application

Extremes influenced by climate change are particularly important in hydrological design, including changes flood characteristics such as their size, spatial and temporal distribution. In normal practice standard flood frequency analyses are used to calculate floods for different return periods (average time interval between events of the same magnitude) including extreme rainfall events such as probable maximum precipitation (PMP) and the probable maximum flood (PMF)[6]. These calculations are then used to design components of infrastructure according to a calculated risk factor, representing the probability of occurrence of an extreme flood that exceeds the design, and risk factors that reflect the consequences of possible failure.

Certain flood management decisions (e.g. the choice of non-structural responses, or the selection and size of protection structures, and the area of hazard zoning, where to apply land use restriction, etc.) are typically tied to thresholds, such as the 100-year flood event in rural areas (i.e., a flood expected to occur, on average, once a century), or possibly the 200-year flood in more heavily developed basins. Floods of 1:150 year return periods are often used as design criteria for small, or remote dams. Small embankment dams, and lower hazard categories of dams (classed as such on the basis of the downstream hazard of a dam break), are generally assessed against more frequent (and lower) flood flows using simplified planning techniques such as the rational method that uses runoff coefficients. For large dams 1:10,000 year floods, or the PMF may be used. Here flood hydrographs that are established from records for a particular drainage basin are used to calculate the PMF / PMPs when new infrastructure is considered, or when an assessment of existing infrastructure is carried out.

The PMF (or PMP) is becoming widely accepted as the main design criteria for new large dams in many countries [ICOLD, 1991], including the Mediterranean. Methods for calculating PMF are being updated (in some countries), as a consequence of climate change (e.g. the UK and France), to reflect observations that are outside previous ranges. There is however, no single method or precise calculation method for PMF, as many assumptions and judgements need to be applied. This can lead to some surprises, and also some contradictions during the change over of methods.

For example, recently in the UK, in response to climate change, new flood studies were undertaken to update the Flood Estimation Handbook (FEH) used by all planners and designers.[xvi] From the recent UK study, 10,000-year design storms appear systematically larger than those of the PMP, (using probable maximum precipitation (PMP) to arrive at PMF as calculated by the current accepted methods), by a surprisingly large amount – as much as 60%.

Table 2-1:
Illustration of changes in PMF Estimates Since the Original Design of the Structure

Date of PMF Estimates	Duration	Peak Inflow (m^3/s)	Volume (ML)
1977	3 days	15,000	4,210,000
1983	2 days	42,973	6,170,000
1983	7 days	47,800	10,260,000
1992	2 days	30,670	5,333,920

Source: see text

Table 2-1 shows an example for Australia where PMF and peak flow estimates have been changed upward and downwards by over 100% over 15 year period due to changes in the methods used by the designers, in this case different agencies[xvii]. This was amid concerns over increased hydrological variability in future and the safety of existing dams.

What experience to date indicates is that it takes a while to resolve all the issues in reformulating key hydrological variables and a well-coordinate effort is needed before deciding on new procedures, and how they will be applied an updated.

[6] PMF - the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions reasonably possible in the drainage basin.

A parallel debate is also emerging over whether to apply the new PMF criteria to existing infrastructure, particularly existing flood defences and large dams. Here the debate is over whether it is cost-effective for older dams to be brought up to the same standards as new dams during their normal retrofit cycle, or as special measures, and if not, what should be the design criteria. This also becomes an issue when dams are reclassified as being in a higher hazard than previously (or when the river is reclassified due changes in land use downstream such as urbanization), or other reasons such as sediment build-up in older dams as they reach their design-life (where sediment is an issue), resulting in the increased possibility of upstream flooding.

The emerging practice is a case-by-case approach to systematically assess risks and evaluate the cost of measures for adapting specific infrastructure to the new extremes, such as increasing spillway capacities of dams (lowering or enlarging); reinforcing dams to permit overtopping (such as using RCC methods), partial or full decommissioning of structures, or raising the height of existing dams and other flood defences.

There are many specific calculations in hydrological forecasting and used in planning, which are sensitive to climate change - where revisions, or updates in the procedures, or how the methods are applied would need to be considered. While in many cases awareness of the need for update has always been present, the increased variability from climate change would introduce new thresholds, where the establishment of processes for more frequent, regular revisions could no longer be deferred, or ignored. For example:

- Runoff coefficients that are the basis of many calculations will change in respect to the critical months and changing conditions in both urban and rural areas;
- mass curves will change (i.e. percent of total rainfall for minutes (or hours) over a basin) with torrential rainfall events;
- the predicted peak flows (inflow PMFs) may be too low (or too high) as a result of non-linear effects in runoff and the channel flow process that violate the unit hydrograph;
- sediment yield coefficients would be re-estimated and adjusted for more intense rainfall events; and,
- flood hazard maps need to be updated for higher variability.

Short-term forecasts also called "nowcasts" are another recent development that increases the capacity to adapt to extremes, in terms operation strategies of existing infrastructure (e.g. whether and when to drawdown reservoirs, when to store or release, when to divert). Here the quantitative forecasts of rainfall based on real-time information that comes from monitoring stations, and also from the extrapolation of radar echoes are possible. Radar techniques have been used to forecast rainfall for the immediate future, from 15 minutes ahead out to perhaps the next 3-6 hours.[xviii]

More broadly, flood warning and forecasting systems would be enhanced and connected in various ways to public information programs. Although many countries have early warning systems in place as part of the national or basin hydrological monitoring networks, many systems are not comprehensive (where Mediterranean countries do not have sufficient funding).

Extremes: Drought Indexes and Preparedness

Improved drought monitoring, risk analysis and contingency planning are themes repeated in workshops in the Mediterranean region in recent years.[xix] This reflects the ongoing, deteriorating situation in drought-prone regions where demographic growth is placing more stress on systems, prompting the use of marginal lands and unsustainable practices, and it reflects concerns that climate change would increase the frequency and severity of drought episodes and desertification processes. Research is being carried out to identifying basins most sensitive to climate change and to assess what can be inferred from climate models and "seasonal" forecast procedure.

But in addition to these new 2-3 month forecasting inputs, the expectation is that hydrological information from early warning systems would be combined with drought preparation responses to provide a more comprehensive capacity respond to drought extremes. Here, for example, integrated assessments based on participatory risk analysis, and full water inventory assessments would be used to establish long-term risk reduction programmes, and pre-define a set of emergency response measures. The latter would be implemented in drought episodes, where the prevailing water situation would be taken into account (e.g. the status of water supplies in natural lakes, artificial reservoirs or groundwater levels), combine with information from early warning forecasts of the probability of precipitation.

Box 2-1
Drought Responses - Improving Adaptation capacity

- **Assessment Tools:** Early hydrological warning systems; inventories and surveys of resources, needs, and feasible actions; data collection networks
- **Legislation and Public Policy Tools:** Legislation protecting water resources and providing loans to farmers; water plans; water banks
- **Increasing/Augmenting Water Supply:** Water recycling projects, reservoir rehabilitation, pumps and pipes to distribute water, emergency permits for water use
- **Public Education:** Drought information meetings, water conservation awareness programs and pamphlets, workshops on drought-related topics, drought information centers
- **Technical Assistance:** Advice and information to people and organizations on water quantity/quality, drought planning, water conservation; technologies and software for irrigators and water suppliers
- **Conservation/Demand Reduction:** Economic incentives for water conservation; water metering and leak detection programs
- **Emergency Response:** Water hauling programs for livestock, hotlines and emergency shipments of food for livestock, water system improvements /creation, emergency irrigation permits, low-interest agricultural loan and aid programs
- **Conflict Resolution:** Resolving/negotiating water use conflicts, investigating water use complaints, clarifying water-related laws

One approach in this regard is to connect early warning systems with drought responses by the use of hydrological based drought indexes such as a Standard Precipitation Index (SPI).

These result in drought classifications or stages, which in turn trigger specific mitigation and pre-determined response actions agreed through public consultation and debate. For example:

- **Stage 1**: such as drought-watch (voluntary conservation)
- **Sage 2:** such as drought-warning (mandatory restriction of nonessential water uses)
- **Stage 3**: full mandatory restrictions, implementation of emergency measures, etc.

Box 2-1 illustrates these measures, plus a broader range of measures that may be contemplated for drought responses that depend on the specific situation.[xx]

Appropriate and Inappropriate Use of Hydrological Means

As the IPCC indicated in its 2001 Assessment, key features of climate change in terms of vulnerability and adaptation, are those related to variability and extremes, not simply changed average conditions. Most sectors, regions, and communities are reasonably adaptable to changes in average conditions, particularly if they are gradual. However, these same communities are more vulnerable and less adaptable to changes in the frequency and/or magnitude of conditions other than average.

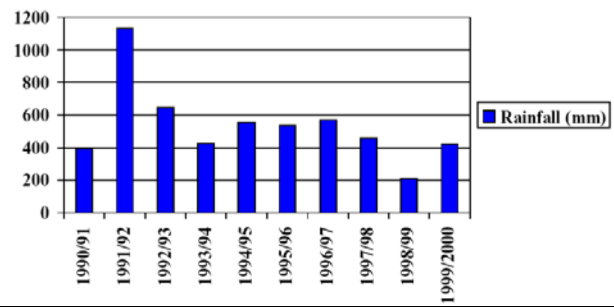
Another aspect is the question of when it is appropriate to use means, and when not. Broadly, means are appropriate as general indicators of trends, or to generate scenarios. For example, annual mean river flows provide a measure of the overall water resource for a region. Average river flows can provides a benchmark to assess changes in water balances, and the need for further evaluation and action. IPCC uses means to show possible streamflow changes under different climate scenarios.
However, the use of hydrological means is wholly inappropriate in project-level studies. Contrary to some past practices, means are inappropriate, for example, in impact assessment studies, or in benefit-

cost comparisons of projects to select options, or in the design of infrastructure. This is for several reasons including the fact that the key impacts on human and natural systems and performance are related to the flood and drought extremes, and for public safety reasons. Also there are additional costs involved to ensure the infrastructure can deal with extremes, and consequently the exclusion of these costs form benefit-cost assessments in planning and decision-making processes, can bias the results in terms of selecting options.

Other emerging planning approaches and methods

New methodologies for hydrological forecasting are constantly being introduced, and extensions or modifications to standard methodologies and their applications are occurring. Trend analysis is one example. Hydrologists in some countries, in a break with tradition, are also exploring procedures that give a higher weighting to recent records and incorporate these results as alternative scenarios, or in sensitivity analysis (e.g. weighing the past 10 years more heavily than earlier decades in statistical analyses). This applied to extreme events as well as means. Figure 2-1 indicates the variability in precipitation records in Israel that would have to be taken into account. In Cyprus, over the last century it was observed that average precipitation reduce in a linear trend a rate of 1mm per year, leading to an overestimation of water availability when using conventional forecasting methods[xxi]. A range of methods would typically be applied, however the essential consideration is the degree of uncertainty is inherently higher.

Figure 2-1
10-year cycle of rainfall in Israel[xxii].



Evolving practice is also to give infrastructure, catchments or river reaches different hazard ratings, and then apply design criteria (retrofit of new structures) appropriate to the hazard classification. This is standard practice in the USA where there are different design criteria for hazard classification (e.g. low, medium and high) based on dam height and type, reservoir storage capacity and the downstream population potentially affected by a dam break event. These classifications would have to be adjusted periodically in response to extremes, and their recalculation.

Essentially gradual adjustment of hydrological forecasting methods requires more regular updating of management criteria as climate records lengthen, and as information on the localized effects of climate change improve. Any water system undergoing periodic evaluation of, say, sediment yield in the catchment and the flood return period can incorporate climate change, and different rates of climate change that are observed should, optimally, be matched with different up-date frequencies. In current practice, however, reassessments are mostly made only after extreme events, an approach that would not facilitate smooth adjustment to a changing climate.

Conventional versus emerging practices

Table 2-2 below contrasts some characteristics of conventional and emerging approaches in hydrological forecasting, changes which are partly influenced by recognition of the need to take climate change into account.

Table 2-2 Representative changes in hydrological forecasting methods	
Conventional Practices	**Illustration of Emerging Practices**
▭ Use of standard methodologies that assume the future will look like the past: - where the quality, accuracy and robustness of forecasts was seen as improved with longer records (e.g. streamflow and precipitation); ▭ Methods relatively static over time and not frequently updated once calculated or used, either to reflect land use changes in the watershed, urbanization, etc. or climate variability (e.g. affecting runoff coefficients, return periods of floods, flood hydrographs, sediment yield coefficients, etc.) ▭ Hydrological means used in the feasibility level studies and impact assessments, and in some cases, for infrastructure design optimisation; (many of the costs associated with infrastructure relate to their ability to deal with extremes, and consequently their exclusion for planning and decision-making processes can bias the results); ▭ Limited use of real-time hydrological forecasting (which is a function of available technology but also reflecting investment priorities)	***General Approaches and Methods:*** • Systematic review and update of all methods and tools that are affected by climate change (including those for hydrological components, sediment yield and water quality); • Recalculation and more frequent updates of key methodologies such as return periods of floods, PMF (or PMP), and update of flood hazard maps and zoning based on recalculated hydrological parameters; • Development of new methodologies for unguaged catchments catchments based on these considerations; • More frequent update of infrastructure design standards and procedures based on revisions to standard hydrological parameters (e.g. from sizing storm runoff systems to spillway capacities of dams); • Update of water quality standards based on revised hydrological forecasts (e.g. permissible concentrations of releases in lower in-stream flows in summer); • Drought responses with hydrological-based drought indexes; ***In Design: - Where hydrological forecasts / criteria are used*** • Weighting of recent hydrological recent records to take into account recent hydrological variability; • Greater use of risk and scenario analysis techniques in hydrological forecasting applied to existing structures (failure and performance). ***In Operation Decisions:*** • Development of "seasonal" forecasts to trigger drought, preparedness and response measures; • More intensive hydrological monitoring and data processing including warning systems (floods and droughts); • Real-time data forecasting linked to operational decisions on infrastructure (reservoir) including "Nowcast" methods using monitoring and radar data looking hours and 2-3 days ahead.

2.3 Infrastructure planning and design: Adapting to greater hydrological variability and increasing operational flexibility

As noted, much of the existing water resource infrastructure in the region has been designed and is operated based on past hydrological conditions. This broadly applies to all physical assets in the system (e.g. dam spillway capacities and reservoir operating strategies; flood control structure designs and their placement in rivers, as well as associate river training works; the size capacity, and operation of diversion works, water off-takes, storm drainage systems and water waste treatment and discharge facilities and associated sediment exclusion structures; and the depth, capacity and sizing of shallow water wells and deep aquifer wells, etc.). To a certain extent modifications are continuously being made to these infrastructure and how they are operated to adapt to changing circumstances. However, the understanding and appreciation of climate change is a relatively recent phenomenon and the more significant adaptation issues have yet to be addressed in a systematic way. There are broadly three aims in adapting water resources infrastructure to climate variability and extremes.

- **Improving capacity to operate under a wider range of hydraulic conditions**

The primary factor is that infrastructure and other long-life investments need to be more robust, more flexible in design and operation, and able to function efficiently over a wider range hydrological conditions than in past. Capacities of some infrastructure would need to be reinforced to withstand failure and tolerance to failure (either performance related, or for precautionary safety measures that are identified in risk assessment), and to allow more continuous adjustments in operation over the economic-life of the infrastructure. This applies across the full range of water infrastructure for water management and providing services. This would be necessary to increase the capacity, where appropriate, to adjust to flood extremes and lower stream flows in summer. It also applies to the structural safety, performance and design of other public infrastructure situated in flood-prone areas, such as energy installations, bridges and roads.

- **Increasing Flexibility to allocate water to different uses**

A second factor relates to the Dublin Principle that prescribes water as an economic good. This calls for infrastructure planning and design approaches (new infrastructure, retrofit and operation) that recognize and provide flexibility to change water allocations to higher value use, as policies and priorities for water allocation change. This is particularly important as conditions in the basin change over time, such as land use patterns, population and urbanization, and new regulations (safety, economic, technical, environmental) emerge.

- **Improved environmental performance**

A third factor is to make provisions in the design (or retrofit) of infrastructure and their operation to incorporate environmental improvement and restoration measures, and broadly to more flexibly manage infrastructure in a manner that conforms to the Dublin ecological principle.

For hydropower dams this means, for example, consideration of new turbine designs that reduce fish mortality and injury by 50 percent or more, (e.g. fix propeller units and runners with fewer longer blades), fewer stop gates and a slower turbine rotational speed compared to conventional designs (to improved survival rates for fish passing through hydro turbines), and retrofit systems to attract fish towards bypass systems, and away from turbines. Other design considerations apply to water quality. For example, as noted previously, design measures can be incorporated in new infrastructure (and often in retrofit) that improve the water quality of releases from reservoirs (e.g. dissolved oxygen and temperature profiles), such as by installing variable level inlets, or providing air injection in hydropower turbines to compensate for low DO levels. Flexibility for current and future environmental flows can also be achieve by enlarging bottom outlet works of dams, and considering the choice, size, positioning of gates, and other low or high pressure outlets. They would not be sized just for minimum flows, but to permit periodic larger flushing releases and flood simulations at critical periods relating to the hydroperiod of downstream wetlands. Similarly, provisions and standards for effluent releases from water treatment plants will need to be modified to reflect the growing human production of wastes and changes in the waste assimilation capacities of rivers, and varied seasonally according to flow conditions.

- **Redundant or unsafe infrastructure can be removed**

In some situations also, hazardous or redundant infrastructure may be too expensive to retrofit or rehabilitate and it would be cheaper to partially or fully remove the facilities. In fact, most Mediterranean countries have large dams approaching the end of their design, or economic lives of 50 to 100 years. Decisions to life extend, or remove such dams or other infrastructure are increasingly required. And while the perception is that dam removal is a fringe or radical idea, in fact, the renewal, or removal of physical infrastructure that has exceeded its economic life is a normal consideration – dams are no exception.

Broadly, where it is no longer in the public interest, or economically or financially viable to operate and maintain dam, removal is one option that planners need to assess, where it is physically feasible to do so. Changing social values that call for restoration of river flows and ecological services, or public safety and reduction of legal liability from a hazard that is uneconomical to repair, or obsolescence or redundant services – are all factors that have influenced decision to decommission old or redundant infrastructure. To date there are about 500 examples of partial and full decommissioning in the North America as well as some recent examples in Europe.[xxiii] Most are smaller older structured but a number are large dams. One example is a 12-meter dam on the Léguer River in France that was removed after reservoir sedimentation reduced its effectiveness, while eutrophification effects reduced the water quality, and it was classed as a safety hazard to downstream communities due to inadequate spillway capacity[xxiv]. In the end, in proved cheaper to remove the dam than to rehabilitate it, even without considering the benefits of restored ecosystem services

Government regulations and leadership

Broadly, infrastructure design standards in place in each country would be gradually updated to reflect sustainability and climate change considerations. This is not a new concept, as standards are continuously evolving. However, adaptation adds a new orientation, focus and greater impetus for revision and update of methodologies and standards. One trend is to introduce regular risk assessments for safety and performance functions. Most Mediterranean countries have, or are now in the process of reinforcing dam safety management programs and legislation requiring environment assessment as part of the design of new infrastructure, or retrofit. Assessments that are more integrated have also been proposed by the WCD, such as to extend the assessments to encompass environmental and social performance and risks and not just. Compliance with the European Water Directive and other Environmental Directives will also be an increasingly important issue in EU Mediterranean countries. However, standards vary considerably and as yet, few countries require regular ex-post evaluations of infrastructure projects or the necessary monitoring systems in place (engineering, environment and social parameters) to generate information needed for decision-making on existing infrastructure. Ultimately the issue to be faced is the higher front-end costs that are involved, and how these are balanced against the much larger stream of benefits that are derived, or the increased risk and cost of delaying adaptation of the infrastructure.

Conventional versus emerging practices

Table 2-3 illustrates some of the considerations moving from conventional practice, to emerging practice incorporating climate change in infrastructure design and retrofit.

Table 2-3 Representative changes Infrastructure design approaches and methodologies

Conventional Practices	Illustration of Emerging Practices
- Design approaches for performance and safety design based on projection of past hydrological conditions - Infrastructure often planned and optimised for dominant single economic use - Design with limited physical provision or flexibility to change standard operation - Limited consideration of provisions for environmental effects and mitigation in design or operation	**Design Approaches: greater emphasis on:** - Flexibility to accommodate future changes in operation (e.g. increasing allocation of water to non-agriculture uses) - Operation under a wider range of hydrological extremes and river flow conditions (e.g. spillway capacities, and sediment exclusion and management) - Interactive effects and cumulative impacts of infrastructure in the basin (e.g. cascade operations, environment impacts, instream flow and groundwater recharge relationships) - Selection of equipment, design and operating strategies with environmental performance in mind (e.g. variable level intakes, size of outlet works, type of turbines, waste treatment releases in low flow conditions) **Operating strategies: greater emphasis on:** - More continuous adjustment of operation rules to reflect hydraulic conditions including real-time inputs; - Enhance environmental performance and releases for environmental flows; - Integration with land use management strategies (e.g. erosion and sediment control, releases and waste assimilation); **Life-Cycle Approaches and Decisions:** - Life cycle assessment and approaches in maintenance and management of infrastructure - Incorporation of climate change factors in maintenance planning, rehabilitation, and replacement cycles of existing assets. - Removal of infrastructure that is redundant or unsafe and more expensive to rehabilitate

2.4 Sediment management: Addressing a growing "hidden" problem exacerbated by climate change

Higher sediment loads in rivers expected with climate change would impact on water resource systems in various ways. Apart from potential direct impacts on the physical performance of water regulation infrastructure (e.g. accelerated riverbed aggredation between river channelisation structures and accelerated sediment infill of storage reservoirs), increased sediment loads would influence or change river morphological processes, as well as ecological processes and their productivity through changes in habitat and water quality.

Reservoir sedimentation has recently emerged as a major concern in water resource planning, not only in managing aging reservoirs with reduced live storage capacity (reduced reliability of water supply and power generation, and flood control effectiveness), but also in decisions on the long-term sustainability of proposed new dams and reservoirs. The present annual loss of storage in existing reservoirs is estimated at 0.5 to 1.0 percent globally, though the "best guess" is 2 % annually in some Mediterranean countries[xxv]. At a 1.0 percent loss rate there will be a 25 percent reduction in the existing freshwater storage capacity (6,000 km^3 of surface storage provided by large dams at present), globally in the next 25-50 years[xxvi]. And it will occur mainly in countries that are water stressed and most vulnerable to climate change effects. In particular, rates of sediment yield from large catchments with high induced erosion rates, such as prevalent in arid and semi-arid southern and eastern parts of the Mediterranean, as well as parts of semi-arid or drought prone northern Mediterranean countries (e.g. parts of southern Spain and Italy) are projected to increase from the combine effects of elevated temperatures that would affect soil retention characteristics, cycles of drought, land use change - and more concentrated, intense rainfall and flood events.

- **4000 existing large dams in Mediterranean water resources systems: where reservoir sedimentation may be a critical, and possibly ignored issue than needs attention**

The Mediterranean has just under 4000 large dams where sediment may be a concern, depending on the type of dam and basin context. As indicated in Annex A, the top five countries (in terms of the number of dams) are Spain, with 1,196 large dams, or just under one third of the Mediterranean total, Turkey (625), France (569), and Italy (524); while and southern and eastern Mediterranean counties have over 1,000 large dams combined, including those Turkey. In addition, there are tens of thousands of smaller embankment dams used for irrigation or water supply for farms, municipalities and towns that may be vulnerable to accelerated sedimentation. While many reservoirs are not subject to extreme sediment and have performed for centuries, key groups such as the International Committee on Large Dams (ICOLD) indicate that sediment related problems are set to intensify as more dams that were built since the end of the Second World War come of age (the average age of large dams in the world is 35 years, and it is higher in the Mediterranean). Sediment issues can appear within ten years of construction, but more typically appear as a significant issue 40-50 years, or more after construction.

In the past it was standard practice to consider reservoirs with an economic life of 50 or 100 years. Sedimentation infill that reduced storage capacity and service provision in latter years was not an important factor in benefit-cost analysis, due to economic discounting. In addition, physical provisions such as for sediment flushing by incorporating larger size of bottom outlets were not important as design criterion. In light of the controversy over large dams, it is not difficult to understand that reactions to the reservoir sediment issues vary. One perspective is that dams as new options for water storage need to be carefully reconsidered in light of issues such as accelerated sediment and evaporation affecting their long-term sustainability, while others argue that new storage capacity is urgently required to replace that lost to sediment in existing reservoirs.

- **More comprehensive incorporation of sediment concerns in planning and design**

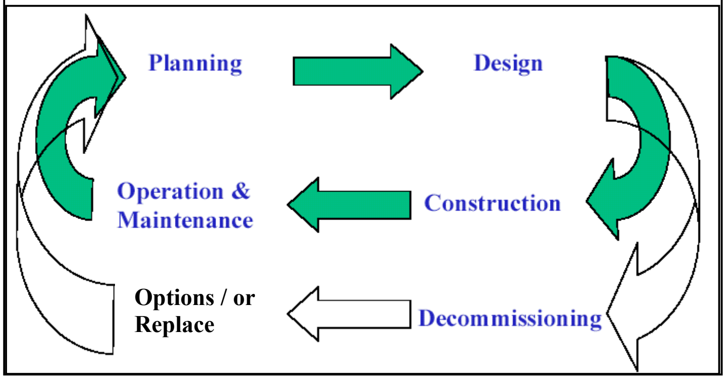
Broadly, the emerging approaches are to comprehensively included sediment concerns when balancing the selection of structural and non-structural responses to floods, and in the design of new water infrastructure, and for planning retrofit measures and operating strategies for existing facilities. Erosion and sediment control is also a major aspect of catchment and watershed management planning. Increasingly more in-depth sediment studies being undertaken in this regard, though the comprehensiveness varies considerably between countries and planning agencies within countries. Where approaches are more advanced, sediment studies are increasingly being extended to consider sediment-related water quality impacts to fish and wildlife habitat, recreation, wetlands, and cultural resources in assessment, planning, and the design of water resource interventions. Others studies are exploring long-term interactions of sediment and sea level rises including a sustainable ways to maintain land elevations in river deltas subject to sea level rise. One such case is the Ebro Delta, an important wetland area of the western Mediterranean where between 40 and 50% of the delta is below 0.5 m and part of the southern margin of the delta at mean sea level is an area protected by dikes.[xxvii] Issues there related to sediment management strategies for existing and proposed upstream dams.

- **Renewed focus on reservoir sediment management would be needed**

The following points illustrate some of the new approaches being considered to address sediment as part of life-extension and replacement studies for existing reservoirs to make services more sustainable. The options centre around five main approaches[xxviii]:

- **Improved catchment management**
  improving soil retention, reducing erosion and sediment yields with a variety of land use management measures, possibly supplemented with small sediment retention check dams - is broadly applicable in most circumstances;

Figure 2-2:
Life Cycle Approach to Reservoirs and Infrastructure Management



- **Routing sediment around reservoirs**
  use of sediment exclusion structures, bypass tunnels or canals to route sediment laden flood waters around reservoirs through tunnels at critically high flow period (when sediment concentrations are greatest) may be possible in certain situations;

- **Flushing and sluicing**
  use of low-level gates and bottom outlets to flush or sluice sediment during high floods and at other times, density current venting where applicable in certain situations; during refurbishment cycles in may be possible to retrofit measures (such as enlarging bottom outlets) to increase capacity for these measures;

- **mechanical removal**
  hydraulic dredging or dry excavation may be an option for some medium or smaller reservoirs depending on the characteristics of the sediment, though general estimates are that dredging can be five times more expensive than flushing; other factors that affect the viability of this option are the characteristics of the sediments (degree of consolidation, presence of toxic contaminants from agriculture or industrial pollution), and the availability disposal sites for dredged sediments.

- **Partial or full decommissioning**
  this strategy is considered where structures (or reservoirs) are rendered redundant, inoperable or unsafe due to sediment build-up and due to a combination of factors, it may be in the public interest to partially of fully remove the infrastructure.

The possible application of each strategy would be assessed on a case-by-cases basis including consideration of the potential effects on downstream uses, the effect of sediment management on the normal operation of the dam, effects on other reservoirs or water management infrastructure in the basin, and in relation to overall approach for water management in the basin.

While awareness of sediment management is growing, adaptation planning would call for more concerted efforts, such as to: improve monitoring of cumulative sediment build-up in reservoirs; assess the extent of vulnerability to sediment effects; and, selection and implement viable options as part of a comprehensive sediment management programme. The initial focus would be on major structures such as reservoirs and flood management systems. Here, a considerable amount has been learned over the past years and tools exist to provide solutions that overcome some of the problems. To move in this direction, it would be important to influence the public and private agencies and owners of infrastructure, either through regulation, or through building awareness of how measures improve performance or profitability. Mainly because of cost-cutting or regulatory obstacles, investment in improving aging infrastructure has been lagging behind what is generally desirable.

Conventional versus emerging practices

Table 2-4 illustrates some of the considerations moving from conventional to emerging practice incorporating sediment issues in planning and infrastructure management.

Table 2-4 Representative changes in sediment management approaches and methodologies

Conventional Practices	Illustration of Emerging Practices
• Sediment exclusion and control always considered in various structures – e.g. water intakes, irrigation canals • Storage reservoirs designed for economic life (e.g. 50-100 years), with discounting no real effect of rate of reservoir loss was factored in – thus not influencing either the choice of option or design • Sediment issue considered on a case-by-case design basis in isolation from other infrastructure, landuse practices in the basin; • Limited on no sediment monitoring of major facilities • Little explicit planning or design of sediment management, and sediment management a limited factor in operating strategies of water regulation	***Approaches to Sediment Management:*** • More explicit up-front consideration of sediment issues in planning, selection of options, and their design • More comprehensive approaches to sediment control and management including life-cycle approaches to reservoir sediment management; • Stronger emphasis on watershed management, soil stabilization and erosion control programmes as complementary to sediment management with infrastructure • Consideration of basin-wide and cumulative impacts of sediment; • Consideration of sediment as a water quality issue impacts on ecological processes. • Consideration of longer-term sediment interactions in deltas in conjunction with possible sea-level rise ***Methods and Applications: introduction / reinforcements*** • Of sediment monitoring of strategic infrastructure; • Of methods for reservoir sediment management: - improved catchment management (erosion control) - routing sediment around reservoirs - flushing, sluicing, density current venting - mechanical removal of sediments • Partial or full removal/decommissioning of critically impaired flood defences /water management structures and facilities; • Extensions of findings from sediment studies (under climate change scenarios) to all potentially affected infrastructure, and operation practices, and design standards.

2.5 Environment Flow Methodologies: Sustaining aquatic and wetlands systems and increasing their capacity to successfully adapt autonomously

Policies on environmental flows are perhaps the most important, direct connection between water resource and wetland resource management. Environmental flows (sometimes referred to as ecological, or instream flow requirements, or compensation flows) are defined as the amounts and quality of water necessary to preserve ecological functions and values in watercourses. One set of challenges in water resources planning today is to define environment flow requirements (quantity, timing, quality on a seasonal basis), integrate them in water allocation policies and achieve consensus on this, and translate and incorporate those requirements into the operating rules for flow regulating structures, such as dams, reservoirs and diversion schemes.

- **Wetlands hydroperiod rely on precipitation, surface flows, and groundwater discharge – or a combination**

Wetlands are a critical component of aquatic systems and depending on their location and type may rely on precipitation, surface flows, and groundwater discharge - or some combination. Environmental flows actually define the "wetness" of the wetland systems that rely on surface flows (i.e. the patterns of water depth, and the duration, frequency, and seasonality of flooding) that together constitute a wetland's hydroperiod. In turn, the hydroperiod, among other factors, determines its vegetation composition, habitat for aquatic organisms, and other ecosystem services and production characteristics. Environmental flows also serve to recharge ground water and thus also serve many groundwater-dependent wetland systems in the watercourse.

As noted previously, climate effects such as higher human water demand and surface evaporation (temperature effect), and lower stream flows in summer (hydrological cycle effect), would increase competition for available water supplies, thus directly and indirectly add pressure to aquatic ecosystems and wetlands. Effects will be most critical in water-stressed basins. In highly regulated watercourses where water availability exceeds demand, environmental flow provisions are equally important to "simulate" the wetland's natural hydroperiod, to ensure water quality is not harmful, and conforms to standards required by government environmental regulations and water policies (e.g., temperature, dissolved oxygen and chemical properties of water releases as specified in regulations).

- **New approaches are being developed to quantify and apply environmental flows standards**

A number of new planning approaches are emerging to quantify and apply environmental flows standards. These have been be grouped in four main categories: historical flow record methods, hydraulic rating methods, habitat-rating methods, and holistic methods.[xxix] The first category consists of approaches where historical flow records are used to develop environmental flow, or instream flow recommendations, based on subjective assessments of ecosystem needs. Hydraulic and habitat rating methods utilize relationships between habitat condition and discharge to develop instream flow recommendations. In this category the Instream Flow Incremental Methodology (IFIM) represents a type of hydraulic-habitat methods, and it is now widely used in the Australia, New Zealand, Britain and South Africa, as well as the USA. The final and more complex method is the holistic approach to the assessment of instream flows and water quality aspects, in which all components or attributes of the ecosystem and their interrelationships are addressed.

What the new methods have common is that flows are based on maintaining ecological processes reflecting what may be daily and seasonal variations that correspond to ecological processes and aim to approximate, or as best as possible, recreate minimum critical aspects of the hydroperiod of downstream wetlands. Because riparian and estuarine ecosystems may require higher average flows than stream biota need, and because such ecosystems and riparian wetlands require periodic flooding to maintain the productivity and life cycles of their biotic components, this may include periodic flushing releases and periodic flood simulation; such as provision for non-summer conditions, for spring flushing every year, a larger flood simulation every 5-10 years. These assessments of the minimum requirements are translated into flow volumes, and then within the framework of regulations are balanced against other off-stream and instream uses to arrive at operating strategies.

Often the more critical periods are during drought situations. Here, additional considerations would include adjusting minimum environmental flows to the drought classification system and linking environmental flow provisions in longer-term drought policies. Frequently, the most important starting point is a clear policy on environmental flows.

Conventional versus emerging practices

Table 2-5 indicates some of the broader shifts that are occurring in respect to incorporating environmental flows in water resource planning and management.

Table 2-5 Representative changes in environment flows approaches and methodologies

Conventional Practices	Illustration of Emerging Practices
• Downstream releases initially developed by water resource planners/civil engineers to met downstream human uses (e.g. water supply off-takes, navigation, etc, and sometimes water quality), but less consideration of ecological protection or restoration considerations • No regulatory requirement, or explicit provision for environmental flows or taking these into account in abstraction policies or infrastructure design (location, design or operation) • Sometimes rules of thumb such as 10% minimum flow provision sometime used • No internalisation of flow releases in benefit-cost analysis of proposed water regulation projects • Strictly flow volume, or quantity based and calculated for average flow conditions • Design of structure with limited flexibility to change environmental flows (e.g. outlet works design)	**Awareness and Regulatory Basis** • Basis for environmental flows reflected in Agenda 21 and Dublin Principles, Ramsar Convention, EU Directives and increasingly in national environmental regulations in broad terms; • Increasingly incorporated in planning including linkages between ground and surface water flows • General shift to use environmental quality indicators as basis for establishing environmental flows. (e.g. observing critical spawning and migration periods, water quality and temperature at different seasons, ecosystem health and productivity indicators) **Planning /Design Approaches** • Use of more sophisticated instream flow methodologies that integrate biophysical considerations with social and economic considerations; • Introduction of a variety of new methods (historical flow record methods; hydraulic rating methods; habitat rating methods; and holistic methods) • Stream classification systems for required environmental flows; • Internalised in benefit-cost evaluations of infrastructure (e.g. taking into account effects of environment flow provisions on reduction in power production and project benefit-cost analysis and different scenario's of environment flows) ***Applications: (Increasing trends)*** • Incorporated in design of dams and reservoirs (e.g. sizing outlet works, variable level intakes; and releases patterns and water quality factored into infrastructure operating strategies) • Strategic monitoring of environmental quality and making flow adjustments in first critical years of operation • Incorporated as consideration in retrofit (e.g. provisions for flushing releases, water quality)

2.6 Decision support systems: Optimising solutions to complex problems

Decision support systems have emerged in reaction to the growing complexity in water resource planning, and the need to reconcile many conflicting interests in managing land, water and infrastructure in river basins. Decision support systems are a natural evolution and extension of conventional methods of planning and analysis, particularly where they serve as a common "platform" to integrate new approaches with conventional practices. Decision support systems and tools have been made possible by parallel advancements in information technology, computer modeling and relational data bases, hydrological and water quality monitoring, computer-based GIS mapping and access to satellite imagery. Typically they amalgamate a number of analytical procedures and methods to enable planners to assess selected components of complex systems, and then investigate causal relationships between the various sub-systems. Some of the more sophisticated versions link GIS mapping systems and relational databases with computer models that are capable of simulating certain physical and natural processes in basins. These are increasingly being developed and applied in a variety of multi-sector and sector-specific water resources planning applications. For example, it is now possible to model land use changes in a catchment and compare how the different land management policies would impact on infiltration, runoff, instream flows and groundwater levels in the watercourse, as a basis for planning.

Decisions support systems are also used for day-to-day operational decisions for water regulation facilities. For example, they are especially used to optimize releases from reservoirs for peak and off-peak hydropower generation, often on an hourly and daily basis, and to meet schedules for releases for other purposes (irrigation, environmental flows, and flood management, etc.). These tools have a high degree of specificity and optimize short-term demand-supply relationships (demand following - at operational levels), taking into account real-time fluctuations in power and water demands in the system (that may be climate related). This is balanced with real-time information on hydrological conditions in the basin relayed from strategically located monitoring stations.

Conventional versus emerging practices

Table 2-6 indicates some the changes between conventional to emerging approaches in the used of optimisation techniques and decision support tools in water resource planning.

Table 2-6 Representative changes with decision support systems and tools

Conventional Practice	Illustration of Emerging Practices
Decisions based on standard analysis (decision support systems are relatively new) Limited use of optimisation analysis and studies (which reflected practices of the day, and more limited access to data access, computer processing, and information systems, etc.) Optimisation studies that were undertaken were largely applied in the design of major structural components of facilities, but with a limited set of technical and economic criteria Operating strategies and rules typically remained static once they were established, and usually updated only in response to significant events or crisis only (e.g. rule curves for reservoirs) Limited capacity and access to real-time information systems	***Types of Tools: e.g.*** • Simple models for policy/planning or design decision support on specific issues • More complex, interactive expert systems for identifying, assessing and priorizing in options in long-term planning taking into account interactive effects (systems, options and impacts) using multiple criteria • Real-time systems for optimising operational decisions in the operating facilities ***Applications: Policy/Planning/Design Decisions e.g.*** • Options Assessment (e.g. looking at effects of structural, and non-structural responses to water management issues) • Environmental Impact assessment and looking at specific natural processes (e.g. river morphology, ground water recharge in riparian zones) • Asset management and life cycle assessments (e.g. for maintenance and rehabilitation planning) • Operating planning (e.g. reservoir release patterns, for water withdrawals and instream uses and water quality) • Adaptation planning (e.g. identifying and selecting measures) ***Applications: Operation Decisions e.g.*** • Optimising day-to-day releases/withdrawals of water for different uses (within water allocation policy); • Emergency responses (such as draw down of reservoirs based on flood warning systems)

The UNFCCC Secretariat has published a survey of decision support tools to evaluate strategies and measures for climate adaptation planning.[xxx] The tools which are both multiple-sector and sector specific and are intended for use by managers or technical researchers, and do not require extensive specialist knowledge of the modelling or decision-making techniques that are employed. Broadly, decision support systems and the associate investment in human resources and hydrological monitoring facilities and networks would be a priority investment in climate adaptation programmes.

2.7 Risk assessment and management: A wider perspective to take account of all issues and stakeholder perspectives

Risk assessment is one component of an overall a risk management perspective or approach to water resources planning and development and climate adaptation. Here, risk assessments may be seen both as enabling processes and analytical tools - that help identify, evaluate and priorize broader water resource development options, as well as measures for climate adaptation.

For example, translated to the basin or local level, risk assessment processes provide a way to engage local stakeholders and rural communities in planning decisions that affect them, such as the measures to mitigate the specific drought or flood risks that they face (e.g. crop, livestock and health risks in the case of drought, and loss of property or facilities on an individual or community level in the case of floods - and general financial, economic, livelihood and environmental risks). Risk assessment in its various analytical forms is also important as a standard tool in project-level decision-making. Various risk assessment techniques are increasingly used to inform strategic decisions at all stages of the project cycle from options assessment, to choices about design, operation, retrofit, and life-extension or decommissioning of infrastructure.

- **Risk assessment can help stakeholders and decision-makers to better understand the issues and resolve conflict in the selection of measures**

The range of issues that are brought out in risk assessment processes often lead to a better understanding among stakeholders and decision-makers of why different groups of people actually view specific options in a more favourable, or in less favourable light. They thus lead to more informed debate about the tradeoffs that invariably have to be made (e.g. to build higher flood defences, or to strategic retreat from more vulnerable flood plains, or coastal areas). Properly carried out, they can improve public acceptance of the more difficult decisions, and foster the cooperation, and ultimately ownership and partnerships needed to implement measures (e.g. demand management or water recycling measures that require investment by end users collectively, with the result that restrictions in supply may not need to be imposed, or less severe).

- **Risk management at different levels, and incorporating different perspectives on risks**

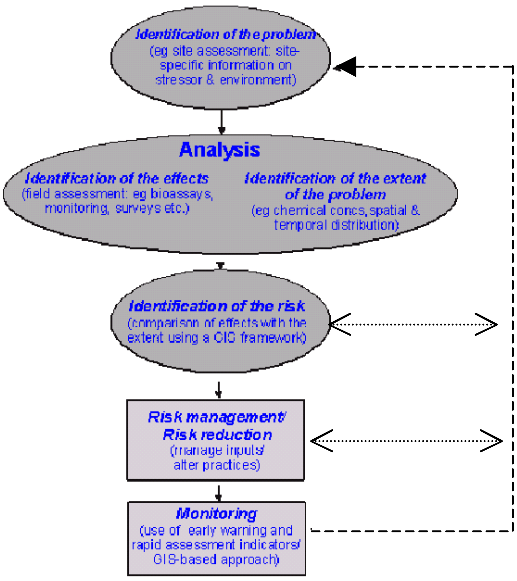
While water resource planning has always required an implicit recognition of the inherent risks and uncertainty in water resources development, the explicit treatment of risk in planning studies has been uneven and limited. Until quite recently, risk assessments were focused on risk-safety analysis of water infrastructure structures related to hydrology (mainly floods), or risk-cost analysis for project planning, evaluation and selection (e.g. technical performance, conventional project-risks, cost recovery and loan repayment). To some extent these approaches have been overtaken by a number of events that include the recognition of inability of past hydrology to forecast climate change, controversy over the risks to different stakeholders that have been excluded from decision processes, and the determination of acceptable risks that would influence the choice of options. The larger picture now is that risk management in water resources has to be approach at different levels: from strategic planning to operational levels. For example, assessment of the vulnerability of whole sectors of the economy to climate change has now become part of the decision-making process to inform public policy and strategic choice.

- **Integrated risk assessments are important in assessing adaptation measures**

There is no single risk analysis technique. Risk concepts from different social and natural science disciplines have recently been introduced in the growing body of risk management theory and practice in water resource planning, such as the precautionary principle that was introduced (or reintroduced) with Agenda 21. Broader more encompassing approaches to risk would take into account the fact that all disciplines now involved water resources planning, (e.g. ecology, economics, social science, and engineering) possesses their own professionally developed procedures for risk analysis and perspectives. What is important is that risk analysis appropriate to each sector or discipline is undertaken, and then brought together in an integrated risk assessment – applied to the project, measure or activity.

In the case of an infrastructure option, this means risk analysis would be undertaken for engineering structures and environmental and socio-economic effects, along with the conventional engineering and economic risks. It also means that risks to all water users will be considered, not just generalized public safety. Here for example, individuals or communities may face certain risks of loss of property, livelihood or entitlement either as a consequence of climate change, or the measures taken to combat them (e.g. resettlement from a flood plain, or reservoir areas of a proposed dam). Risk to poorest and vulnerable in society would be considered in terms of both empowerment to participate as an equal voice in decision-making processes that affect them, and entitlement for appropriate compensation for loss of various entitlements, water access and other livelihood risks.

Figure 2-3
RAMSAR – Risk Assessment Procedure (COP-6)



The risk assessment processes may also have a sector specific orientation. Figure 2-3 Illustrates wetlands risk assessment procedure adopted by RAMSAR in 1999 (from COP-6).

For risk assessment of climate adaptation measures, many of the standard methodologies apply. For example, the UNEP Handbook on Adaptation Planning[xxxi] sets out three standard approaches to be applied in assessing measures in a planning context, namely:

- **Sensitivity analysis:** determining whether varying input values significantly alters the output value (net benefits); and determining whether the decision has characteristics that suggest that climate change (or other sources of uncertainty) could be relevant.

- **Scenario analysis:** generating a limited set of plausible input values and their associated outcomes (net benefits); generally used for climate parameters, but it can also be used for other areas of uncertainty and evaluating a measure under both "worst case" and "best case" scenarios to illustrate whether uncertainty is important to the final decision.

- **Use of thresholds**: indicating how defined critical thresholds can be affected by a measure, or used to implement a vulnerability-oriented approach to climate change assessment.

Another concept in adaptation is looking at risk assessment as a "living approach" which can be used by planners and decision-makers to periodically reassess the current position in light of changing hydrological conditions, an also more broadly evolving political considerations, the economy, evolving community values, results of performance and impact monitoring, and other factors. Here for example, climate change may alter the risk that design standards for safety are exceeded (e.g. the previous standards for dam spillways designed for PMF would be exceeded – where climate change increases the PMF calculation), or the management threshold that relates to the tolerable risk is altered (e.g. where political, social or economic costs are perceived to be higher if a failure in performance, safety or environmental effect of a measure occurs). One emerging approach to address the increase in uncertainty and change is to move from strictly performance-based to risk-based standards and procedures using multiple scenarios for estimating the risk of a threshold being crossed. At the present these approaches at mostly at the forefront of thinking but are expected to become more standard in future.

Conventional versus emerging practices

Table 2-7 compares some conventional and more contemporary aspects of risk assessment and risk management in water resource planning.

Table 2-7 Representative Changes in Risk Assessment and Management Practices

Conventional Practices	Illustration of Emerging Practices
• More limited use of risk analysis in water resource planning, particularly as regard to the evaluation and selection of options (structural and non-structural response) • More recently, it became common practice to included sensitivity analysis in feasibility studies, and at some basin planning studies • Mostly focused on risk-safety analysis of water infrastructure structures • Risk analysis procedures and criteria focused on economic, engineering and public safety risks • Use of standards based approaches to account for risk in infrastructure design (standards that are based on historical experience, hydrological conditions, etc.)	***Approaches and Methods*** • Risk criteria extended from mostly engineering to now include a wider range of environmental and social criteria; • Integrated risk assessment approaches that draw on the risk assessment procedures prepared in each sub-discipline in water resource planning; • Greater use probabilistic risk-based analysis; • Expanded use of sensitivity analysis – in determining whether varying input values significantly alters the output value (net benefits); • Expanded use of scenarios analysis - generating a limited set of plausible input values and their associated outcomes (net benefits). Evaluating a measure under both "worst case" and "best case" scenarios • More user-friendly risk and uncertainty analysis for multi-disciplinary stakeholders, analysts and decision makers alike; • Use of multi-criteria risk formulations; • Expanding the scope of "risk" considered from that of public agency and/or investors risk to the "risks – interests" of all stakeholders (positively and negatively effected); • Incorporation of continuous risk management concepts – moving to a "living approach" in risk management; ***Applications*** • Applied now in a broader range of planning stages from strategic options assessment, to evaluation of overall plans, evaluating design options and operation decisions; • Planning related to new infrastructure, and deciding rehabilitation and maintenance options (linked to life-cycle infrastructure decisions) • Used in contingency planning covering all public risks and management of water resource as a public good; • Risk-based dam safety assessments • Supporting the moving in some settings from standard-based approaches to a mix of standard and risk-based approaches to infrastructure design.

2.8 Scenario-based analysis: Decision-making under uncertainty

Scenario analysis is becoming increasingly important as an approach and tool in water resource planning, given the increased complexity, uncertainty that has to be dealt with and the expanding participation in decision-making processes. Of all the methods for participatory decision-making, experience has shown that mixed groups of professionals and stakeholders interact best using scenario analysis methods. Simulation modeling can be made user-friendly enough to enable scenario analysis even in workshop settings for large public planning studies[xxxii].

Scenario analysis is also applied at different stages of water resource and adaptation planning. For example, a coherent scenario, or set of scenarios that incorporate a plausible range of future conditions (socio-economic and environmental, demands forecasts, hydrological regimes) is a starting point for planning exercises. Here it is possible to discuss and obtain upfront agreement on the critical assumptions. Scenarios are also an intermediate output of planning, where scenarios provide the basis for integrated, multi-criteria assessment and debate on various policies and actions that are identified in the planning process.

Scenarios are commonly used in climate change impact, adaptation, and vulnerability assessments to provide those engaged in planning with alternative views of future climate conditions, and outcomes from adopting adaptation measures where the probabilities cannot be established with a high degree of certainty. Here, scenarios analysis can be also used to evaluate specific measures under both "worst case" and "best case" situations. The EU in its 3rd Communication to the IPCC indicated that water resource managers will need to develop better methodological procedures for adopting a scenario-based approaches to strategy or scheme management, and develop adaptive techniques to allow incremental adjustments over time. The GWP similarly calls for the use of scenario building for water demand projections to identify possible ranges for various categories of future water demands, assessing effective demand by analyzing the behavior of users as they react to water scarce situations to provide key information vital to determining appropriate pricing policies.

Table 2-8 indicates some of the directions emerging for use of scenario analysis in water resource planning.

Table 2-8: Representative changes in scenario analysis approaches and methodologies

Conventional Practice	Illustration of Emerging Practices
• In general, more limited use of scenario analysis in past water resources planning exercises • When scenarios were used, they were most common as input for planning focused on demand projections (e.g. low, medium and high water or power demand forecasts) • Common practice was to produce one (optimal plan), not a series of plans or variants (scenarios) for debate and discussion. • Uncertainty was usually addressed using sensitivity analysis in project feasibility studies	***Scenario Analysis and Methods:*** • Scenarios now used as a basis for up-front identification (and agreement where provided for) on the key planning assumptions • Use of a wider, enriched set of scenarios for input to planning exercises such as demand, and socio-economic conditions, hydrological conditions) • Shift to multi-criteria scenario analysis approaches, also involving stakeholders in identify and weighing criteria • Instead of a single plan, production of different plan alternatives (or scenarios), that are subject to scenario analysis and public debate before the preferred plan is advanced got approval (e.g. different scenarios, with and without pre-agreed demand, supply and policy options; structural and non structural options, etc.) • Different mixes of climate change measures evaluated for different scenarios of climate change and sea level rise (e.g. sea level rise by a certain date, and different frequencies of floods of a certain height, or reductions of summer river flows)

3.0 CLIMATE ADAPTATION IN THE WATER RESOURCES SECTOR-TOWARD A FRAMEWORK

In its Third Assessment Report, the IPCC (2001) referred to climate change adaptation as the changes in the policies, processes, practices, and institutional arrangements to moderate the significant vulnerabilities, and to benefit from the opportunities associated with climate change. Both mitigation and adaptation would require a complementary mix of short, medium, and long-term strategies and measures, implemented on a stage-by-stage basis, in a priorized way.

Recent UNFCCC sessions saw constraints and slow (varied) progress putting in place adaptation plans and measures

The recent Conference of the Parties to the UNFCCC (COP-8) held in New Delhi (Nov 2002) reaffirmed the need for more urgent action to advance adaptation measures. General themes in the Ministerial Declaration of COP-8, on adaptation matters were restatement that:

- Adaptation requires urgent attention and action on the part of all countries to conform to the Convention. Effective and result-based measures should be supported for the development of approaches at all levels on vulnerability and adaptation, as well as capacity-building for the integration of adaptation concerns into sustainable development strategies.
- National sustainable development strategies should integrate more fully climate change objectives in key areas such as water, energy, health, agriculture and biodiversity, and build on the outcomes of the World Summit on Sustainable Development (Johannesburg); and
- Parties should promote informal exchange of information on mitigation and adaptation to assist Parties to continue to develop effective and appropriate responses to climate change.

In the expert group sessions at COP-8 additional concerns were expressed over the apparent lack of progress in adaptation planning. This was noted as partly due to difficulties in identifying and applying methodologies to assess the effects of climate change and the response measures, and partly due to lack of follow-up and connection of the findings with policy-making[xxxiii]. This was tempered by the fact there was also some difficulty in distinguishing what was purely an adaptation response, and what was a general advancement in sustainable resource management.

What came out as general conclusions from some of the working sessions in regard to adaptation was:

- National communications have provided a good leaning process for considering adaptation issues and measures. But, in view of the technical constraints and problems encountered in the preparation of national communications, there is a need for financial and technical resources to enhance national capacities in non-Annex I Parties for preparing national communications;[7]
- While many adaptation studies have been undertaken by non-Annex 1 countries, as yet, only a few have seen results reflected in actual adaptation policies or activities;
- Numerous broader approaches (frameworks) have been adopted, and with them, many specific methods have been employed. The approaches and methods chosen are usually determined by the sponsoring agency (in the country or externally supporting);
- For most stakeholders and policy decision makers, conventional climate change conditions and impacts (e.g. impacts of changed temperature in 2050) appear to be of less interest. However, stakeholders and policy makers are very interested in more immediate climate variations and extremes, which have significant impact;
- There is a need to show the connection between long-term climate change and variability and extremes more clearly. Here, there is a need to modify variability, impacts and adaptation

[7] As at June 2002, all Annex 1 countries, and 20 of 46 least developed country Parties had already submitted their initial national communications while 64 of 100 non-Annex I Parties that are not least developed country Parties had yet to submit their initial national communications;

approaches and methods to climatic conditions other than temperature, e.g. flood frequency, drought magnitude and probability, rainfall intensity storm locations and frequency;
- For the enhancement of adaptations (as per UNFCCC Article 4.1), methods and guidelines need to connect better with policy; and,
- For most countries, particularly non-Annex I, methods must be practical, appropriate, feasible, easy to implement, not costly, not requiring data which is unavailable or would require time and money to compile. Thus while further action is needed to improve the quality of information, it is important to enhance the capability of developing country Parties to make the best use of available methods and tools.

It is now widely accepted that a national process and plan is needed to coordinate responses to climate change across sectors, and to harmonize planning in the different sub-sectors, and at different levels of water resource management. In fact, there may be a hierarchy of plans (or guidance papers, procedures, etc.) at the national, sectoral, basin and municipal or local levels that correspond to how the various responsibilities for planning and decision-making on water resource management are allocated within the country.

Here transparent processes for producing and harmonizing these plans also provide a mechanism to involve stakeholders and for public debate on the alternative strategies and measures.

3.1 Adaptation Planning Framework: Processes and Measures

In COP-7 (2001 decision 28/CP.7) a set of guidelines for National Adaptation Programmes of Action (NAPAs), aimed at non-Annex developing countries were approved. These are cited in Annex B. They were for all sectors, not just water resources. The rationale for developing the guidelines rests on the comparatively higher vulnerability, but low adaptive capacity of many developing counties, which renders them in need of immediate and urgent support to start adapting to current and projected adverse effects of climate change. Activities proposed through NAPAs would focus on those whose further delay could increase vulnerability, or lead to increased costs at a later stage. The decision at COP-8 was the current versions of the guidelines would be maintained for the time being, and updated at COP-9 based on progress applying them and working group recommendations.

Starting with a National Framework

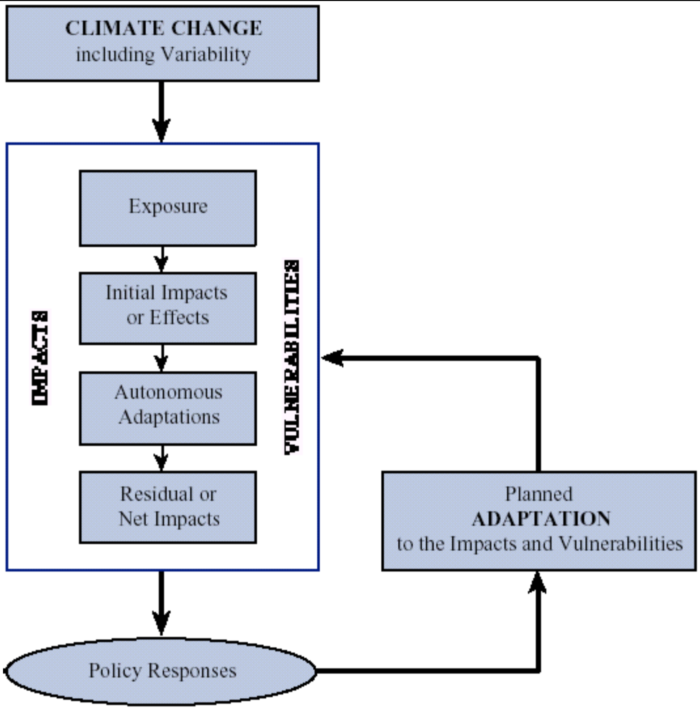
An illustration of what the NAPA guidelines broadly suggest is provided in Figure 3-1, which actually shows the analytical framework used by IPCC to prepare its regional-scale assessments of climate change impact, vulnerability and adaptation. By analogy, it indicates how country-based adaptation frameworks may be initially conceived, and then go further to institutionalise the process after the first NAPA. The eight process elements show in Figure 3-1 represent activities that may be incorporated in the first cycle of a national level processes.

The general approach would likely reflect the model many Mediterranean countries chose in responding to the UNFCCC to meet GHG emission reduction targets. Here, management of the national processes would generally be under the responsibility of the national climate change focal point initially, or whatever Commission, Agency or Interdepartmental Panel, Task Group or Committee that the Government mandates to co-ordinate work across sectors.

The National group would sketch out the broader conceptual outlines of the national program, and develop, or ensure preparation of basic scenarios for future climate change, as well as the socio-economic and environment conditions on which impact, vulnerability and adaptation planning in each sector would be based. Individual sectors would then be invited to prepare the assessments and formulated adaptation measures within this framework, possibly with the sector representative on the lead group functioning as a coordinator. Once the sector inputs were available, these would be brought together in an integrated assessment to produce a set of overall national priorities and express these in a plan.

The UNFCCC Secretariat suggests using an interdisciplinary NAPA team to prepare model sector responses where sub-sector capacities are limited, at least for the first round of the NAPA.

Figure: 3-1 Illustrative Analytical Framework and Process Elements For the All Sectors

<table>
<tr><th>Conceptual Framework</th><th>Eight Process Elements</th></tr>
<tr><td>


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- **Assess Key Vulnerabilities:** in each sector in relation to projected "best and worst" case scenarios for climate change;
- **Clarify Adaptation Policy**: e.g. guidance on balance between precautionary approaches to risk, acceptable risk, and the use of cost-benefit methods;
- **Establish Adaptation Priorities**: areas where implementing adaptation response is most urgent, and those that are secondary;
- **Select Adaptation Measures**: Evaluate and select measures (short, medium and longer term effect) responding to adaptation priorities;
- **Cost Measures**: Estimate financial cost of measures and how they will be borne;
- **Define Implementation Responsibilities /Roles**: For resource management agencies, government, stakeholders, and actions that others might have to consider;
- **Formalize Adaptation Plan**: Prepare plan for public consultation, showing integration and coherence with existing resources management plans;
- **Continuously Modify Plans**: Based on progress monitoring, feedback, examples/experience of others, and new information.

</td></tr>
<tr><td>Source: Conceptual Framework Adapted from IPCC – 1995</td><td></td></tr>
</table>

The process would have iterative steps, and the integrated national plan, and sector-based adaptation plans, would be opened for public consultation (either in the first iteration, or in a second iteration when the details are more specific). In any event, plans would be produced in consultative processes that widely engage, civil society, the private sector, non-government organizations, academics and key research institutions in all stages, and from the outset. Decision-makers would thus be better informed of the tradeoffs that are implied, and public attitudes on the more contentious issues.

In the Mediterranean, the required networks for this are already in place at both regional and national levels, and in many cases, it would largely be a matter of involving them appropriately. In fact, the same working groups and review networks that are now in place for emission reduction planning and implementation may be appropriate for the adaptation work, though there may need to be some reconstitute of the membership to ensure adequate representation of those groups involved in adaptation, and at different levels.

Figure 3-3: Illustration- Integration of Assessments Across Sectors

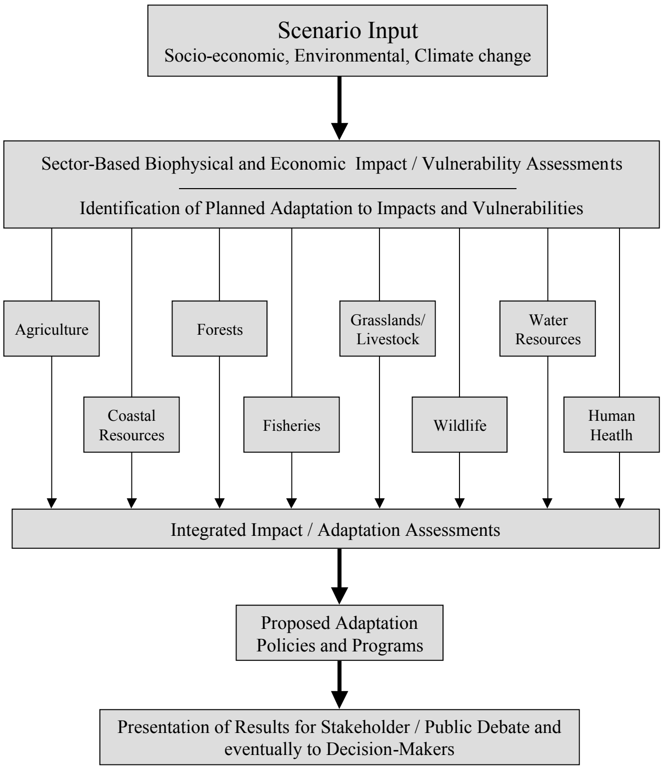

Figure 3-2 shows the framework used by Egypt to develop its first national adaptation assessment and preliminary plan in the mid 1990's, with UNEP and USAID support. For Egypt, one major consideration was to obtain a preliminary understanding of what accelerated sea rise (ASR) implied, in terms of the probable impacts on vulnerable coastal zones.

- **Water Resources: Sector level processes**

Adaptation planning in the water resource sector (as part of a larger national effort) would require a similar, overall coordination processes involving each sub-sector in water management and service provision, and the major constituencies.

Apart from the appropriate policy, planning and regulatory groups in government, those involved would include, for example:

(1) organizations involved in supply provision (e.g., key municipal /provincial agencies and private sector groups responsible for water service delivery);
(2) organizations involved in resource and environmental management (e.g.; basin organizations, watershed management organizations, environment and wetland organizations, agencies responsible for flood, natural disaster, and drought management);
(3) organizations, or representation from each of the water demand sectors (e.g. irrigation, municipal water supply, industrial user, recreation/tourism industries), and the owners/operators of facilities for instream water uses (e.g. hydropower, and navigation as appropriate); and,
(4) Civil society, non-government and private sector groups actively involved in research and policy dialogue on water resource management, climate change and related environmental issues.

How the actual process for adaptation assessment and planning is structured will depend on the existing water resource planning and management framework and division of responsibilities in the country.

Because the assumption and approaches used in each sub-sector need to be coherent and coordinated, guidance materials from the central/lead organization would be necessary, at least initially. Here common assumptions to prepare vulnerability assessments and adaptation plans in sub-sectors would be specified, and meetings and workshops would be organized to explain them. For example, "worst and best" case climate change scenarios would be prepared by the national coordination entity, directly, or by tasking the appropriate hydrological institutes in the country. This task would not be left to each sector, as it important not to divert the efforts of planners and water managers away from adaptation work. Here the IPCC (2001) remarked that water managers mostly need resources, research and management tools aimed at adapting to uncertainty and change, rather than refining and improving climate scenarios. Key assumptions would be set out in a way that planners could readily use. For instance, agencies working on gap reduction measures (demand-supply) would need to know the provisional water allocations for each sector (e.g. irrigation, commercial, household, industrial sector and environment flows), and whether to assess responses against different demand-supply gaps, and over what time frames.

Similarly, in order to prepare vulnerability assessments in each sub-sector, it would be important to establish a common understanding of the tolerable risks, and the basis for determining them in the guidelines. This is because the priorities for adaptation would be considered in relation to how the current resource management measures respond to current climate variability, plus the changes that are anticipated under the climate change (baseline and additional scenarios), and assessment of the residual impacts – that is the extent to which the residual impacts are acceptable or unacceptable. This is in addition to whether development policy goals have been met (as illustrated in Figure 3-1).

Experience also shows there are various institutional conditions, barriers and constraints that may limit the range of adaptation measures that are considered by public agencies. There are also sources of market failure that may limit the adoption and effectiveness of private, or market-driven, adaptations in sectors and regions - that are otherwise are cost-effective and make sense. Therefore, a mix of regulation, incentive and removal of barriers to potential actions by water users and water management agencies would be also considered in adaptation planning.

Generic Components of Water Resources Adaptation Plans

Apart from general national guidelines that are multi-sector, there is no standard protocol or format for what adaptation plans for the water resource sector should cover. They are context specific, and the mix of measures and priorities will depend on the specific vulnerabilities in the country.

Because adaptation planning is continuous process, the initial adaptation plan for the water resource sector would likely be more generalized than subsequent plans. The nature of the plan would also depend on institutional capacities. For example, if planning capacities are well developed in each sub-sector, then the national-level, or even the sector level adaptation plans may be more strategic and directional in nature. In other situations, it may be appropriate to set out sector-specific adaptation measures in more detail in the national plans. This is also influenced by how the government chooses to engage stakeholders and the mechanism for public debate – that is whether it occurs for the national plan or in sector-based processes.

Table 3-1 below shows some of the likely elements of adaptation plans for the water resource sector.

Table 3 –1 Representative Elements of a National Adaptation Plan – Water Resources

Representative Elements	Characteristics
Scenarios	Socio-economic, environment and climate change scenarios, typically 30-50 years or longer, as a basis for impact/ vulnerability assessment and adaptation measures in each sub-sector: - Best/worst case regional/national climate scenarios (temperature, precipitation, seasonal change in river flows, flood extremes, drought cycles, etc.); - Expressed in practical terms water managers can apply in sector specific demand-supply assessments (e.g. water supply would remain the same, or decrease by 5%, 10%, or 20%, by some future date)
Key Assumptions and Common Criteria	Criteria used for determining vulnerability and impacts Criteria used for assessing cost-effectiveness, cost-benefit of measures; Criteria used for assessing risk and classifying acceptable risk, unacceptable; Assumption on water allocation and water quality for normal hydrological conditions and drought situations (e.g. based on current standards) Assumptions for applying the precautionary principle; Assumptions for dealing with different basins/watershed of different characteristics;

Impact and Vulnerability Assessment	- Key themes of studies that have been undertaken for each sub-sector and overall water resource management - Comparisons of climate change with current measures showing where policy goals are met or not, and residual impacts; - Indications of the level of risk associated with incremental impacts (tolerable and not tolerable)
Adaptation Measures (and removal of maladaptive practices)	- Identification of measures: e.g. new initiatives and reorientation of existing policy, planning and management activities to: o Reduce key vulnerabilities to increased hydrological variability and extremes; o Close the demand-supply gap in water dependent sectors; o Balance human and nature needs for water;
	- Priorities for Adaptation - Appropriate Classification of measures, such as: - "Least Regret" measures (low, moderate cost - see next section) - Longer-term measures
Estimated Cost and Financing of Measures	- Estimate of the economic and financial cost of measures - Indications of how financial costs will be borne; e.g. - Budget allocations from different levels government; public-private sector cost-sharing initiatives; tariff measures, fees and other cost recovery measures where user pats; other direct investments by water user investments;
Implementation Arrangements for Measure identified	- Roles and responsibilities of all actors in the water management system on both the supply and demand side, water quality, and environment management to implement the measures, including: - Regulatory agencies (safety, infrastructure, water quality and environment regulations) - Land use managers / authorities (in catchments and flood plains)
Direction and guidance to water-using sectors, public information and other matters	- Beyond the adaptation measures, additional actions to be considered to improve adaptation capacity including public awareness and information programmes, changes in building codes, basis for establishing water quality standards; - Other aspects may be regional cooperation such as water management of shared basins;
Continuous monitoring of implementation of the plan and update	- Specification of monitoring indicators that will be used - Indication of the processes and procedures for revision and update of the adaptation plans.

3.2 Establishing Adaptation Priorities and Measures for Water Resources

One key task in adaptation is to set priorities and select measures that are aligned to those priorities.

Generic Types and Classifications of Adaptation Responses

In the IPPC work over the past decade and that sponsored by UNEP, a distinction is made between the many types of adaptation responses[xxxiv]. They are distinguished by factors such as: the purpose (autonomous or planned); the timing (anticipatory or reactive); the time span (short term or long term); the spatial scope (localized or widespread); the form (e.g. structural or non structural); and the function (tolerate or restore). Other systems have also been used to classify the range of responses that water resource planners would consider in adaptation programmes.

Commonly used classifications include those identified by the UNEP (Burton et al., 1993), namely:

- ***Bear losses***
- Share losses
- Modify or mitigate the threat
- Prevent effects
- Restoration
- Change use
- Change location
- Reinforce Research
- Educate, inform, and encourage behavioural change

The important consideration in helping to avoid controversy (as in wider water resource planning) is that all options should be on the table, and options should only be taken off by consensus, in participatory planning processes that involve those significantly affected by the decisions.

Autonomous or Planned Adaptation?

The two principle classifications of responses are autonomous and planned adaptations[8]. The distinction is more than academic, particularly where it helps to resolve key questions on climate change and water resource management, such as: Are we doing enough now? Can our existing planning processes and institutions for water resource management adequately deal with climate change? What steps should be taken now to adapt to unacceptable risks, or capitalize on opportunities? And what are the risks and consequences of not taking precautionary steps?

Broadly, experience in Europe and North America shows that different views can arise on the appropriate mix and balance of autonomous and planned responses to climate change in the management of water resource systems[xxxv]. At one end of the scale are confident assertions that human adaptive capacity is very large and that coping with climate change will not present a difficult problem, although adaptation could be costly and costs remain in large part unknown, and unestimated. Other views are that unless the projected pace of climate change can be slowed, there may not be enough time for many of the proposed adaptation measures to be implemented. Mainly the differences relate to different perceptions of the degree of risk and whether scarce financial resources should be committed today; or in effect, whether to pay an "insurance" premium. There are also debates on how the precautionary principle should be interpreted and applied in formulating responses to longer-term climate change effects and in choosing options for sustainable management including long-life infrastructure options.

But it also stems from different views of the role and functions of government and other stakeholders in water management and service provision. For example, governments may directly undertake "planned adaptation" measures such as involving public investments, or use regulatory tools to shift and direct community or private sector investment to patterns of economic activity that reduce current, or future vulnerability to climate change. Other responses, more in the realm of "autonomous" adaptation, are also critically important when seen as the collective response of water users at all levels, communities and industries to evolving circumstances. Here, government can facilitate their actions, but government does not necessarily control them. Nevertheless, their behaviour would be shaped by the policies set by government, such as for water access and rights, water allocation, water quality and water pricing.

Nonetheless, consensus is that autonomous adaptation has not been sufficient to offset damages associated with temporal variations in climatic conditions, even today, where the direct and indirect costs of climate variability are rapidly mounting. For example, in France compensation payments for all forms of natural disaster relief that include floods have escalated to the point where they dwarf the size of the budgets for prevention and adaptation by sever orders of magnitude. Here a debate is beginning to emerge on whether to adjust the balance between spending on compensation versus prevention and adaptation measures that would lower risks. [xxxvi] But broadly, evidence (under the UNFCCC and IPCC processes) now convincingly shows that the ecological, social, and economic costs of relying on reactive, autonomous adaptation to the cumulative effects of climate change would

[8] Autonomous or spontaneous adaptations take place in reaction to a change in circumstances as a matter of course, over time. In unmanaged natural systems, adaptation is autonomous and reactive - species and ecosystems respond to changed conditions either successfully or unsuccessfully. Autonomous adaptation in human systems occurs where planners (and water users) adjust to gradually changing circumstances, generally in a reactive mode. Planned adaptations can be reactive, but they are generally anticipatory and preventative and have a mix of short, medium and longer-term aims. Governments and public agencies consciously undertake them, along with private decision-makers, including those in economic sectors, managed ecosystems, resource use systems, settlements, communities.

be substantial.

- **Strategic Considerations: Building in “climate headroom” into water resource systems and their management**

There are numerous strategic and practical considerations involved selecting adaptation priorities and measures. These depend on the circumstances. A broader strategic aim in climate adaptation is to build “climate head room”, or flexibility, into the water resources system, and how it is managed. This recognizes the nature of the climate change impacts and the uncertainties. Three broader orientations or strategies to achieve this involve:

- Reducing the risk associated with hydrological variability, and secondly to extreme events;
- Closing the demand-supply gap in water resources; and,
- Balancing human and nature needs.

These three orientations and representative measures for each are illustrated in Table 3.2. The relative emphasis placed on each strategy, and the interactive mix of measures (policy, institutional, non-structural and structural) that support each strategy would be determined by assessing vulnerabilities in relation to current management practice and scenarios for climate change.

- **Practical Considerations**

Practical considerations that would come into play to influence the priorities, sequencing and timing when measures are introduced might include:

- Starting with measures where there is a demonstrable degree of stakeholder agreement and public consensus, and building from there;
- Priorizing measures where institutional capacities to implement them are greatest;
- Priorizing on the ability measures to reduce critical risks, and those with a higher degree of success in implementation, and
- Focusing on the most important gaps and pressure points.

The UNFCCC also indicates a complementary approach is both strategic and practical. This means building upon existing plans and programmes, including national action plans under the United Nations Convention to Combat Desertification, Ramsar, and national biodiversity strategies and action plans under the Convention on Biological Diversity, and sectoral policies. Priorization and selection of these measures would also taking into account current financial resources of governments and water users alike. The list of priorities would be dynamic and revised with continuous diagnosis of impacts of climate change and the effectiveness of the responses.

Table 3.2
Strategies and Measures to Build in "climate headroom" into water resource systems and their management

Strategies and Strategic Orientations	Representative Responses / Measures
Reducing the risk to hydrological variability, and secondly extreme events	• Reinforcing/introducing flood and drought preparedness programmes • Modifying infrastructure to cope safely and perform in higher floods (e.g. raising, setback or removal of structures in flood plains, changing operating procedures of reservoirs based on real-time information in advance of storms, and increasing spillway capacities in dams); • Reinforcing or introducing watershed management measures to regulate runoff, erosion and sediment • Sustainable manage of urban stormwater (e.g. increasing infiltration and capacity of storm water systems)
Closing the demand-supply gap in water resources	• adjusting water allocation policies to higher value uses • introducing greater flexibility to allocate between competing demands and matching water quality with demand • Balancing demand-supply for off-steam water services with: - Demand side measures (end-use technologies, recycling and conservation) - Supply side measures (conventional and non-conventional sources) • Optimizing existing water regulation infrastructure (operations and retrofit) to most efficient uses and ongoing changes in water allocation priorities • Conjunctive use surface and ground water and their management
Balancing human And nature needs	• introducing policies that recognize environment needs in water allocation • continuous update of water quality (surface and ground water) linked to hydraulic variability (river flow conditions and current pollution levels) • recognizing and sustaining ecological services from rivers and wetlands (e.g. for ground water recharge and water purification) • adapting minimum environmental flow provisions (surface and groundwater) to the hydroperiod of wetlands

"Least Regret" adaptation measures

Adaptation measures that would improve the performance of water resource systems in today's climate conditions, whose further delay could increase vulnerability, or lead to increased costs at a later stage, are sometimes referred to as "win-win", or "least-regret" measures. They would be effective and sensible as resource management measures and have high social and economic returns, even in the absence of significant climate change effects.

Least-regret measures can either be low cost, or require more substantial up-front investment. The lowest-cost least regret measures typically include the policy measures that influence behaviour or stop maladaptive practices, or provide beneficial changes in operation of flow regulation infrastructure, and demand management measures such as installation of water-saving devices. Demand management measures are low-cost in terms of government investment, though they require investment by end-users - which would be cost-effective from the end-users viewpoint where tariffs reflect the marginal cost of supply. The low cost measures also include those actions that help aquatic systems and wetlands adapt autonomously.

Measures such as installation of hydrological monitoring and flood warning systems and associate institutional capacities require some up-front (moderate), and ongoing investment. However, these costs are typically small in comparison to the incremental cost paid by government in compensation for flood and drought episodes, and the economic loss to the local and national economy from not having adequate warning and response measures in place. Still other measures involve significant upfront investment, but as "least regret" measures they have multiple benefits that would be beneficial to the society. Dam safety measures such as to enlarge spillways to safely pass higher floods, economic investments that structural changes in demand are examples.

Large-scale and long-term indivisible investments also need to be seen in a 30 to 50 year view, or preferably on a life-cycle basis. These investments (such as dams, irrigation projects, coastal defences, bridges, and storm drainage systems) can be costly to retrofit to meet new climate conditions, and so adaptation measures need to be considered in such investment decisions at an earlier stage. This also has to be balanced with their appropriateness as long-term sustainable solutions and with removal of maladaptive practices associated with infrastructure and land use.

Table 3-3 illustrates some of the "least regret" measures in these categories, relating to the relative degree of up-front investment.

- **Adaptation Measures for Mid-term and Longer-Term**

Other measures that would be implemented gradually over time are numerous and cut across all water resource management and demand-supply activities for service provision in each sector. These would involve further measures to prepare for climate change and adjust to evolving circumstances (e.g. monitoring, information and awareness, reduce decision uncertainties), improve resource and infrastructure management practices, and promote institutional capacity (boundary organizations, networks centered on resource managers).

They would partly depend on how climate change manifests itself in particular areas (beneficial or adverse ways), but again they would involve a mix of both demand and supply side approaches to water management and consideration of many water-land resource management actions. These measures would be brought about through a range of approaches, including strengthening legal and institutional frameworks, removing pre-existing market distortions (e.g., subsidies), correcting market failures (e.g., failure to reflect environmental damage or resource depletion in prices or inadequate economic valuation of biodiversity), and promoting public participation and education.

More critically they would involve investment in conventional and non-conventional supply, though supply-side measures are likely to be more costly than demand side measures, even before environmental impacts on aquatic systems and riverine habitats are considered. Thus demand-side measures that go beyond encouraging water-efficient appliances will be required, such as with recycling, matching of water quality to endues demand, etc. - should be taken to the limit before investing in higher cost options. Invariably, it means working on a number of fronts simultaneously and in particular increasing alternatives for water supply to the agriculture sectors, which in many countries involve transformation of agricultures role in the economy – though not necessarily diminishing.

Table 3 –3 Representative "Least Regret" Measures – Water Resources Sector

Cost Aspects	Representative Measures
Low-cost Measures	**Adapting to hydrological variability and extreme events** - Flood zoning, land use controls to discourage further development in high-risk areas; - Optimizing operation of reservoirs for flood responses in conjunction with flood warning systems; - Introduction of climate change considerations in infrastructure design standards (safety and flexible performance)
	Closing the demand-supply gap - Remove perverse subsidies - Raising public awareness of water scarcity / costs of new supply - Demand-side management measures (water-efficient devices) - Tariff restructuring (step tariff, marginal pricing and lifeline rates for equity) - Groundwater extraction licenses and fees
	Balancing human and nature needs - Introducing environmental flows policies (low cost in some situations) - Incorporating buffer zones in designated areas for wetland migration - Improved protection and management of existing designated conservation areas
Moderate cost Measures to those requiring more significant up-front investment	**Adapting to hydrological variability and extreme events** - Investment in hydrometric monitoring and early warning systems; - Watershed management (soil stabilization and erosion control) - dams safety and retrofit of infrastructure for improved safety and performance under higher hydrological variability and extremes
	Closing the demand-supply gap - Reinforcing/introducing drought preparedness programmes - Addressing water supply leakage reduction in priority areas - More aggressive demand management, coupled with restrictions, and incentives encourage/required structural shifts in demand
	Balancing human and nature needs - Strengthening environmental flows policies for a range of conditions and linking to drought measures - Operating/Retrofitting infrastructure to improve water quality - Restoring and maintaining watersheds (e.g. vegetation) and wetlands as an integrated strategy for managing water quality and quantity.

3.3 Developing and Enhancing Capacities

As the IPCC noted the adaptation capacity is determined by a number of ingredients. These include by access to financial resources, information and technology, the skill and knowledge to use them, and the stability and effectiveness of cultural, economic, social, and governance institutions that facilitate, or constrain how human systems respond.

Capacity building issues are increasingly the focus of the UNFCCC process. But the IPCC also cautioned against alarmist positions in terms of adaptation responses. It is comparatively early days in dealing with this issue, and yet, only a few countries, not just in the Mediterranean but globally, have actually proceeded very far beyond the stage of initial identification of impacts and outlining the possible adaptation measures and their costs. Most Mediterranean countries have already set up the initial organization capacity to address climate change on the mitigation side - with focal points and coordination units to prepare responses and interdepartmental coordinate inputs on emission reduction. In some cases these groups have moved further to diagnose impacts and vulnerabilities. These groups and processes can be a positioned to move into adaptation aspects at the national level, and provide the initial guidance for responses that will inevitably have to come from the sector-level and basin and local levels, and be amalgamated.

And it is also a local and regional issue simultaneously. Here the means of identifying and Here the means of improving capacities, selecting and implementing measures would be based on principles of dialogue and partnership between government, business, civil society and water users.

In the Mediterranean, as in other regions, this is an undertaking that would stretch well into the future. Thought eventually, the adaptation planning would merge with normal planning and decision-making processes. This would be analogous to the way that awareness of environment and sustainability principles in water resource development was raised initially by giving these issues a special focus, while setting in place processes to ensure these concerns are gradually incorporated into mainstream planning, standards and practices.

Responding to the threats posed by climate change would mean that some difficult water resource management decisions would be faced sooner than otherwise. Some of these decisions are recognizable now, such as changes in water allocation among sectors to reflect changing priorities, growing competition for water and greater hydrological variability. Upward adjustment of tariffs is also inevitable to cover the higher costs of developing new supply sources, to fund increased requirements for water treatment, and to encourage efficient water-use. It may also be necessary to introduce licenses and fees for groundwater extraction, or to dramatically strengthen the enforcement of current provisions.

Difficult choices will also be faced in managing the stock of existing water infrastructure – such as whether to raise existing flood defences in high-risk floodplains and costal zones, or to strategically retreat; and critical decisions will arise around how best to respond to the loss of water storage capacity in erosion-prone basins due to sediment infill of reservoirs, processes that will accelerate and intensify with climate change[9]. Numerous other decisions will be requited on actions to cope with the effects of climate change that are not possible to anticipate today, given the inherent uncertainties. This is understandable, as 15 years ago the scientific community did not anticipate climate change.

[9] See also sediment management Section 2 and Annex 2. Choices such as whether to raise the height of existing dams to compensate for lost functional capacity due to reservoir sediment, or replacing them with new storage dams, or to partially or fully remove them and instead develop alternative demand-supply options.

Annex A:
Selected Mediterranean Water Resource Statistics[10]

HYDRO-GEOGRAPHIC BASE

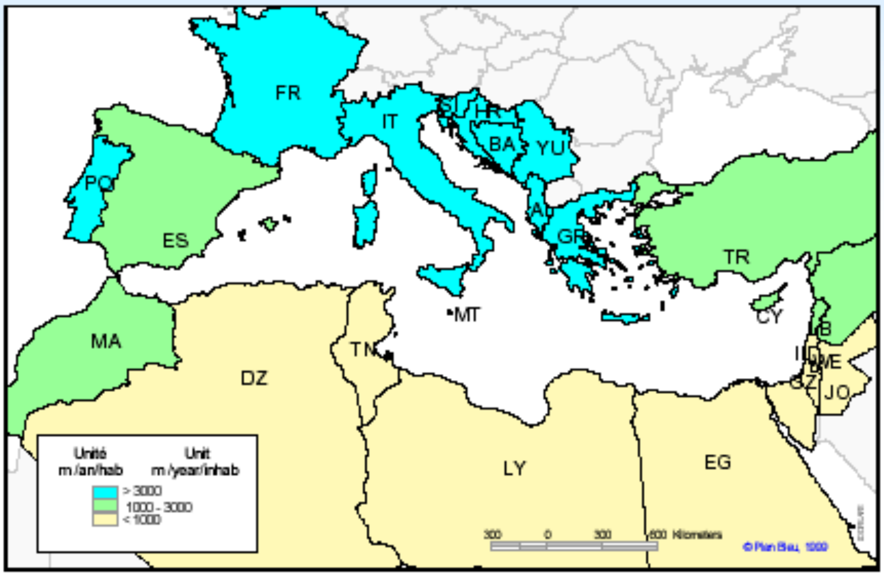

Figure 4: Mediterranean region. Classification of the countries in hydro-geopolitical sub-units.

AGGREGATE WATER DEMAND BY SECTOR

	Water use Sectors (km^3/year)					
Mediterranean Region	Consumptive Use			Non-Consumptive use		
	Communities	Agriculture	Large Industry	Energy and Power Plants	Total	%
North	23	65.5	20	47	155	52.1%
East	7.5	43	4	-	55	18.3%
South	7.5	72.5	8.5	-	88.5	29.6%
Total	38	181	33	47	299	100%
% Consumptive Use	15.1%	71.8%	13.1 %			
% Non-Consumptive	12.5%	60.5%	11.0%	15.7	100%	
Numbers may not add due to rounding Countries correspond to classification in table that follows						

[10] Unless otherwise indicated maps and statistics are from PlanBlue web-pages and the Report, "Mediterranean Vision on water, population and the environment for the 21st Century"

GROUPING OF COUNTRIES BY WATER AVAILABILITY

Geographic Location	Water Resource (Availability) Status
The North or greater Europe Portugal, Spain, France and Monaco, Italy, Malta, Bosnia-Herzegovina, Croatia, Slovenia, F.R. of Yugoslavia, Albania, Greece; **The East** Turkey, Cyprus, Syria, Lebanon, Israel, Palestinian territories of Gaza and the West Bank, Jordan; **The South:** Egypt, Libya, Tunisia, Algeria, Morocco.	- Group 1: European countries rich in water (above 3000 m3/year/cap) and where water demand is stable, or even decreasing, without quantity shortage problems (except for short periods of time and for localized areas) until 2025 and more, but having to face water quality degradation and meet the increasing needs of environmental protection. - Group 2: Western Mediterranean or Middle East countries, with overall excess resources (1000 to 3000 m3/year/cap), but where demands are more or less increasing, more sensitive to short term or structural shortages, in certain areas, with the risk of extension after 2025. - Group 3: countries from North Africa, the Middle East, or islands where the resources (less than 1000 m3/year/cap) are already saturated or are becoming so (whether demands be high or low), are already experiencing structural shortages, with possible future aggravation in places where demographic growth is strong.

Group of countries or territories		Population change	Water resources per capita			Water demand per capita	
			Current m^3/year	Trends	Average forecast 2025 in m^3/year	Current m^3/year	Trends
Group 1	France, Italy, Portugal, Greece, Slovenia, Croatia, Bosnia-Herzegovinia, Albania, FR of Yugoslavia.3	Stability or decrease	> 3000 (> 20000 the Balkans)	Stability until 2025 and after	> 2000	Low to moderate 700-800 in EU 200-400 the Balkans	Slight increase or reduction
Group 2	Spain, Cyprus, Syria, Lebanon, Maroc, Turquie.	Stability in Spain growth in South and East countries	> 1000 Max: TR 3200	Stability in Spain; decline in the South and the East	ES > 3000 Southern and Eastern countries < 1000	Moderate to high 300 to > 1000	Decrease Spain, Cyprus, Morocco increase Turkey, Lebanon
Group 3	Malta, Israel, Palestinian Territories of Gaza and the West Bank, Jordan, Algeria, Tunisia, Egypt, Libya.	Moderate to high increase	500 below 100 (GZ, MT) Egypt: ~1000	More or less rapid decline	from 100 to 300 EG ~ 600 LY < 50	Low in the Levant, in Malta, in the Maghreb 100 to 400 high in Egypt and in Libya 800 to 1000	Slight to moderate increase in the Maghreb stabilisation in Israel reduction in Egypt, Libya

INDICATORS OF WATER STRESS AND SUSTAINABILITY

Indicator	Measures	Implication (National averages)
Exploitation index of renewable resources (surface and groundwater)	the degree to which renewable natural water surface and groundwater) is exploited at a given date and the vulnerability of the country as regards cyclical shortage.	• the exploitation index in most Mediterranean countries is higher than 10% indicating local pressure in specific basins • In a number of SEMC indicators above 50% reveal high pressure and the need for fully rationalising management of water uses and demands. • This is the case in Tunisia and Egypt in North Africa and Israel in the Near East.
Non-sustainable water production index (groundwater)	the proportion of the annual total volume of water withdrawals (including transport losses) taken from fossil aquifer reserves or from water table overexploitation, expressed as a percentage.	• in Europe only Spain covers a significant proportion (3.2%) of its water production through overexploitation • In SEMC most countries show an index between 9% (in Algeria and Malta) and 18% (in Israel). • In the Gaza strip, one quarter of total water supplies is derived from overexploitation. Libya is the highest though the size of the aquifer is exceptionally large
Share of irrigated agricultural	This is the area under irrigation expressed as a percentage of the total area of cultivated agricultural land.	• the trend is growth in absolute values (doubling over 35 years up to more than 20 millions ha) to 20% of total agricultural land which comes to but with a high diversity of situations: • In EU Mediterranean countries, the proportion is close to the Mediterranean average. (rapidly growing to 35% in Greece from 2% over 35 years) and under 9% in France. • In SEMC, it ranges form 28% in Cyprus and Lebanon, 45% in Israel and 48% in Gaza, 100% in Egypt.
Relative changes in "arable land"	the ratio of the area of arable land in 1961 to the area of arable land in reference year (1996).	• the Mediterranean basin, had a net reduction of 3.7 million ha (Mha) of arable land between 1961 and 1996, which means (about 3.5% of the 1961 area) • most of this was in Europe where only Greece increased its arable area; • In the other Mediterranean countries, three main groups of countries were identified: 1. Those, with a relatively stable arable land area (Cyprus, Libya and Egypt) 2. Those, which have lost arable land: (Syria, Tunisia and Malta) 3. Those, which have increased their arable land area (Morocco, Turkey, Algeria and Albania)

INFRASTRUCTURE: NUMBER OF LARGE DAMS IN MEDITERRANEAN COUNTRIES

	Number of Large Dams in 2000[11]	Percentage of Dams in the Region
North or greater Europe		
Albania	306	7.8%
Bosnia-Herzegovina	25	0.6%
Croatia	29	0.7%
Spain	1196	30.6%
France	569	14.5%
Greece	46	1.2%
Italy	524	13.4%
Malta	-	-
Monaco	-	-
Portugal	103	2.6%
Slovenia	30	0.8%
Yugoslavia	69	1.8%
East Mediterranean		
Cyprus	52	1.3%
Israel	?	?
Jordan	5	0.1%
Lebanon	5	0.1%
Syria	41	1.0%
Palestinian authority territories	?	?
Turkey	625	16.0%
South Mediterranean		
Algeria	107	2.7%
Egypt	6	0.2%
Libya	12	0.3%
Morocco	92	2.4%
Tunisia	72	1.8%
Total	3914	100%

[11] Source: The World Commission on Dams, Dams and Development: A New Framework for Decision-Making, Statistical Annex that is based on information provided by The International Commission on Large Dams (ICOLD), based on member surveys.

Annex B

UNFCCC National Communications and Adaptation Guidelines (NAPAs)

The UNFCCC (Article 4) provides that adaptation to climate effects would require short, medium, and long-term strategies which should be cost effective, take into account important social economic implications, and should be implemented on a staged-by-stage basis. Annex 1 countries are required to provide annual information and periodic National Communications of progress. Non-Annex and other developing countries are required to provide an initial communication, and progress reports thereafter as agreed by the Conference of Parties, in an agreed format. As at 1 June 2002, 20 of 46 least developed country Parties had already submitted their initial national communications while 64 of 100 non-Annex I Parties that are not least developed country Parties had yet to submit their initial national communications. Part B of the Annex provides the Guidelines that the UNFCCC has issued for national adaptation plans.

Mediterranean countries submitting Communications to the UNFCCC

	Initial National Communication	2nd National Communication	3rd National Communication	Country Annex Status
North or greater Europe				
Albania	13/09/02			Non-Annex
Bosnia-Herzegovina				Other
Croatia				Other
Spain	√	√	01/04/02	Annex-1
France	√	√	30/11/01	Annex-1
Greece	√	√		Annex-1
Italy	√	√	√	Annex-1
Malta				Other
Monaco	√	√	02/11/01	Annex-1
Portugal	√	√		Annex-1
Slovenia	28/08/02			Annex-1
Yugoslavia				Other
East Mediterranean				
Cyprus				Other
Israel	18/11/00			Non-Annex
Jordan				Other
Lebanon	02/11/99			Non-Annex
Syria				Other
Palestinian authority territories				Other
Turkey				Annex-1 (partial)
South Mediterranean				
Algeria	30/04/01			Non-Annex
Egypt	10/07/99			Non-Annex
Libya				Other
Morocco				Non-Annex
Tunisia	27/10/01			Non-Annex
EU				

Decision 28/CP.7 - 2001

Guidelines for the preparation of national adaptation programmes of action

The Conference of the Parties,

Recognizing the specific needs and special situations of the least developed countries referred to in Article 4, paragraph 9, of the Convention,

Recognizing further that many of the least developed country Parties do not have the capacity to prepare and submit national communications in the foreseeable future, or to convey their urgent and immediate needs in respect of their vulnerability and adaptation to the adverse effects of climate change. *Recognizing also* that information contained in national adaptation programmes of action may constitute the first step in the preparation of initial national communications, and would help to build capacity for addressing urgent and immediate adaptation needs, as well as for the preparation of national communications:

1. *Decides* to adopt the guidelines for the preparation of national adaptation programmes of action included in the annex to the present decision;
2. *Invites* Parties to make submissions with a view to improving the guidelines, by 15 July 2002, for consideration by the Subsidiary Body for Implementation at its seventeenth session;
3. *Decides* to review, and if necessary revise, the guidelines at its eighth session, taking into account the views submitted by Parties and the least developed countries expert group established under decision 29/CP.7;
4. *Invites* least developed country Parties to use the above-mentioned guidelines, in accordance with their national circumstances, in preparing their national adaptation programmes of action.

Guidelines for the preparation of national adaptation programmes of action

A. Introduction

1. National adaptation programmes of action (NAPAs) will communicate priority activities addressing the urgent and immediate needs and concerns of the least developed countries (LDCs), relating to adaptation to the adverse effects of climate change.

2. The rationale for developing NAPAs rests on the low adaptive capacity of LDCs, which renders them in need of immediate and urgent support to start adapting to current and projected adverse effects of climate change. Activities proposed through NAPAs would be those whose further delay could increase vulnerability, or lead to increased costs at a later stage.

3. The NAPA will be presented in the form of a document specifying a list of priority activities, with a concise justification based on a tight set of criteria.

4. The NAPA document will not be an end in itself, but rather a means for the dissemination, by an LDC Party, of its proposed programme of action to address its urgent needs for adaptation. The priority activities identified through the NAPA process will be made available to the entity that will operate the LDC fund referred to in decision 7/CP.7, paragraph 6, and other sources of funding, for the provision of financial resources to implement these activities.

B. Objective of NAPAs

5. National adaptation programmes of action will serve as simplified and direct channels of communication for information relating to the urgent and immediate adaptation needs of the LDCs

C. Characteristics of NAPAs

6. National adaptation programmes of action should:

(a) Be easy to understand;
(b) Be action-oriented and country-driven;
(c) Set clear priorities for urgent and immediate adaptation activities as identified by the countries.

D. Guiding elements

7. The preparation of NAPAs will be guided by the following:

(a) A participatory process involving stakeholders, particularly local communities;
(b) A multidisciplinary approach;
(c) A complementary approach, building upon existing plans and programmes, including national action plans under the United Nations Convention to Combat Desertification, national biodiversity strategies and action plans under the Convention on Biological Diversity, and national sectoral policies;
(d) Sustainable development;
(e) Gender equality;
(f) A country-driven approach;

(g) Sound environmental management;
(h) Cost-effectiveness;
(i) Simplicity;
(j) Flexibility of procedures based on individual country circumstances.

E. Process

8. The preparation of the NAPA may proceed as follows:

(a) The setting up of a national NAPA team: the national climate change focal point will set up a NAPA team composed of a lead agency and representatives of stakeholders including government agencies and civil society. This group would be constituted using an open and flexible process that will be inclusive and transparent. The NAPA team will be responsible for preparing the NAPA and coordinating the implementation of NAPA activities;

(b) The NAPA team will assemble a multidisciplinary team:

(i) To synthesize available information on adverse effects of climate change and coping strategies, which would be collated and reviewed, including the national strategies for sustainable development, the Programme of Action for the Least Developed Countries, the United Nations development assistance frameworks, and poverty reduction strategy papers, if available in the countries;

(ii) To conduct a participatory assessment of vulnerablity to current climate variability and extreme weather events, and to assess where climate change is causing increases in associated risks;

(iii) To identify key climate-change adaptation measures, based, to the extent possible, on vulnerability and adaptation assessment; such measures would also be responsive to needs identified under other relevant processes, such as the preparation of national action plans under the United Nations Convention to Combat Desertification and national biodiversity strategies and action plans under the Convention on Biological Diversity;

(iv) To identify and prioritize country-driven criteria for selecting priority activities to address needs arising from the adverse effects of climate change, drawing on the criteria referred to in section F.4 below.

(c) Development of proposals for priority activities to address needs arising from the adverse effects of climate change: the national team will:

(i) Organize a national and/or subnational consultative process to solicit inputs and proposal ideas in order to help develop a short list of potential NAPA activities. The national team would facilitate this consultative process, and would help in translating ideas into activities. This process will allow adequate dialogue between the national team and the public, with time allowed for public comment and revisions;

(ii) Identify potential activities, which may include capacity building and policy reform, and which may be integrated into sectoral and other policies;

(iii) Select and identify priority activities, based on the agreed criteria;

(iv) Propose profiles of priority activities using the following format:

- Title
- Rationale/justification in relation to climate change, including sectors concerned
- Description
  - Objectives and activities
  - Inputs
  - Short-term outputs
  - Potential long-term outcomes
- Implementation
  - Institutional arrangement

- Risks and barriers
- Evaluation and monitoring
- Financial resources

(d) The development of the NAPA document: the document will be prepared following the structure set out in section F below;
(e) Public review and revision: the NAPA document will undergo public review and be revised accordingly;
(f) The final review process: the NAPA document, including the profiles, will be reviewed by a team of government and civil society representatives, including the private sector, who may take into consideration any advice solicited from the Least Developed Countries Expert Group;
(g) National government endorsement of the NAPA: after the NAPA has beenprepared, it will be submitted to the national government for endorsement.
(h) Public dissemination: the endorsed NAPA document will be made available to the public and to the UNFCCC secretariat.

F. Structure of NAPA document

1. Introduction and setting

9. This introductory section will include background information about the country that is relevant to the NAPA process. It will cover current characteristics, key environmental stresses, and how climate change and climate variability adversely affect biophysical processes and key sectors.

2. Framework for adaptation programme

10. This section will also provide an overview of climate variability and observed and projected climate change and associated actual and potential adverse effects of climate change. This overview will be based on existing and ongoing studies and research, and/or empirical and historical information as well as traditional knowledge.

11. This section will describe the NAPA framework and its relationship to the country's development goals, as described in subparagraph 8(b)(i) above, to make the framework consistent with socio-economic and development needs. In addition, it would also describe the goals, objectives and strategies of the NAPA, taking into account other plans and multilateral environmental agreements.

12. Where possible, a description of the potential barriers to implementation should also be included.

3. Identification of key adaptation needs

13. Based on this overview and framework, past and current practices for adaptation to climate change and climate variability will be identified as related to existing information regarding the country's vulnerability to the adverse effects of climate change, climate variability and extreme weather events, as well as long-term climate change. This section will explain how and to what extent activities may address specific vulnerabilities.

14. Given the actual and potential adverse effects of climate change described in section F.2 above, this section will identify relevant adaptation options including capacity building, policy reform, integration into sectoral policies and project-level activities.

4. Criteria for selecting priority activities

15. A set of locally-driven criteria will be used to select priority adaptation activities. These criteria should include, *inter alia*:

(a) Level or degree of adverse effects of climate change;
(b) Poverty reduction to enhance adaptive capacity;
(c) Synergy with other multilateral environmental agreements;
(d) Cost-effectiveness.

16. These criteria for prioritization will be applied to*, inter alia*:

(a) Loss of life and livelihood;
(b) Human health;
(c) Food security and agriculture;
(d) Water availability, quality and accessibility;
(e) Essential infrastructure;
(f) Cultural heritage;
(g) Biological diversity;
(h) Land-use management and forestry;
(i) Other environmental amenities;
(j) Coastal zones, and associated loss of land.

5. List of priority activities

17. This section will list priority climate-change adaptation activities that have been selected based on the criteria listed in section F.4 above.

18. For each of the selected priority activities a set of profiles will be developed for inclusion in the NAPA document. This could follow the format set out in subparagraph 8(c)(iv) above.

6. NAPA preparation process

19. This section will describe the NAPA development process, including the process of consultation, the methods for evaluation and monitoring, the institutional arrangements, and the mechanism of endorsement by the national government.

Nov 2002
Draft decision -/CP.8
Review of the guidelines for the preparation of national adaptation programmes of action

The Conference of the Parties,

1. *Decides* that a revision of the guidelines for the preparation of national adaptation programmes of action is not necessary at this time;
2. *Invites* the least developed country Parties to use, as appropriate, the annotations to the guidelines for the preparation of national adaptation programmes of action prepared by the Least Developed Countries Expert Group;
3. *Decides* to review, and if necessary revise, the guidelines for the preparation of national adaptation programmes of action at its ninth session, based on the experience of least developed country Parties in the preparation of national adaptation programmes of action, and on the outcome of the work of the Least Developed Countries Expert Group.

References and End notes:

[i] Different groupings of Mediterranean countries are used. This grouping was provided in PlanBleu's report, "Mediterranean Vision on water, population and the environment for the 21st Century", which offered a perspective on different scenarios for available water resources and water demands.
[ii] The Global Water Partnership (GWP) establish a network of five regional "centres of excellence" under its ageous to collaborate on sustainable development and water management research and policy dialogue. Networks include: MedWet - The Mediterranean Wetlands Initiative Network consisting of CEU, Governments, NGOs and scientific institutes on Mediterranean Wetlands; MWN- Mediterranean Water Network Mediterranean Network of Water Directors; Blue Plan - Regional Activity Center of the Mediterranean Action Plan/UNEP (Barcelona Convention) – Intergovernmental; CEDARE - Center for Environment and Development in the Arab Region and Europe Network of Governments and Governmental Agencies on Environment and Development; CIHEAM - International Centre for Advanced Mediterranean Agronomic Studies Network of Mediterranean Agronomic Institutes; IME -Mediterranean Institute on Water (Hosts the GWP-Med Chair and the Administrative Unit of the Secretariat) Mediterranean Network of Water Agencies, Water Authorities and Experts; MIO-ECSDE – Mediterranean Information Office for Environment, Culture and Sustainable Development (Hosts the Coordinating Unit of the Secretariat) Mediterranean Environmental and Development NGO Federation.
[iii] Economic Tools for Water demand Management in the Mediterranean, UNEP and GWP-Med, Progress Toward Demand Management in the Mediterranean Region, Oct, 2002, Italy.
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