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Adaptation strategies for improved flood management in the Mediterranean

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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 (UNFCC-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 countries have yet to initiate processes to enable steps to moderate the 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 synergies in the responses to the UNFCC 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 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

Floods are the most common type of natural hazard in the Mediterranean region, after the earthquakes: only in the last decades all the Mediterranean countries had to defend from some massive flood and its associated catastrophic effects.
Two main categories of floods may be distinguished in the Mediterranean area, according to the present climatic conditions and catchments characteristics. The amount and types of damages are clearly influenced by these factors. When a flood occurs within a great river basin, affecting large sectors of alluvial plain, huge economic damages are expected to buildings and infrastructures. Nevertheless, frequently there is time to limit the loss of human lives. On the other hand, when a flood is triggered by an intense rainfall over small catchments in arid regions ("flashfloods"), the main cost is in terms of human lives, basically because its quickness do not allow alert procedures.
In the last years, the economic and social impact of floods is growing due to the increasing urbanization. In terms of flood risk, urbanization is amplifying enormously the vulnerability and causes also a tremendous change in the rainfall-runoff relations.

Flood management comprehends any human activity to prevent loss of lives, properties and production after a flood disaster. The level of protection selected is frequently based on costs, desire of the community, potential damage, environmental impact, and other factors. Sometime, communities choose a lower level of protection because of the initial financial cost.
Structural measures such as dams, reservoirs, channel and catchment modifications, levee-banks, if wisely applied can greatly reduc[1]e the impact of flooding. However, structural measures can be very expensive and disruptive to the environment. Non-structural measures are any procedure altering the exposure of lives and properties to floods, such as flood forecasting and warning, flood insurance, planning controls, public information and education. These measures do not avoid the occurrence and the effects of floods, but are aimed at limiting their social and economic cost.

An overview to the policies adopted by national countries in the Mediterranean area put in evidence that these are based on the integration of specific measures for flood prevention and measures for flood management during the emergency. However, there is not an univocal strategy to mitigate the flood risk, due to the different types of floods that induce different impacts on people and land. For this reason, in national programmes against flash floods, emergency responses must have a preferential role, while longer-term preparedness must be programmed in large alluvial plains in order to prevent high economic damages.
Concerning land use management, a basic point is the development of River Basin Plans (RBP) for all river basins. These plans must be elaborated at the river basin scale because each structural measure induces some changes in the river hydrology and, as a consequence, in the magnitude of erosional and sedimentary processes. Unfortunately, the elaboration of RBP needs a long period of time, while land use is in fast evolution often without an institutional control due the dissemination of tasks and responsibilities among a complex hierarchy of national and local administrations.
Referring the project management of structural works, data input used in flood risk analyses for the elaboration of forecasting models are often not realistic: for example rainfall data could not make clear the occurrence of an extreme rainfall event in a small

[1] The picture in the cover page shows a house strongly damaged by a mud-flow occurred during the October 2000 flood that affected Dora Baltea River Basin (Northern Italy)

catchment. Moreover, sometimes the need to mitigate the effects of a flood disaster may require a political decision to realize some structures without enough time for a correct project management, inducing remarkable environmental problems. Moreover, it is evident the need of maintenance programmes for each structure to guarantee for a long time its functioning. Unfortunately, the lack of maintenance is increasing in the last decades due to the decline of agriculture mainly in mountainous areas.

Regarding non structural measures focusing on saving people before the occurrence of a catastrophic flood, all the Mediterranean countries have a specific legislation concerning emergency plans for flood disasters. In the last years, national surveys for the civil protection are improving these plans due to a significant contribute from new technologies (including mass-media, internet, etc.). However, the success of alert messages is still now uncertain, as well suggested by the main flood events occurred during the last years.

International cooperation in the Mediterranean area includes a large amount of programmes and initiatives concerning long-term preparedness and emergency mitigation. Integrated water management programmes for sustainable development are a crucial tool to identify the urgent action to be undertaken at the river basin scale in relation to the water as a resource to preserve, but also as a potential factor for triggering floods. The information exchange of hydrologic data between different countries is fundamental as well as the transfer of technologies. However, it is important to outline that a flood management model reliable for a country is not necessary good for all, and the exporting of measures and policies needs always a careful political and technical evaluation.
Multilateral agreements for mutual help during and immediately after a flood disaster are also very important tools. International research projects on flood risk analyses and mitigation are also very interesting and valid, but probably could furnish better results if connected directly with the real national strategies against floods.

A long-term perspective of flood management must consider also the variability of flood hazard in terms of magnitude and return periods induced by climate change. In fact, although the role of the human activities in the climate change is still an open debate, there is no doubt on the effects of climate change in altering the precipitation patterns in terms of distribution, intensity and duration of extreme rainfall events and a higher frequency of strong precipitations.
Regarding the Mediterranean area, climate change may have particularly serious consequences in some areas threatened by desertification. For these areas increasing rainfall during winter and spring may lead to some extreme events. As a consequence, torrential rain also in short time may trigger dangerous flash floods.
Mitigation action to stabilize atmospheric concentrations of greenhouse gases at lower levels would generate greater benefits in terms of less damage. Adaptation is a necessary strategy at all scales to complement mitigation actions to lessen climate change impacts. However, adaptation would entail costs and cannot prevent all damages.
Over the years, a wide range of adaptive techniques has been developed, largely in response to local needs. The optimum extent of adaptation can be characterised in terms of the benefits and costs of adaptation. The optimum level of adaptation minimises the combined costs of adaptation and residual negative effects, with the most cost-effective steps taken first.

Broad distinctions can be drawn among “supply-side” and “demand-side” adaptive techniques. Examples of supply-side adaptations include increasing flood defences, building weirs and locks to manage water levels for navigation, and modifying or extending infrastructure to collect and distribute water to consumers. Demand-side techniques include water demand management, changing water allocations and land-use controls. In order to reduce as soon as possible the effect of climate change, long-term adaptation strategies should be joined with least regret, low-cost, immediate measures.

Adaptation strategies taking into account the climate change, can reduce adverse effects of climate change and can often produce immediate benefits but they can’t prevent all damages (IPCC, 2001). Moreover, it is important to outline that some changes in the climate system (i.e. melting of ice sheets) are effectively irreversible over a period of many human generations.

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1. Floods in the Mediterranean region

1.1. Basic concepts on floods

1.1.1 Definitions

The term "flooding" indicates a natural process of over-bank flowing which periodically may occur onto lands not usually submerged, because the banks of river channels are unable to contain extraordinary discharges of water and sediments. As a consequence of a flood event, a large number of ground effects occur, including also gravitational phenomena like landslides, rock falls, mud flows and debris flows.

In general, floods can be described as situations of extreme water run-off threatening human lives and their activities, properties and infrastructures (EEA, 2001). Nevertheless, it is important to outline that flooding is a natural phenomenon and it becomes a problem if areas susceptible to flooding are employed and/or if human activities induce and enhance flood occurrence.

1.1.2 Types of floods

The spatial scale of floods can be highly variable. In strict connection with the characteristics of rain-fall and catchment, two main groups of floods may be distinguished: i) occurring in large basins and ii) flash floods.

Floods occurring in large river basins are a consequence of intense and long duration rain-fall over a large part of the upstream catchment. It results in the inundation of extensive areas of alluvial plains, with peak discharges lasting a number of days, but rising water levels are relatively slow and response times are long. For this reason, although the economic damage may be very important due to the extent of the flooded area, there are more chances for real-time forecasting and mitigation measures such as evacuation.

Upstream floods (or "flash floods") are associated with intense, localised thunderstorm activity occurring in small basins generally located in mountainous areas where orographic uplift may intensify rainfall and steep slopes may increase the potential for landslides. Although peak discharges are maintained only for hours or even minutes, the extremely rapidity of this phenomena limits the efficiency of warning procedures and emergency actions. Thus, flash floods are the most significant flood hazard regarding the number of fatalities.

1.1.3 Flood hazard and flood risk

All flood management strategies need specific investigations focused on the flood hazard and flood risk assessment. Flood risk must take into account vulnerability of lands prone to flooding, too.

The statistical approach to the flood hazard assessment implies the analysis of the probability of flood occurrence in terms of return period and frequency law of maximum discharges.

Availability of historic flood data allows us to estimate the peak flows for given probabilities (or return periods). The return period with a defined flow is equal to the number of years between floods that exceed that flow (average value). The maximum discharge frequency law is formed by discharges corresponding to different return periods.

Flood risk assessment requires the use of a hydrologic simulation model, which simulates river flow on the base of an assumed temporal and spatial distribution of precipitation. Hydrologic simulation models enable the analyst to simulate stream flows, for actual conditions in the watershed or for future conditions.

Developing flood hazard maps for a particular drainage basin implies the analysis of stream flow data from gauging stations over a period of years. However, in many case flow data are not available, especially for small streams, so alternative data sources must be applied to assess the flood hazard. Concerning the urbanising areas, the flood hazard mapping must include not only stream flow data, but also the expected urban conditions (for example in the next 100 years) with estimated percentage of impervious areas. Moreover, the extremely dynamic climatic conditions for the present period of time, impose dynamic flood hazard models, that should take in account the influence of climate change on the occurrence of flood events (see 3.4).

Methods of "upstream" flood hazard evaluation may involve estimation of flood peak discharges based on physical properties of the drainage basin. Flood hazard evaluation for "downstream" areas may also be accomplished in a general way by direct observation and measurement of physical parameters.

Geomorphological contributions to the flood hazard problem (Cooke & Doornkamp, 1990) commonly are focused on the mapping of flood limits from aerial photographs taken during flood events or estimated from high water lines, and flood deposits mapped in the field after the water has receded.

In order to estimate the flood hazard within a time window larger than the historical period, a geological approach for the flood hazard assessment is the paleofloods analysis: it consists in detailed stratigraphic analyses of recent alluvial deposits in exposures or in boreholes in order to calibrate the characteristics (size, shape, thickness) and time of recurrence of paleofloods events occurred in the last 10,000÷50,000 years (Benito et al., 1998 for details)

Careful mapping of soils and vegetation may help to evaluate the downstream flood hazard. Soils on floodplains are often different from upland soils and, with favourable conditions, certain soils can be correlated with flooding of known frequency. Vegetation type may facilitate flood hazard assessment because there is often a rough zonation of vegetation in river valleys that may be correlated with flood zones. However, the use of soils and vegetation must be combined with other methods of flood hazard evaluation such as satellite data, aerial photographs, historical records and floodplain features.

1.2 Flooding in the Mediterranean region

1.2.1 Large flood events occurred in the Mediterranean region

Year	Country	Month	Day	Damage US(000´s)
1994	Italy	11	5	9.313.500
1983	Spain	8	25	3.900.000
1966	Italy	11	4	2.000.000
1987	Spain	11	4	1.283.000
1990	Yugoslavia	10	30	766.100
1992	Italy	10	31	687.300
1982	Spain	10	19	630.000
1983	France	3	31	604.000
1995	France	1	21	570.000
2000	Italy	10	13	434.143
1973	Spain	10	19	400.000
1989	Spain	11		375.000
1995	Macedonia	7		350.000
1965	Yugoslavia	5	9	347.000
2001	Algeria	10	9	300.000
1951	Italy	11		300.000
1982	Spain	11		300.000
1970	Italy	10	7	268.300
1977	Italy	10		150.000
1994	Egypt	11	2	140.000
2001	France	3	20	132.350
2001	Italy	9	15	100.000

Year	Country	Month	Day	Killed
1927	Algeria	11		3.000
2001	Algeria	10	9	921
1995	Morocco	8	17	730
1994	Egypt	11	2	600
1969	Tunisia	9	24	540
1973	Spain	10	19	500
1962	Spain	9	27	474
1967	Portugal	11	26	462
1963	Spain	9	27	445
1955	Lebanon	12		440
1954	Italy	10		322
1948	Turkey	2		200
1968	Turkey	12	28	147
1998	Italy	5	6	147
1956	Turkey	8		138
1948	Turkey	6		132
1951	Morocco	1		131
1982	Tunisia	10	28	117
1966	Italy	11	4	116
1968	Italy	11	2	113
1951	Italy	11		100
1963	Morocco	1		100

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basins (i.e. Po and Arno Rivers in Italy, Ebro River in Spain), while flash floods, that are characteristic in small river basins even in arid environment, are more dangerous for people because its quickness do not allows alert procedures.

1.2.2 Natural and human factors controlling the occurrence of floods in the Mediterranean area

Flooding is controlled basically by natural factors (climate, vegetation, soils, etc.), but some human activities are able to trigger the occurrence of floods and intensify their impact. The role of these factors in the Mediterranean area is briefly described in the following.

Climate

Currently, the Mediterranean climatic condition are characterised by generally warm temperatures, winter-dominated rainfall, dry summers and a profusion of microclimates due to local environmental conditions. The North tends to be relatively temperate and damp, whereas the South is hot and arid. The strong summer-winter rainfall contrast that characterises the Mediterranean climate is associated with pronounced seasonal cycles in most climatic variables. July, August and September are warm and dry, whereas the winter is characterised by cyclonic disturbances, also influenced by local orographic effects.

Intense precipitation falling on small catchments is the main cause of flood in the Mediterranean area. These short but extreme intense rainfall events take place at the end of summer and in autumn. It is important to outline that in some areas of the Mediterranean coast, the recorded maximum daily rainfall is close to the mean annual rainfall.

Although the role of the human activities in the climate change is still an open debate, there is no doubt on the effects of climate change in altering the precipitation patterns in terms of distribution, intensity and duration of extreme rainfall events and a higher frequency of strong precipitations.

Worldwide, all the scenarios consistently predict that air temperature would change substantially throughout the year and increments are predicted for winter months coinciding with increased precipitation. These conditions would result in a greater rate of winter snowmelt and a rise in the snowline, thus increasing the winter run-off and diminishing the spring and summer run-off due to the snowmelt. Another impact of the increasing temperature is the change of the vegetation structure, strictly connected with the soil retention capacity and, consequently with the run-off.

Due to higher temperatures and drought, lands could be more susceptible to runoff, exacerbating floods intensity, especially in semi-arid catchments. Moreover, changes in rainfall intensity and distribution influence river morphology changes (erosion of banks, fast sedimentation in river-beds) introducing more dynamic change in flood patterns.
Another significant impact of climate change is connected to the increasing sea levels that would influence the occurrence and the effects of flooding in coastal areas (the length of the Mediterranean coastline totals about about 46,000 km).

Role of vegetation, soils and forests

In the Mediterranean area, the presence of vegetation and forests, and the soil development degree clearly increase with the latitude: as result, in the northern African countries hot and dry climatic conditions cause a desert environment (scarcity of vegetation, thin soils), while at higher latitude (southern Europe) wetter and cooler climates allow the development of a continuos covering of vegetation, forests and soils.

The effects of vegetation and soil development degree in the catchment are very important in determining the response in water flow and flood generation.

Vegetation play a protective role against erosion and flooding because intercepts water when precipitation starts. The vegetation covering has a substantial effect on the attenuation of small and medium-sized floods.

The soils store a quantity of water that is a function of porosity and depth of soil and can store up to 100 times the quantity of water held by vegetation.

Forests are essential in areas with not well-developed soil: the impact of forestry on peak flows depends on the different stage and type of the forest and the different climatic zones. In any case, deforestation in headwater basins mainly in the mountainous areas, produces an increase in surface run-off.

Urbanisation

In 1985 the countries bordering the Mediterranean sea had a total population of 352 million people. At present it is about 450 million inhabitants (EEA, 2000). According to some projections, it is expected to reach 545 million in the 2025. About 75% of the population is expected to live in urban areas.

Moreover, it is increasing the buildings and the infrastructures for tourists by the rivers (about 200 million people per year). In terms of floods risk, urbanisation increased enormously the vulnerability of many alluvial areas close to rivers (floodplains). In particular, flood-risk analysis distinguishes different areas within the floodplain, according to the frequency of the flood (for example, the 10-year floodplain will be covered by the 10-year flood and the 100-year floodplain by the 100-year flood). As a consequence, the economic and social impact of flooding in a specific area in the last decades has become much greater than in the past centuries.

Urbanisation causes also a tremendous change in the rainfall-runoff relations. For example in the US, one study showed that urban runoff is 1.1 to 4.6 times preurban runoff (Keller, 1985). The increase of runoff with urbanisation occurs because less water infiltrates the ground, as suggested by the significant reduction in time between the majority of rainfall and the flood peak (lag-time) for urban versus rural conditions.

Influence of local factors on the cost deriving from floods

Figure 1 illustrates in a logarithmic diagram the cost sustained by each Mediterranean country in terms of economic damages and loss of human lives because of the recent flood disasters. Although the database is not complete, it illustrates that for each country local climates, land characteristics and urbanisation degree of alluvial plain clearly influence the type and the amount of damages.

For example, in Algeria the main problem is the loss of human lives in consequence of sudden flash floods, while in France or in the balcanic countries the main problems is the location of buildings and infrastructures in the alluvial plains. Italy and Spain record a huge economic damage and a great number of killed people due to the land characteristics (floods occur in large river basins and in small catchments as well) and the high vulnerability of the alluvial plains.

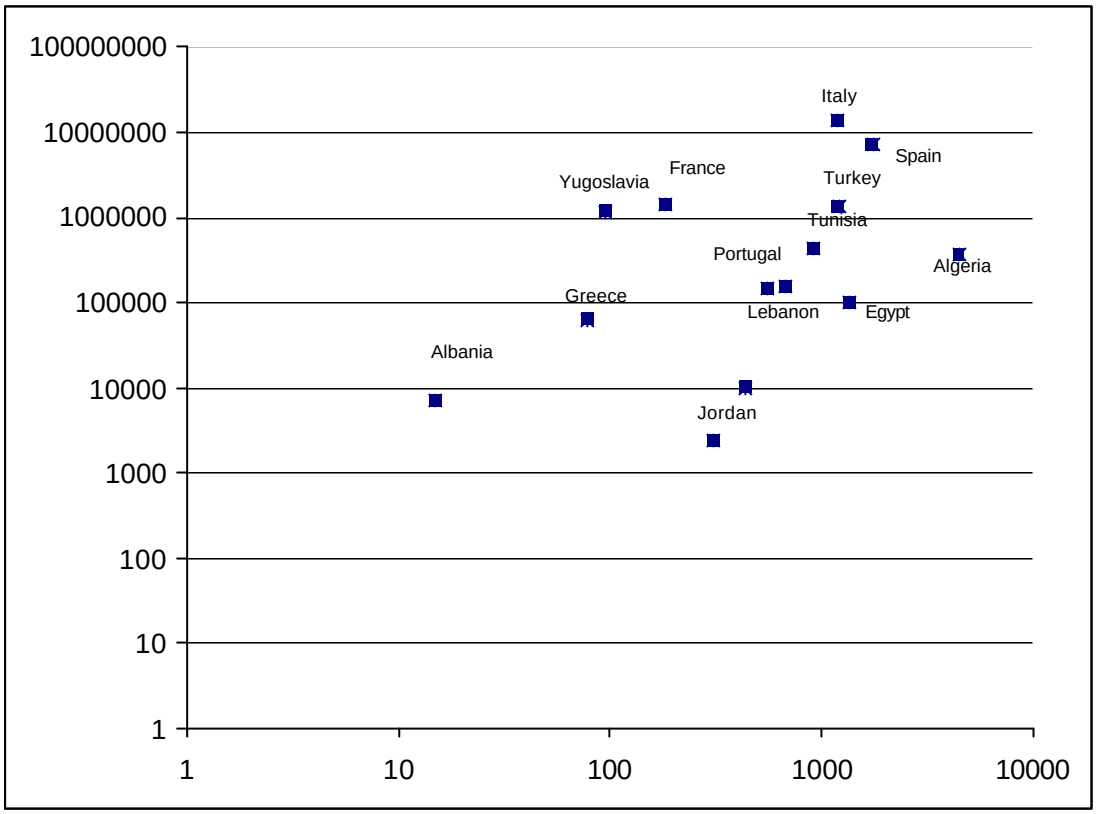

Figure 1. Costs deriving from flood disasters for each Mediterranean country, in terms of economic damages and human lives lost (from EM-DAT: International Disaster Database). Available data are underestimated due to some lack of information in the database.

2. Flood management in the Mediterranean region

Any human activity to prevent loss of lives, property and production due to floods is defined as flood management.

Nowadays, much can be done to prevent from flooding, such as to adopt land use planning policies at national or local scale to manage urban or population growth and to minimise the associated risks. Furthermore, dams, levees, channels and other protective measures can constructed to provide a very high level of protection.

Nevertheless, the level of protection selected is frequently based on costs, desire of the community, potential damage, environmental impact, and other factors. It is a very hard balance between the flood disaster potential and other socio-economic goals and benefits. Sometime, communities choose a lower level of protection because of the initial financial cost.

In this chapter, after a brief presentation concerning the types of measures (structural and non structural) to defend from floods, the major characteristics of policies on floods preparedness and mitigation, at international and national regional scale, will be described.

2.1 Types of measures

Measures are classified into two major groups: structural measures and non-structural measures. Combined together these measures can minimise the effects of floods.

2.1.1. Structural measures

Structural measures are the tools altering the physical characteristics of the floods, such as dams, reservoir and retarding basins, channel and catchment modifications, levee-banks, flood proofing, (see ANPA, 2000, for a complete review). Wisely applied, the impact of flooding can be greatly reduced. However, structural measures cannot get rid of flooding and they can be very costly and disruptive to the environment.

The effect of a dam, for example, differs whether a site is above or below the reservoir created: above the reservoir, the local base level of groundwater rises and river draining into the reservoir, deposits its load both within the bed near the reservoir margins and within the reservoir itself, as a delta. A higher groundwater may produce slope instability since deposition of sediment decreases its water-holding capacity and, in an area of high rates of soil erosion, may even make the construction of the dam expensive.

Downstream the dam the rivers carries a reduced sediment load and to acquire a new load the river can produce a large amount of channel erosion immediately after the dam. Former flooded lands become vegetated and this may extend into the channel whose full capacity is no longer used. As tributaries come in and the contribution of water from sides slopes and groundwater sources increase so the dam construction tend to reduce the flow downstream and even cut flood peaks.

2.1.2. Non-structural measures

Non-structural measures are any procedure altering the exposure of lives and properties to floods, such as flood forecasting and warning, flood insurance, planning controls public information and education, etc.
There are evidences that the efficiency of emergency response depends on the real-time forecasting and the reliability of the prediction. The earlier and the more precise is the forecast, the greater the chance of saving lives and properties.
Real-time hydrological forecast systems generally consist of several tools including highly sophisticated computers for very complex models. Moreover, since real-time hydro-meteorological data and a large amount of geo-related information are necessary, the whole system is based on a Geographical Information System (GIS).
The transfer of information to the public has always been a crucial point in the risk management strategies. Public awareness consists in explaining to the people living in a hazard area the specific risks the meaning of warnings and in inciting to participate to decisional procedure.
Much needs to be done concerning the role of the mass-media. As matter of fact, media tend to reflect the mood of their community.
Flood insurance may be considered an example of financial instrument that mitigates or reduces the adverse effects of floods, but its limit is that it supports only after the event. While some kind of insurance policies are linked to the improvement of the surroundings, there are not many examples of built-in incentives to motivate to invest in the mitigation of floods. Surprisingly the presence of the insurance may even discourage the investment to prevent the floods! A highly evolved insurance policy may encourage to perform the appropriate risk management by lowering premiums if it is compliance with building codes and land use regulations.

2.2 International policies and regional cooperation in the Mediterranean area

International policies and regional cooperation adopted in the field of defence against floods occurring in the Mediterranean area can be gathered in two principal groups according to its main focus:

- prevention of floods as a natural disaster, potentially able to produce huge damages to people, buildings and infrastructures;
- *floods control within integrated water management strategies at river basin scale*, including also the mitigation of other environmental problems (i.e. water pollution, droughts) *for a sustainable development*.

2.2.1. Floods as a natural disaster

IDNDR regional conference for the Mediterranean

In 1989, 155 Member State of the United Nations co-sponsored a UN resolution (44/236) that declares the years 1990-2000 the International Decade for Natural Disaster Reduction (IDNDR). The purpose of the decade was to marshal the political resolve, experience and expertise of each country to reduce loss of life, human suffering and economic losses from natural hazards.

Countries of the Mediterranean basin agreed on guidelines for the development of a "Mediterranean strategy for disaster prevention and vulnerability reduction " (IDNDR

Workshop, Rome 1996). Although some countries put the focus mainly on the mitigation of seismic risk, several national and international activities took place also for the prevention of floods as disasters, in the field of public education and information, hazard assessment, land-use and risk management, monitoring, prediction and early warning.

In 1999, at the end of the decade, the delegations to the IDNDR regional conference for the Mediterranean meeting in Valencia, produced a common declaration (Declaration of Valencia) that reaffirmed in the Mediterranean area:

- the occurrence of potentially dangerous natural phenomena such as flash floods and landslides;
- the importance of risk evaluation as a tool for effective policies of prevention and mitigation;
- the need of land use planning including flood hazard zonation, particularly in those areas with expanding demography;
- the role of intergovernmental organisations (i.e. International Civil Defence Organisation);
- the need of regional cooperation in exchange of information, methodology and procedures;
- the important role played by the citizen and the mass media in prevention, mitigation and alert.

Civil Protection Strategies

The Euro-Med pilot project financed by the MEDA programme 1 is one of the most important area of international cooperation in the field of Civil Protection.

The broad objective is to contribute to political and security confidence-building in the Mediterranean. This pilot project, for the creation of a Euro-Med system of disaster prevention, mitigation and management of natural and man-made disasters, has been established in the Civil Protection field on the initiative of Italy and Egypt. Activities in training, exchange of experts and networking of Civil Protection schools are planned.

Following on from a workshop initiated by the Commission, Slovenia volunteered to take the role of lead country in a cooperation project in the field of Civil Protection under the PHARE programme 2 . The aim is to bring the Civil Protection policies and practices in the CEECs and the EU closer together. Activities will include the networking of CEEC and EU experts and other initiatives -such as common workshops and training, etc- will also be developed. It is noteworthy that as far as Civil Protection is concerned this project is a key element in the enlargement process.

Concerning the European Community Members Countries, the Council Decision 1999/847/EC established a Community action programme during the period from 1 January 2000 to 31 December 2004. The programme must contribute to:

- prevent risks and damage to persons, the environment and property in the event of natural disaster;

- increasing the degree of preparedness of those involved in civil protection;
- detecting and studying causes of disasters;
- improving methods of response and rehabilitation after emergencies;
- public information, education and awareness.

The European Commission has approved a Community Initiative programme intended to prevent flooding in the Mediterranean regions of France (Languedoc-Roussillon, Rhône-Alpes, Provence-Alpes-Côte d'Azur and Corsica), Italy (Val d'Aosta, Piemonte, Liguria) and Spain (Andalusia, Aragon, Catalonia, the Balearic islands, Murcia, Valencia, Ceuta and Melilla).

The programme comprises the following subprograms:

- Flood management and spatial planning to facilitate the implementation of flood protection measures, the spread of information among the local population, the design of a method enabling the local authorities to perceive and assume responsibility for the risk, and the improvement of weather forecasting tools.
- Risk prevention by means of a better joint approach to forecasting. In view of the importance of measuring precipitation on the ground and the flow rate of rivers in evaluating the risks in real time, there is a need to develop an observation network making it possible for neighbouring regions to exchange comparable measurements, and to reinforce the area's hydrometeorological system to this end (rainfall and hydrometric stations, completion of the Mediterranean Arc's radar cover).

Moreover, a large amount of research projects are aimed at the prevention and forecast of flood disasters (i.e. FLOODAWARE project including institutions from France, Spain and Italy) and at the exchange of information about natural and environmental disasters including floods (i.e. EM-DAT and NEDIES projects).

2.2.2. Integrated water management at the river basin scale for sustainable development: a tool for the protection from floods

"For sustainable development, it is necessary to take into account water's social, environmental and economic dimensions and all of its varied uses. Therefore, water management requires an integrated approach. Integrated water resource management is needed to bring all water users to the information sharing and decision making tables". (2001, Bonn International Conference on Freshwater).

Ramsar Convention on Wetlands: River Basin Initiative (RBI) and MedWet

The Ramsar Convention on Wetlands is an international treaty adopted on 2 February 1971 in Ramsar (Iran). The Convention entered into force in 1975 and in 2001 there are 124 contracting Parties to the Convention. Within the Convention, the River Basin

Initiative (RBI) supports international cooperation for the sustainable development of river basins. In particular, specific guidelines outline "*the important function of wetlands for the flood mitigation*" (Resolution 6.23). Thus, a goal of the RBI is "*to make multi-stakeholder river basin management authorities responsible for preparing river basin management plans*". Moreover, countries sharing a drainage basin are encouraged to establish frequent specific contacts in order to exchange information on the water management and flood prevention.

Concerning the Mediterranean area, a Mediterranean Wetlands Initiative (MedWet) was launched in 1991 involving some EU Mediterranean countries and various international NGOs. In 1996, the initial MedWet project was extended to five non-EU countries. The involved countries are currently preparing national plans and inventories of their wetlands, applying MedWet tools and methodologies to a number of test sites and planning national seminars to discuss and evaluate the results of the project.

Euro-Mediterranean Conference for sustainable development

The Euro-Mediterranean Conference held in Barcelona in November 1995, adopted a Declaration establishing a new partnership between the European Union and 12 Southern and Eastern Mediterranean Partners. The overall objective of the partnership is to guarantee peace, stability and prosperity in the region through enhanced and regular dialogue, free trade and cooperation.

Participants at the Conference emphasised their interdependence with regard to environment, the need for a regional approach, increased cooperation, better coordination of existing multilateral programmes. They recognised the importance of reconciling economic development with environmental protection, of integrating environmental concerns into the relevant aspects of economic policy and of mitigating the negative environmental consequences which might result.

A comprehensive programme of multilateral cooperation (MAP, Mediterranean Action Plan) aims at protecting the environment and fostering sustainable development in the Mediterranean basin. For it, it is developing policy recommendations and/or legal instruments to be used and implemented by the contracting parties of the Barcelona Convention.

All interested parties accepted the need of identifying the priorities for the environmental protection: the SMAP (Short and Medium-Term Action Programme) is focused on a limited number of significant priority issues on which major efforts must be concentrated during the coming years.

The priority criteria of the SMAP are:

- regional or transboundary dimension;
- impact on human health and quality of life;
- serious deterioration of natural resources (soil, water, etc.);

sustainable development of the region. Concerning the water management. In particular, it must be based on a global and integrated approach capable of anticipating future problems and aiming at the increase and diversification of supply and the sustainable management of water resources. For it, one of the more urgent actions to

be undertaken is the establishment of river basin and catchment area management plans.

The METAP is a joint programme of big donors investing in the Mediterranean. It aims at offering technical assistance and contributing in capacity building of the non-EU Mediterranean countries.

Several cooperation programmes involve organisms and institutions for monitoring, information and divulgation on water management.

The MED-HYCOS project (Mediteranean Hydrological Cycle Observing System) is one of the regional components of the global programme WHYCOS, launched by the World Meteorological Organisation (WMO. The National Hydrological Services of 24 countries of the Mediterranean and Black Sea region participated in the project implementation. In the first phase a hydrometeorological data collection network (DCPN) has been established and a regional hydrological information system has been developed. The participating countries have expressed their interest in transferring at national level the technologies and tools developed at regional level. Particular emphasis will be given to the use of real time data for flood forecasting and warning.

The CEDARE (Center for Environment and Development in Arab Region and Europe) aims at promoting skills in environmental management, transfer of technologies, environmental education and development of environmental policies. It also facilitates cooperation among its 32 member countries, exchange of information and experience through its Land & Water Resources Management Programme.

It is also important to outline the significant role of the NGOs in the Euro-Mediterranean environmental policies. Their declarations, expressed through specific periodic meetings (i.e. Turin, 1999; Marseille, 2000), look forward to the establishment of a sustainable and peaceful Euro-Mediterranean area. For this, it is necessary the elaboration of an overall Euro-Med sustainable development strategy which fully integrates environmental concerns into all policies.

EU Legislation in the field of water management

The EU Treaty lays down that "*environmental protection requirements must be integrated into the definition and implementation of other community policies*". However, the legislation about water had been always focused on the protection of the environment from water pollution problems (i.e. directives 76/160; 76/464; 83/513; 82/176; 80/68; 80/778; 91/271; 91/676).

An integrated water policy at the river drainage basin scale was introduced only by the Directive 2000/60. Under this Directive, member states have to identify all the river basins lying within their national territory assigning them to individual river basin districts. River basins covering the territory of more than one member state will be assigned to an international river basin district. By 22 December 2003 at the latest, a competent authority will be designated for each of the river basin districts. Nine years after the date of entry into force of the Directive, a management plan and programme of measures must be produced for each river basin district.

2.3 Flood protection and alleviation measures at national scale: examples from some Mediterranean countries

The protection against floods is an institutional task of national countries. Measures adopted by some European countries (France, Spain and Italy) and an experience of international cooperation occurred in Algeria are described in the following.

2.3.1. France

In France there is a long tradition in land-use planning; plans of submersible areas were required in zones prone to flooding to ensure free movement of water ant to preserve flood plains.

In 1987, a new law integrated these objectives into a requirement for producing *risk exposure plans*. These plans determined *three zones*: red (non-building area), blue (building area under constraints) and white (with one flooding each century).

The large flooding events in 1992-1993 led to a new natural risk policy: in 1995 a new legislation requires a national 10-year plan to prevent natural disasters and concentrates primarily on river management and protection against floods. It requires also a risk prevention plan (known as PPRs, which cover, in fact, all types of natural risk, including floods and forest fires) to be produced by all high-risk communes within five years. In particular, the PPRs:

- requires to identify the risk areas;
- prohibits the construction of new installations in the risk areas and reduces the number of existing installations in these;
- reinforces the flood forecasting and alert systems;
- establishes a new financial and institutional budgets for prevention programmes and
- river restoration and dam manteinance;
- setting-up of and procedures to aid the development of flood prevention programmes (including the definition of risk prevention plans) and provide in risk zones.

Flooding risk areas were identified for approximately 30% of all communes in France (IFEN, 1999).

In 1998, approved PPR documents had only been for 10% of the communes at risk of natural disaster and many of the large cities have not been covered yet.

Many are the difficulties in producing these documents: financial (cost of studies), technical (lack of specialists), institutional (poor definition of responsibilities of the State and the local authorities) and political (consequences of defining risk zones on property values and building rights).

For example, a new integrated 10-year policy for the River Loire (*Loire grandeur nature*) started in 1994 covering population safety, water supply and ecological protection.

Under this plan,

i) the mapping of risk zones in the Loire valley was accelerated;

ii) the evaluation of regional and local prevention strategies for the Loire were developed by a multidisciplinary team composed of ecologists, hydraulics experts, geographers, agriculture experts and economists;

iii) priority actions and measures were systematically adopted such as the removal of sediments and other obstacles within the river channel, plant and habitat engineering works in order to stabilise the river banks, flood-warning alert and evacuation system with several alert levels.

Recent massive floods (November 1999) in the South of France (Aude, Tarn and Pyrénées Orientales) have shown how floods can have devastating material and human consequences, particularly flash floods.

In this case, a full protection against flooding is impossible. It is recognised that such events will occur from time to time and it can only be estimated, on average, how often they may occur. Whatever the techniques used, the economic resources employed and the human will, no physical infrastructure will guarantee complete protection from flooding and be universally acceptable. Land-wise management is also being exercised for flood control. The aim is to control the risks of flooding by strengthening the flood prevention policy for upstream watersheds, using real time flood forecasting and management. The agricultural domain is thus likely to be encroached upon for flood alleviation expansion.

2.3.2. Spain

Structural measures: the Water Act and the National Hydrological Planning

The main structural measures used in Spain have been the construction of reservoirs and river channelisation works.

Flood control reservoirs: there are more than 1000 large dams in Spain, many of which are used only for flood control or in combination with other uses (urban and agriculture demand, hydropower, etc).

River channelisation works: a great number have been constructed since the 1960s, mainly to protect against floods. In some cases, these works have constituted a new flood-way that substitutes or supplements the natural river channel.

Among the non-structural measures, there are those regarding the management of the future development of the areas susceptible to flooding, for example the flood-plain planning.

The Water Act (1986) and its regulation deal with the planning of river channels and banks. The concepts of restricted use, surveillance and flood risk zoned are contained therein, and a series of general considerations are made which are supplemented and defined in the hydrological plans for each basin.

The restricted zone is generally a 5 m strip on either side of the channel. Specific authorisation is required from the river basin authority to plant trees and, above all, to construct.

The surveillance zone is generally a 100 m width stretch on both sides of the channel. Hence again, authorisation is required from all the administrative bodies for constructions of any kind and also if the relief is to be substantially altered, aggregates

extracted or the current obstructed. The boundaries of this zone can be modified on the initiative of the regional, local or central administration, but it is the River Basin Authority that has the jurisdiction to carry it out.

The flood risk zone is defined by the theoretical levels that the water would reach during floods for the 500-year return period flood, unless the corresponding ministry defines it in another way.

The Spanish National Hydrological Plan (NHP) was submitted by the Spanish Ministry of the Environment on 5 September 2000. It includes a list of investments amounting to a total of 863 water infrastructures and other works (new dams, reservoirs, river canalisation) for the whole Spanish territory. The NHP total cost is about 23,000 million EURO.

The aim of the NHP is the execution of these works in order to regulate water resources by transfer from river basin that have water "in excess" to river basins with a "water deficit". However, environmentalist associations, as WWF, are very critics regarding the NHP because this program:

? did not evaluate the socio-economic and environmental impact and did not study possible alternatives;

? violates the new EU Water Framework Directive (2000/60) which aims at preventing further deterioration and protecting enhancing and restoring freshwater ecosystems in order to achieve "good ecological and chemical status".

Early warning system

A nation-wide flood forecasting and early warning system was created (SAIH – Sistema Automatico de Informacion Hidrologica). It provides hydrological and hydrometeorological information in real time and makes short-term discharge forecasting. The river basin authority manages this system in each basin. During a flood situation, the information produced by SAIH is supplied to Civil Protection, which is in charge of establishing the warning system. Hydrological information in real time is basically provided by the SAIH and includes data on the precipitation recorded (about 700 rainfall gauging stations), sequences of water levels (about 700) at control sites (rivers and reservoirs) and forecasting about flood evolution. The structure of SAIH operates on a three-level network:

control sites, where data are recorded;

? concentration sites that govern specific zones where information is received through their control sites;

? basin processing centre, which receives and elaborates sites and wherein decisions are taken.

2.3.3. Italy

In Italy, natural risk associated to flood and landslides phenomena is a remarkable problem both in terms of economic damages and cost of human lives (Figure 1).

Legislation for land-use planning at river basin scale: national laws n° 183/89 and n° 267/98

In 1989, a national law (*n°183*) introduced specific structural measures for the mitigation of flood and landslides risk. According to this law, *each River Basin Authority (RBA) must elaborate a River Basin Plan (RBP)* to program actions and policies for soil defence and water use. The same law concerns also a program of structural works to reduce the effects of floods and landslides in the high risk areas.

However, the elaboration of the RBP has resulted very complex, also because the technical structures are not sufficient. At present, although specific RBA have been instituted in the whole Italian territory, no RBP has been completed and approved.

In 1993, to adopt structural measures where the flood and landslide risk is higher, to elaborate the RBP, the law n°493 introduced the concept of River Basin "*Stralcio Plan*" (RBSP), which limits the area only to critic sectors of the river basin.

In 1998, following the catastrophic flash flood occurred nearby Naples (147 killed people in Sarno and Quindici), a significant improvement in the soil defence from floods and landslides was introduced by the law *n°267* that includes:

- *a fast identification of the high-risk areas, classified in four classes* (R1 = low risk; R4 = high risk), in a River Basin Extraordinary Plans (RBEP), elaborated by the RBAs. In 14,5% of the italian municipalities, highest risk areas (R4) were identified and mapped;
- *a program of urgent measures to mitigate the flood and landslide risk in R4 areas*. Structural works, financed for about 600 millions EURO in three years, are still in progress. In order to verify the functionality and the environmental quality of these measures, a specific monitoring was adopted by ANPA (Italian Agency for the Environmental Protection).
- *the improvement of hydrological network*, with real time data for warning systems and alert (25 millions EURO).

Although recent flood and landslides continue to affect the Italian peninsula, there is no doubt that the law n° 267/98 significantly improved the safety regarding the floods threatening: for example, during the huge flood occurred in Piemonte and Valle d'Aosta in October 2000, alert systems worked very well, limiting the loss of human lives.

Emergencies after a catastrophic flood: the role of Civil Protection

Civil defence in Italy is organised as a coordinated resources system where national, regional, provincial and local authorities work together with local and public institutions, the scientific community, private institutions and organisations, voluntary organisations, and professional associations.

Each of these authorities, community institutions and organisations has developed its own part of the National Civil Defence Service and makes its own contribution to the achievement of the aims of civil defence.

This involves a series of practical measures in the various sectors involved in civil defence and, as a consequence, it makes necessary to place responsibility for managing and coordinating to a central unit

In the event of exceptional cases of this type, the Council of Ministers can make use of a special ordinance, prior to a declaration of state of emergency (of limited duration and scope), with the consequent assumption of shared responsibility at the highest level of government.

Emergency powers can also be used in order to prevent dangerous situations or serious damage to persons or property. Emergency management activity is based either on emergency plans drawn up on a national level by the Department for Civil Defence and on a local level by the Prefecture, or else on national emergency programmes.

The special organisation that is required to ensure the central management and coordination of emergency assistance is the Operations Committee of Civil Defence.

When the state of emergency is proclaimed, the prefects of the provinces affected will take all necessary measures to guarantee relief; they will implement the dispositions of the provincial emergency plans on behalf of the President of the Council of Ministers or the Minister Charged with Coordinating Civil Protection.

2.3.4. Algeria

With over 30 million people, the Democratic People's Republic of Algeria is the largest country in the Maghreb region. In this country the significant exposure to recurring natural hazards (e.g., floods, earthquake, drought) emphasises the vulnerability of the poor population because of the recurring social, financial and economic losses. By diverting financial resources from regular development to recovery and reconstruction, *natural disasters are a serious threat to Government's effort to stabilise the country's economic and social situation*.

Factors triggering flooding phenomena

Algerian urban environment, is characterised by *rapid urbanisation and environmental degradation*. Algeria's urbanisation rate grew from 31 percent in 1966, to reach a mark of 50 in 1993 and in 2000 approach 60 percent. Cities attracted rural population due to country-wide economic difficulties and on-going social strife. High urban densities, overcrowding in dwellings, inadequate housing finance markets and a system of social housing production, are all factors that influence the fast deterioration rate of the building stock. With the lack of, or inadequate maintenance of aged buildings in low-income neighbourhoods and social housing complexes, conditions are set in Algiers as well as other Algerian cities for inherent urban vulnerability. Poor or non-existent drainage, water supply, sanitation, sewer and solid waste disposal systems, further enhance the deterioration and destabilisation of buildings and infrastructure.

Deforestation, the elimination of vegetation cover, due to uncontrolled and often illegal development has contributed to further erosion, thus increasing hazard exposure.

Current urban planning system, particularly its land-use aspects needs to be improved. In addition, integration with environmental planning and enforcement of building codes and zoning regulation need to be strengthened.

The 2001 Algiers catastrophic flood: an occasion to improve flood management

On November 2001, severe rains accompanied by floods and mud-flows affected fourteen villages in the northern part of Algeria. The disaster caused the loss of about

900 lives, approximately 95 percent of which occurred in the capital of Algiers (specifically in the Oued Koriche catchment area).

Damage and loss of property were considerable across sectors, amounting to about US$300 million (according to the Government sources). In addition to the unprecedented rains that in a short period of time pummelled a narrow gorge leading to the sea, the main factors that aggravated the damage of this disaster include massive (and often illegal) urban development, often coupled with sub-standard constructions. Huge masses of land got destabilised with the torrential rain, causing massive land slides.

The most seriously affected economic sector is housing, accounting for about 33 percent (or more than US$133 million) of total damage, followed by losses to the rain water sewage system, other public infrastructure such as roads, bridges, ports, social infrastructure (especially in the education sector) and agricultural facilities.

Environmental impacts of the disaster are also significant, as they emphasised the ongoing process of barely checked environmental degradation (including deforestation and denuding the hillocks of their protective vegetation cover for urbanisation purposes). As evidenced by the losses to the housing sector, social cost of the disaster is tremendous and cannot be fully calculated in financial terms, as it includes (in addition to the loss of shelter) loss of livelihoods. Especially affected are the low-income and informal participants in the urban economy, fragile families and extended support networks, resulting in the loss of productivity due to physical disability and importantly, loss of the traditional urban, commercial and social space.

In December 2001, Algerian Government formulated an official request to the World Bank for assistance on rehabilitation and prevention works. Jointly with the Algerian Government, the World Bank Team formulated an approach to the proposed operation including to strengthen the national capacity for overall disaster management, urban multi-hazard vulnerability in the villages of Algiers (including re-housing of population occupying hazardous sites and buildings), and project management.

The UN office proposed a cooperation project in disaster reduction with the Algerian government. A World Bank delegation has similarly visited Algeria to discuss a long-term project in disaster risk management. An expert in urban planning from USAID visited Algiers less than a month after the disaster to discuss eventual cooperation in disaster reduction in urban areas with many Algerian institutions. USAID has expressed an interest in preparing a project proposal for that purpose. Within the first six months after the disaster, several seminars or conferences related to disaster reduction were either held or being planned.

An Algerian-French colloquium on sustainable development and disaster reduction took place in Algiers only weeks after the disaster. Similar colloquia are planned for other regions of the country. All of these actions demonstrate that Algerian authorities at all levels are more aware today about the risks they face.

Since this disaster, there is a new way of thinking about disaster management in Algeria, particularly in urban areas. This has been demonstrated through several initiatives that started only months after the disaster. For the first time ever, the Head of State ordered all the ministries to take serious account of the notion of disaster

reduction and include it in their various programmes. The Prime Minister also discussed the matter during the Council of the Government, and called for a permanent coordinating structure of all the actors involved in disaster management. The Ministry of Interior is developing a permanent structure which will coordinate all phases of disaster management including risk reduction measures, response and rehabilitation. The General Directorate of Civil Protection is shifting its attention towards prevention activities. The current ruling political party in Algiers is preparing to include disaster management in its program for a forthcoming legislative election campaign. Senior party officials are soliciting expert advice from scientific and technical advisors in preparing their programme. Since the floods, international organisations have joined forces to help in risk reduction projects.

3. Perspectives of flood management in the Mediterranean area and adaptation strategies

After earthquakes, floods are the most common type of natural hazard in the Mediterranean region. *All the Mediterranean countries had to defend from some catastrophic flood*. However, the cost of floods in terms of economic damages and human lives is very different according basically to the type of flood. On one hand, when a large river, like Nile, Po or Ebro rivers, flows out of its embankments, huge economic damages are expected to infrastructures (roads, railways), farms and civil buildings located in the alluvial plains, but there is generally time to provide alert messages to the people and limit the loss of human lives. On the other hand, when a flood is triggered by an intense rainfall in a small catchment ("flashflood"), that is typical in many areas of European and African countries located in the Mediterranean area, the main cost is in terms of human lives, basically because the phenomenon occurs suddenly.

An overview to the strategies adopted by national countries in the Mediterranean area put in evidence that *all the strategies are based on the integration of specific measures for flood prevention and measures for flood management during the emergency*. *However, there is not a univocal strategy to mitigate the flood risk, because of different types of floods that induce different impacts on people and land*. For this reason, in national programmes against floods, emergency responses should have a preferential role where "flash floods" occur while longer-term preparedness should be programmed in large alluvial plains in order to prevent huge economic damages.

3.1. Land use management policies and structural measures

All the Mediterranean countries adopt measures to prevent the occurrence and the effects of floods generally through *land use management policies*. Successful national policies try to balance the flood disaster potential with other socio-economic benefits.

Catchment flood management plans should be developed for all rivers. Studies should be undertaken to understand the process of flooding in river catchments, to develop integrated plans for the management of the risks associated with high flows to people. Land use planning and building codes for the whole territory of each locality should be made available, including also the frequently flooded areas where permission to build should not be allowed.

A basic point is the *appropriate scale for land use planning*, that must be the *river basin scale* because each structural measure induces some changes in the river hydrology and, as a consequence, in the magnitude of erosional and sedimentary processes. It could be obvious, but it is important to outline this point, because only recent legislation adopts this scale (i.e. EU Directive 2000/60).

Many problems in flood management common to all the adopted strategies are a consequence of the *dissemination of tasks and responsibilities* among a complex hierarchy of national, regional or local river administration and other agencies. As a consequence, the elaboration of River Basin Plans needs a long period of time, while

land use is in fast evolution often without an institutional control. To adopt structural measures where the flood risk is higher before the elaboration of RBP, some countries limited the study area only to critic sectors of the river basins (i.e. Italian *River Basin Stralcio Plans*) or put in evidence the priorities for structural works planning (*River Basin Extraordinary Plans*).

Concerning the *general criteria for the financial support* for measures, these are often not based on a correct flood risk analysis, but simply on the amount of population living in the area affected by floods. As result some structural works are not justified in terms of costs/benefits while some other measures are not enough to mitigate the flood risk. For this reason, in the realisation of a structural work, *monitoring activities* are fundamental to joint and coordinate the activities between national and local administrations and to elaborate guidelines for planning future structural works programmes.

Regarding *environmental implications* for structural measures, the need to mitigate flood risk may require a political decision to realise some works inducing remarkable environmental problems (in terms of water pollution, biodiversity). Although specific legislation on the Environmental Impact Assessment (EIA) adopted in many countries should avoid this possibility, frequently in the period immediately after a flood disaster, *structural works are built without enough time for a correct project management*.

Referring the planning of structural works, it is important to outline that data input used in flood risk analyses for the elaboration of forecasting models are often not realistic. In fact, the statistical analysis of rainfall data could not make evident the occurrence of an extreme pluviometric event in a small catchment.

Moreover, the inappropriate use of the stream river-beds (for example as a deposit for waste) reduce the real size of river sections in comparison to the theoretic models. This is a very important point, because it explains why dangerous flash flood events occur also where well-designed structural measures are adopted.

For this reason, it is evident the need of maintenance programmes for each structural work to guarantee for a long time its ability to work. It generally consists:

- in a *regularly check of the technical and functional situation of the major hydro-technical works* for defence against the floods;
- *in routine attention to drains, gullies, water cuts, and culverts, keeping them clear and facilitating removal of rainfall from roads and other public areas*.

The lack of maintenance is increasing in the last decades due to the decline of agriculture mainly in mountainous areas: only a few years ago, peasants cultivating lands on mountainous slopes used to remove debris and mud in order to keep the cultivated areas, but also to prevent slope movements.

3.2. Emergency plans and non structural measures

If the aim of land use management is to mitigate the consequences of a flood disaster, public warnings and other non structural measures are basically focused to save people before the occurrence of a catastrophic flood. All the Mediterranean countries have

specific legislation concerning emergency plans for natural disasters (not only for floods but also for earthquakes, volcanic eruptions and hurricanes).

In the last years, national surveys for the civil protection are improving these plans due to a significant contribute from new technologies (including mass-media, internet, etc.). It is important to call a state of emergency at an early stage so that the locally responsible disaster protection authority can take over the centralised direction of emergency. This is a prerequisite for efficient and cost-effective emergency action and allows the direction of emergency operations to be with the locally responsible county administrative authority because they are the only one who can have the detailed knowledge of the local situation necessary for decisions on emergency operations.

However, the success of alert messages is still now difficult, as well suggested by the main flood events occurred in the last years: for example in May 1998 nearby Naples (Sarno and Quindici), a large flash flood which caused huge damages to the villages and 147 people were killed. The main reason for such a large number of human lives has been probably the late arrival of alert messages.

On the other hand, in October 2000 an extreme rainfall occurred in Northern Italy (see ANPA, 2001 for details) producing huge economic damages but there were "only" 20 deads. In this event, real time data forecasted the occurrence of flash floods and landslides within a large area within the Dora River basin, and warning messages allowed to safe many people.

Another key-action during and immediately after a flood emergency is the monitoring of the effects of inundations to hazardous sites from the environmental point of view in order to prevent water and air pollution. This is essential for sites devoted to store radioactive wastes.

Activities aimed to the education of people living in areas prone to flood disaster are very important for the success of civil protection emergency plans. These plans need always the active collaboration of the civil population involved in the emergency.

To mitigate the economic risk in some countries, specific insurances policies have been stipulated concerning the occurrence of catastrophic floods. However, these kind of measures should not be adopted in general because discourage investments in the mitigation of flood risk (in particular land use planning and structural works).

3.3. The role of international cooperation

International cooperation in the Mediterranean area includes a large amount of programmes and initiatives concerning long-term preparedness and emergency mitigation.

Integrated water management programmes for sustainable development (i.e. RBI and MedWet within the Ramsar Convention and the multilateral projects under the Euro-Mediterranean Conference for the Mediterranean) are a crucial tool to identify the urgent actions to be undertaken at the river basin scale in the field of water as a resource to preserve, but also as a potential factor for triggering floods. The *information exchange of hydrologic data* (i.e. MEDHYCOS programme) between different countries is fundamental in order to compare flood hazard in different areas of Mediterranean. Moreover *transfer of technologies* is very important because it allows to improve flood

management in different countries. However, it is important to outline that *a flood management model reliable for a country is not necessary good for all*, and the exporting of measures and policies needs always a careful political and technical evaluation.

Multilateral agreements for mutual help during and immediately after a flood disaster (i.e MEDA programs) are also very important tools. For a better result, the cooperation should not imply only an economic contribute but also the availability of specialists (disaster managers) and techniques (geologists, meteorologists, hydraulic engineers) to mitigate the emergency and to prevent future disasters. For example, the 2001 Algiers catastrophic flood had been an occasion to improve flood management at a regional scale.

International research projects on flood risk analyses and mitigation are also very interesting and valid, but probably could furnish better results if connected directly with the real national strategies against floods.

3.4. Long term scenarios and adaptation strategies

According to the current models about the effects of climate change on the hydrological cycle, more intense precipitation events over many areas will probably increase the occurrence and the magnitude of floods in many areas of the planet. Concerning the Mediterranean area, climate change may increase the occurrence of dangerous flash floods (see par. 1.1.2). Although this report is not focused on the strategies for the mitigation of global warming and other climate change effects, a long-term perspective of flood management must consider also the variability of flood hazard in terms of magnitude and return periods induced by climate change. In fact, although the adopted measures are correct for today's flood regimes, for the future some scenario-based risk analysis approaches may be needed.

Mitigation actions to stabilize atmospheric concentrations of greenhouse gases at lower levels would generate greater benefits in terms of less damage. Adaptation is a necessary strategy at all scales to complement mitigation actions to lessen climate change impacts. However, adaptation would entail costs and cannot prevent all damages.

Over the years, *a wide range of adaptive techniques has been developed*, largely in response to local needs. *The optimum extent of adaptation can be characterised in terms of the benefits and costs of adaptation*. The extremes of adaptation are "no adaptation" and "adaptation sufficient to eliminate all effects" (which usually is not physically possible). The optimum level of adaptation minimises the combined costs of adaptation and residual negative effects, with the most cost-effective steps taken first. For example, the retreat from some floodplains should be strategically combined with the building of structural works increasing the skill of protection from floods.

Broad distinctions can be drawn among "supply-side" adaptive techniques (changing structures, operating rules, and institutional arrangements) and "demand-side" techniques (changing the demand for water or protection against risk and include institutional changes as well). Examples of supply-side adaptations include increasing flood defences (i.e. embankments coping with higher floods, larger retention basins),

building weirs and locks to manage water levels for navigation, and modifying or extending infrastructure to collect and distribute water to consumers, changes in infiltration characteristics of urban areas, increasing capacity of storm runoff and drainage systems, etc. Demand-side techniques include water demand management (such as encouraging water-efficient irrigation and water pricing initiatives), changing water allocations and land-use controls).

In order to reduce as soon as possible the effect of climate change and the longer-term cost of adaptation, long-term strategies should be joined with least regret, low-cost, immediate measures.

Examples of low-cost strategies are:

- re-evaluation operating strategies of dams in flood control, in light of climate change;
- increasing land-use controls;
- more education and public awareness concerning flood risk;
- improving emergency warning systems;
- simplification of institutional tasks and responsibilities among national and local authorities.

Adaptation strategies taking in account the climate change, have the potential to reduce adverse effects of climate change and can often produce immediate benefits but will not prevent all damages (IPCC, 2001). Moreover, it is important to outline that some changes in the climate system (i.e. melting of ice sheets) are effectively irreversible over a period of many human generations.

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