BLUE ARCHITECTURE 2009: International Symposium
Water, Climate Change and Architecture
Venice: September 24-27, 2009

Adaptation to climate change: a planning process for a changing environment in Italy

Vincenzo Ferrara
ENEA, National Agency for Energy, New technology and Environment, Roma, Italy
vincenzo.ferrara@enea.it

Abstract

Adaptation to climate change is one of the two basic strategies that United Nations international agreements have setup to prevent the adverse consequences and damages to the natural and human environment following climate change. It consists of initiatives and measures to reduce the vulnerability, and enhance the resilience, of natural and human systems against actual or expected climate change effects. After an analysis about the implications of such a strategy, it is shown that adaptation is, and will be in the future, the only unavoidable planning process, which must be utilized by decision makers and planners to cope with the challenges of an evolving environment. Since climate change is now in progress and the Mediterranean area (and Italy) is one of the most vulnerable area to climate change in the world, both for the natural environment and historic and cultural heritage, the adaptation strategy must be implemented now. Adaptation in Italy is fundamental for the coastal zone integrated management, for freshwater resource protection and for infrastructure and settlements planning and management.

1. Introduction

The increasing emissions of greenhouse gases into the atmosphere generated by human activities, and in particular by the burning of fossil fuels (mainly coal, oil and gas), the land use change and deforestation, as well as other factors linked to human activities, are causing modification in the atmospheric composition and in the energy budget of the planetary climate system, which could produce irreversible consequences in the future.

The primary modification of atmospheric composition is due to the net accumulation into the atmosphere of emitted anthropogenic greenhouse gases (in particular carbon dioxide and methane) non-removed by natural processes such as the terrestrial absorption by forests and vegetal ecosystem (through photosynthetic processes), and the ocean absorption (through water solubilisation and phytoplankton action). Those absorption processes are named "*sinks of greenhouse gases*" and those referred, in particular, to the carbon dioxide are known as "*carbon sink*" (IPCC 2007a).

As a consequence of that accumulation, the global atmospheric concentration of carbon dioxide has increased of approximately 37% since 1750 (from 280 ppm in pre-industrial times to about 385 ppm today). The current carbon dioxide concentration in the atmosphere have never been exceeded in the past 650,000 years, and the mean rate of increase of 0,5 ppm per year of the last decades, has now reached the speed of 2 ppm per year. The global atmospheric concentration of methane has increased of 1480%, from a pre-industrial value of 715 ppb to 1775 ppb of today and also this concentration is unprecedented in the last 650,000 years (IPCC 2007a).

Increases in the concentration of greenhouse gases reduce the efficiency with which the earth's surface radiates to space. It results in an increased absorption of the outgoing infrared radiation by the atmosphere, with this radiation re-emitted at higher altitudes and lower temperatures. This resulting increase in net radiative energy budget, which is termed "radiative forcing", tends to be transformed and dissipated in two main ways: a) warming the lower atmosphere and the earth's surface; b) intensifying the dynamic of atmospheric processes. The amount of radiative forcing that occurs is

dependent on the magnitude of increases in the concentrations of greenhouse gases, the radiative properties of the gases, and the concentrations of existing greenhouse gases in the atmosphere.

As secondary and more long term consequences, a series of modifications will occur in the oceans and marine environment, which warm and change their physical and chemical characteristics and in the terrestrial geo-chemical and ecological systems, which change their old steady-state conditions and evolve toward new equilibrium. The overall result is a climate change, caused by anthropogenic factors (natural factors in the last two centuries are negligible). Climate change operates on different time scales. Some changes, such as those linked to atmospheric process, can be more evident in a short time (such as temperature, precipitations, extreme events, etc), some other, such as those linked to ocean and terrestrial processes, are more evident in delayed times (sea level rise, desertification, biodiversity loss, etc).

To cope with anthropogenic climate change problems, United Nations have established two action strategies in a 1992 treaty, named UNFCCC (United Nations Framework Convention on Climate Change), and in the following first implementation treaty: the Kyoto Protocol, which will be replaced in 2012 by a second and new international treaty, now under discussion and next approval in the scheduled Copenhagen Conference, to be held in December 2009.

The two action strategies are respectively defined: mitigation of, and adaptation to, climate change. Mitigation of climate change means all that actions which act on the anthropogenic causes of climate change and in particular on the atmospheric emissions of greenhouse gases. Those emitted gases, in fact, are only in part absorbed by the mechanism of the natural environment. More than 50% of the emissions remain into the atmosphere and accumulate in time such as to produce a variation of the energy equilibrium of the climate system and then a global climate change.

Adaptation to climate change means all that actions which act on the limitation of the negative effects and prevention of damages to human and natural systems, originated not only by the impacts of the climate change in progress, but mainly by the future environmental and socio-economic impacts of the projected evolution of climate change (IPCC 2007b, IPCC 2001, Ferrara & Farruggia 2007).

The number, type and entity of adaptation actions depend on vulnerability to climate change of the different ecosystems, human systems and geographical characteristics, but strongly depend on the global dimension, effectiveness and quickness of mitigation actions for contrasting climate change. The more are the commitments and efforts to mitigate, the less will be the efforts and the necessity to adapt, and vice-versa. Mitigation and adaptation are integrated and correlated each other.

2. The adaptation strategy

In a broad sense, adaptation is not a synonymous of resignation to an ineluctable fate, i.e. a passive behaviour, but an active strategy of climate and climate change risk prevention for the natural environment, socio-economic development and human systems, including well-being and quality of life. Such a strategy is already indispensable now. Protecting natural environment and ecosystems, protecting natural resources and in particular water resource and promote efficient management o water use and natural resources, as well as, planning land use, land use change and economic development such as to reduce natural and man made risks, are all actions of adaptation.

Climate change can introduce new risks, or can exacerbate some existing risks and reduce some others. In this perspective the adaptation strategy applied to a specific spatial context, according to the projected or expected new environment evolution, assumes the fundamental role of integration between socio economic development and land use planning and management, including natural resource use and environment protection.

Adaptation is usually subdivided: in proactive adaptation (or planned adaptation) if referred to foreseeable risks and anticipatory actions to avoid damage costs or losses of existing accrued social benefits for, and in reactive adaptation (or emergency response) if referred to unforeseeable risks and reactive actions of intervention for recovery and restoration (IPCC 2007b). Adaptation is also referred to the prevention of many conflicts that could arise as a consequence of climate change on the social

and economic opportunities and the protection of human environment including the conservation of historical and cultural heritage (Ferrara & Farruggia 2007).

The planning processes (spatial planning, physical environment planning, urban and regional planning, land use planning, etc.) cannot be carried out as in the past, assuming that the characteristics of the natural environment (including natural risks) are a time persistent constant whose perturbations depend only on negative impacts of the adverse effect of land use, such as pollution (air pollution, water pollution, soil pollution, etc). The planning process should be carried out looking at the future risks, and not at the present or at the past, as the usual statistics on risk analysis show. Many major projects, such as infrastructure, housing and also large industrial settlements, have a lifespan of 100 years or more and the risks for at least a 100 year timeframe should be considered (WMO 2007, UNFCCC 2006, IPCC 2007, Heinz Centre 2006).

In a future time horizon of 100 years or more, planners should be concerned, not only to protect natural environments from the adverse effects of human use (e.g., pollution), but also to protect people and human activities from the adverse effects of a an evolving natural environment following climate change (e.g.. new risks of a new environment, quite different from what it was historically known). Moreover it should be reconsidered for the benefits of actual and future generations, the functional and evolutional connections among the various processes of planning at different spatial scales and among the various institutional competence and authorities to integrate thematic strategies, such as infrastructures, energy, agriculture, water use, etc., with the climate change considerations. That means adaptation (Ferrara & Farruggia 2007).

Action to mitigate climate change (e.g. reduction of greenhouse gases emissions) which are considered in international UN treaties, such as UNFCCC, the Kyoto Protocol and the next Copenhagen Treaty) are fundamental and absolutely urgent to slow the rate of climate change speed, as long as to reach the equilibrium (named the stabilization level) of the greenhouse gas concentration in the atmosphere and, then, of the climate system. However, the climate change now in progress is a consequence of emissions decades ago, and the process will continue to proceed for long time before the man-made causes can be removed, also in the extreme case of an immediate stop of any man-made emission. The delayed response of the climate system and the further delay to reach the stabilization require a long time lag (IPCC 2007b).

For the time being, mitigation is essential and adaptation is unavoidable. It represents a necessity not a choice. Climate change is already causing a warming of earth's surface temperature and an increase of extreme weather events, both in frequency and intensity. But we do not know in terms of predictions, with a more or less degree of confidence, what will be the future climate in the next decades or in the next hundred years, as well as, how and when climate change will affect specific locations, because the future climate and climate change depend on many factors both of scientific nature (climate modelling, numerical simulations of climate processes, etc) and of socio-economic nature (types of economic development, energy use and in particular, fossil fuels and renewable energies, availability of new energy sources, availability of new environment sound technologies, etc).

Thus, the only feasible way is to set up a given number of scenarios, which are based on various hypotheses of human development and some given hypotheses on the confidence degree of the climate models utilized. The results are a series of climate change possibilities (e.g. scenarios), ranging from a small climate change, with low-level environment consequences, up to a very large climate change, with very adverse or catastrophic consequences. Each of those scenarios is quoted with a confidence level and an occurrence probability.

Every planner who is aware that planning is not a short term exercise, should take into account that climate change is a reality in progress and cannot be, in any way, stopped in the next decades. Thus the planning process should be based on such medium and long term scenarios, according their level of confidence and occurrence probability and planners should be concerned to assess a suitable reference scenario for the particular geographical and environmental situation under analysis, to know what kind of environmental and socio economic impacts can be generated according this reference scenario, and what kind of new major risks (or reduced risks) can be originated.

3. Adaptation and vulnerability

The increasing and the improvement of the adaptation capacity of a given system (natural and/or human) to climate change is linked mainly to the possibility to decrease the vulnerability of that system to climate change, increasing its resilience. The problem of adaptation is fundamentally a problem of understanding how much the system we are dealt with, is vulnerable to climate change and how much is sensitive to the effects of climate change.

To-day increase of vulnerability depends on two main factors:
- the first is linked to the expansion of human activities on lands, costal zone, mountains, etc. that expansion produces additional risks to the existing natural and historical risks;
- the latter is linked to the slow but continuous variations of the characteristics of the environment, including lands and coasts, with time changing risks which are now enhanced and amplified by climate change and climate change effects.

Since the rate of climate change is, and will be, much more fast than the rate of all the other natural processes (geological, morphological, hydrological, marine, etc), the additional and combined risks driven by climate change can assume the more relevant role, a role which is often unforeseeable for a reliable evaluation of the vulnerability change in the human, as well as natural systems.

In the planning processes, planners cannot ignore we are living, and will live, in a fast changing environment. So, the usual methodologies, which assume, directly or indirectly, a constant environment (including constant risks, constant resilience and constant vulnerability), cannot be applied especially in the cases of long term planning of human activities and land use. In a changing environment the priority becomes the assessment of future risks and the reduction of future projected vulnerabilities more than the existing ones, unless the existing risks and vulnerability could be exacerbated in the future according to climate change reference scenarios (UNEP 1998).

However, adaptation to climate change is not only a problem of concern for scientist and land planners. It is mainly a problem of public awareness and of social interest (Maarten et al. 2007). So, Public Administrations and Institutions have to play their role to be prepared and to prepare citizens to cope with the new challenges of climate change and its effects. What appears necessary in this context, is the development of the different aspects of the adaptation capacity and capability, and in particular as regards:
- scientific and technological research and education in the field of climate change and its effects to improve knowledge of the different problems and built, also at social level, the basic know how and a common responsibility;
- strategic planning and management of integrated human activities, land use and natural resources to overcome the sector planning views, the fragmentary subdivision of competence and the lack of effectiveness of actions;
- integrated legal and authorization instruments at local, regional and national level to set up a coherent and consistent regulatory framework, in coordination with the international conventions, protocols and recommendation or, for what is of our concern, with the general provision of the European Laws;
- institutional and operative organization, including emergency structures, coordinated for implementing programs, actions and measures of adaptation
- information and public participation

Many adaptation problems, which were forecast in the future projections, are indeed problems of adaptation for the time being. Since future adaptation starts now, we need now to proceed to adaptation in many sectors that show an increasing vulnerability.

4. European Adaptation Framework: The EU Green Paper and the EU White Paper

Adaptation is complex because the severity of the impacts will vary from region to region in Europe and also within the single member state, depending on physical vulnerability, the degree of socio-economic development, natural and human adaptive capacity, health services, and disaster surveillance mechanisms. Many countries in Europe have set up climate change adaptation strategies

or defined national adaptation plan, in particular: Denmark, Finland, Germany, France, Hungary, Netherlands, Spain, Sweden, United Kingdom (European Commission 2007a). As regards Italy, in 2007 a national conference on climate change discussed the main problems of climate change impacts, vulnerability and adaptation and concluded with a "manifesto" (reported here in Annex I) requiring a national strategy for adaptation and integrated action between mitigation and adaptation. No implementation has been up-to-now done.

At the European level it was recognized that different national adaptation plans with different perspectives, different institutional actors involved and different basis for actions, should find an efficient coordination between regions and communities, in order to avoid discontinuities across borders as well as to keep the cost low. In this context the European Union can play an important role in supporting adaptation efforts by adjusting relevant policies, filling knowledge gaps and coordinating strategies. Certain sectors, such as agriculture, water management, biodiversity protection and fisheries, are largely integrated at EU level through the single market or common policies. It thus makes sense to integrate adaptation goals into these sectors, as well as into EU spending programmes, for instance on regional development, agriculture, fisheries, social, research and rural development.

In 2007 the EU Commission launched a Green Paper: Adapting to Climate Change in Europe (European Commission 2007c), which was followed by a White Paper this year (European Commission 2009a).

The EU Green Paper is focused on four pillars of action:
1 - building a solid knowledge base on the impact and consequences of climate change for the EU filling knowledge gaps through scientific research and exchange of information;
2 - integrating adaptation strategies and actions into EU key policy areas;
3 - employing a combination of policy instruments (market-based instruments, guidelines, public-private partnerships) to ensure effective delivery of adaptation;
4 - stepping up international cooperation on adaptation.

Following a wide-ranging consultation launched in 2007, after the publication of the Green Paper on Adapting to Climate Change in Europe, the EU Commission published in April 2009 a White Paper to enhancing the EU resilience to the impacts of climate change. The White Paper proposes to build up a European Adaptation Framework, based on the following strategic actions:
- developing the knowledge base;
- integrating adaptation into EU policies;
. increasing the resilience of health and social policies;
- increasing the resilience of agriculture and forests;
- increasing the resilience of biodiversity, ecosystems and water;
- increasing the resilience of coastal and marine areas;
- increasing the resilience of production systems and physical infrastructure;
- promoting investments in adaptation proactive actions;
- working in partnership with the Member States.

For the implementation of White Paper toward an European Adaptation Framework, the EU Commission will establish by September 2009 an Impact and Adaptation Steering Group (IASG) to step up cooperation on adaptation and will encourage the further development of National and Regional Adaptation Strategies of Member States on the basis of the four pillars of actions defined by the Green paper and with a view to considering mandatory adaptation strategies from 2012. The European Adaptation Framework to be set up before 2012 will respect the principle of subsidiarity and support overarching EU objectives on sustainable development. After 2012 the European Adaptation Framework will be operatively implemented.

5. Climate change situation and evolution

5.1 The evolution of global climate at global level

According to the Fourth Assessment Report of the IPCC (IPCC 2007a, 2007b, 2007c), warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.

5.1.1 Situation

Temperature: Eleven of the last twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850). The last 100-year linear warming trend is of 0.74 °C. e.g. a mean decadal rate of 0.07 °C per decade. The linear warming rate over the last 50 years is 0.13°C per decade, e.g. nearly twice that for the last 100 years. Urban heat island effects are real but local, and have a negligible influence. Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1300 years. Observations since 1961 show that the average temperature of the global ocean has increased to depths of at least 3000 m and that the ocean has been absorbing more than 80% of the heat added to the climate system. Such warming causes seawater to expand, contributing to sea level rise.

Sea level rise: Global average sea level has risen since 1961 at an average rate of 1.8 mm/yr and since 1993 at 3.1 mm/yr, with contributions from thermal expansion, melting glaciers and ice caps, and the polar ice sheets.

Precipitation: From 1900 to 2005, precipitation increased significantly in eastern parts of North and South America, northern Europe and northern and central Asia but declined in the Sahel, the Mediterranean region, southern Africa and parts of southern Asia. Globally, the area affected by drought has increased since the 1970s.

Extreme events: There is observational evidence for an increase in intense tropical cyclone activity in the North Atlantic since about 1970, correlated with increases of tropical sea surface temperatures. There are also suggestions of increased intense tropical cyclone activity in some other regions where concerns over data quality are greater. Widespread changes in extreme temperatures have been observed over the last 50 years. Cold days, cold nights and frost have become less frequent, while hot days, hot nights and heat waves have become more frequent. The frequency of heavy precipitation events has increased over most land areas, consistent with warming and observed increases of atmospheric water vapour.

5.1.2 Future evolution

Advances in climate change modelling now enable best estimates and likely assessed uncertainty ranges to be given for projected warming for different scenarios of emission and future socio–economic development.

Greenhouse gases: Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century.

Temperature: The best estimate for the low scenario is 1.8°C (with a *range* between 1.1°C to 2.9°C), and the best estimate for the high scenario is 4.0°C (with a range between 2.4°C to 6.4°C). Warming tends to reduce land and ocean uptake of atmospheric carbon dioxide, increasing the fraction of anthropogenic emissions that remains in the atmosphere contributing to a further increase of global temperature. Warming is expected to be greatest over land and at most high northern latitudes, and least over the Southern Ocean and parts of the North Atlantic Ocean. Snow cover is projected to contract. Widespread increases in thaw depth are projected over most permafrost regions. Sea ice is projected to shrink in both the Arctic and Antarctic under all scenarios. In some projections, arctic late-summer sea ice disappears almost entirely by the latter part of the 21st century.

Precipitation change: Climate change will produce changes in precipitation patterns, with substantial increases in rainfall in many parts of the regional areas at high latitudes and declines in others, particularly at low latitudes and subtropical zones. Increased rainfall will likely induce an increase of

flooding and a threat of soils stability particularly of slopes due to high run-off. For the Mediterranean region, it is estimated that the global warming can cause a reduction of the annual rainfalls mainly in the Spain, southern of Italy, Greece and the northern part of the African continent. The contrary will happen for the central and northern Europe, where the estimated r/decade.

Sea level rise: Future projections show an increase in mean global sea level between 18 cm and 59 cm by the year 2100, with a best estimate of about 40 centimetres. The increase in mean sea level rise includes thermal expansion and the loss of ice mass from polar marine ice caps and from middle and low latitude glaciers. In the evaluation of sea level rise it is excluded, both local components of vertical movements (isostacy, subsidence) and eusthatic components due to rapid change in ice flow of Greenland and Antarctica. Moreover, sea levels could continue to rise for several centuries after greenhouse gas emissions are stabilised. It must be emphasized that at regional level, the effective sea level rise depends on the regional thermohaline conditions, geographic situations and other local factors. Hence, in projecting climate trends over the current century, the regional assessment remains fraught with uncertainty. For instance, the evaluation in the Mediterranean basin can be affected by significant errors, owing to a complex combination of various effects, including the dynamic and thermal interaction with the Atlantic Ocean, meteorological and oceanographic factors, geological movements, etc.

Coastal zones: Coastal zones are among the world's most diverse and productive environments. Projection about the future evolution of coastal zones can be done taking into account the specific characteristics of the different environmental, ecological and human situations. In a more general view, the global warming and the sea-level rise will produce one or more of the following consequences on the coastal zones:
- increased levels of inundation and sea storm flooding,
- accelerated coastal erosion and seawater intrusions into fresh groundwater,
- encroachment of tidal waters into estuaries and river systems, and
- an elevated sea-surface and ground temperature of the coasts.

Extreme events: Projected temperature change will likely raise ocean temperatures and sea surface water temperatures. This could result in a greater exchange of energy and add momentum to the vertical exchange processes critical to the intensification of extreme meteorological events such as typhoons and hurricanes in tropical latitudes, or heavy rains, and prolonged droughts in the middle and high latitudes. For the Mediterranean region, as well as for other temperate areas close to tropical latitudes, an increase of heat waves during summers is likely to be expected, as well as an increase of the intensity of heavy rains between prolonged drought periods.

Abrupt climate change: Abrupt, non-linear change is considered any change occurring from a few decades to a century or more, which produces the widespread displacement or loss of a significant number of species. From a societal perspective, abrupt climate change is considered a change in climate occurring within one to two human generations, which result in drastic disruption to the way current civilization is organized and functions. Should abrupt climate change occur, human and ecological systems might not be able to adapt. Some possible abrupt physical and ecological events that have been studied include:
- a strong modification of the thermohaline circulation and in particular the Gulf Stream (the ocean's conveyer belt effect that moves equatorial heat to the north, warming Europe), that produces a cooling of the northern planetary hemisphere rather than a warming;
.- the fast melting and collapse of Greenland glaciers and Greenland ice sheet, that produces an accelerated seal level rise up to 7 metres;
- the rapid deglaciation, and disappearance of high latitude permafrost or increases in soil respiration leading to emission of methane compounds and a fast changes in the greenhouse terrestrial effect.

5.2 The main consequences in the Mediterranean region

On the basis of a projected climate scenarios, elaborated by the IPCC (IPCC 2007a, IPCC 2007b) and the assessments of European Environmental Agency (EEA 2005), the relevant problems that can affect the Mediterranean area, and Italy in particular, can be:

- The different availability in fresh water resources between north and south Europe and between north and south of Italy, due to the different patterns of precipitation: hence, it is not only a problem of modified hydrological balance, but also concerns several socio-economic sectors such as agriculture, industry, urbanisation, tourism and last (but not the least) the insurance sector.

- The migration toward higher latitudes (northward) of ecological systems with variations also in landscapes all over Europe, but in particular of Mediterranean region, due to the combination of temperature increase, soil evapo-transpiration and rainfall modifications: it can imply significant variation in the agricultural production and development, as well as in other sectors including population health and wealth.

- The increased vulnerability of coastal and marine environment, with variations in biodiversity, coastal natural and human environment, due to the seal level rise, increased sea water temperatures and extreme marine events: it implies significant modification in the development of human activities on coastal zones, but also increased risks of flooding for zones of particular natural or artistically relevant value (such as the river deltas and humid zones, and low lying coastal zones, including Venice and other lagoons).

- The secondary effects derived on changed availability of natural resources and a changed natural environment, which modify the opportunities for socio-economic development, rising also problems of equity between peoples living in different modified areas (north and south, coastal or inland, etc)

5.3 The Italian situation and the future evolution

Temperature: The average annual temperatures in Italy has grown over the last two centuries of 1.7 ° C (equivalent to more than 0.8 ° C per century), but the largest contribution to this increase occurred during the last 50 years for which it has been observed an increase of about 1.4°C. So, In Italy the rate of growth of the average temperature appears to be much higher (about double) than the global average (Brunetti et al. 2006).

Precipitation: Over the past two centuries, the total precipitation fell throughout the national territory, approximately 5% per century, with further reductions (9%) in the spring. The reduction is more pronounced in Central-South regions. The number of days of precipitation has fallen, especially in recent 50 years: 6 days per century in the north and about 14 days per century in the centre-south. (Brunetti et al. 2004, 2006, 2006a). The general trend, for all Italian regions, is an increase in precipitation intensity and a decline in their lifetime. There is also an increase of the drought, whose persistence in winter and summer is higher in the northern and southern regions. Precipitation modification patterns will influence water availability all over in Italy and particularly in Southern regions (Struglia et al. 2003). In Po valley where the additional ongoing reduction of the Alpine glaciers, significant consequences are expected on the hydrological regimes both with relevant reductions in discharge in summer and early fall and with increases in runoff in winter and spring. On the basis of the current trends, the river flow especially in the south will decrease of about 60%, and up to 80% during summer, before the end of the century. The hydropower potential in the Alps region could be reduced from 20 to 50% (European Commission.2007a, 2007b)

Evolution of Italian biodiversity: The Italian ecosystems will very like undergo to a northward migration of about 150 km for every degree Celsius of temperature change and a simultaneous upward migration in mountain regions of about 150 m, with strong implication on ecosystem biodiversity and natural habitat modifications. Also for Italian forests, it is very likely an expansion to north Italy and a reduction in southern Italy with conifer replaced by deciduous trees. It is also expected an increased process of soil respiration, which in the Italian lands will lead to loss of biomass and soil degradation and increased forest fires and parasitic attacks. But, regardless of future climate change, indigenous biodiversity is now declining due to the expansion of human activities, the growing use of anthropogenic soil and the progressive reduction and fragmentation of natural habitats. The climate change will accelerate these processes and will favour new forms of biological biodiversity very likely in association with alien species especially in the marine environment.

Agriculture evolution: In terms of production, the changes predicted for the period 2020 -2080 could cause, according Peseta project (European Commission (2007b), a variable yields decline in parts of Southern Italy, from 9% to 22.4%, because of the reduction of the period of growth, the extreme weather events during stages of the production cycle, the particularly intense rainfall during the sowing, the heat stress during flowering period and the dry longer period.

Sea level rise: There are different causes to the rise of sea levels, but the thermal expansion of the ocean seawaters is the fundamental one. However, the regional and local sea level change will be different depending on the different part of the Mediterranean Sea and on coastal zone characteristics. It is will possible, according to a preliminary ENEA assessment in the Third National Communication to the UNFCCC (ENEA 2003), that the mean Mediterranean sea level could rise in the range between 18 and 30 cm before the year 2100, without considering the vertical soil movements such as isostacy and subsidence that are variable for different Italian coastal areas. But this estimate, in consideration of the very complex behaviour of the Mediterranean basin (Lambeck 2000, Valpreda & Simeoni 2003, Pirazzoli 2005, Antonioli 2007, Tsimplis 2008, MedCLIVAR 2009), should be considered only as indicative. In any case, the Italian areas, which will be exposed to an increased flooding risk, are many low-lying zones and coastal plains. In particular (Antonioli 2001, ENEA 2003):
- the whole coast between Monfalcone and Rimini (including Venice, Marano and Grado Lagoons);
- some coastal areas in river's mouth proximity: Magra, Arno, Ombrone, Tiber, Volturno, Sele;
- some lagoon areas such as: Piombino, Pontina coasts and Tavoliere in Puglia.

6. Climate change, water and settlements

6.1 The Mediterranean basin

It is to be pointed out, first of all, the peculiarity of Mediterranean climate and its environment. The Mediterranean basin, owing to its thermal and morphological characteristics, is able to influence both the general atmospheric circulation of the boreal middle latitudes and the general equilibrium conditions of the terrestrial and marine ecosystems, biodiversity and natural environment. Moreover, the Mediterranean basin acts as a big thermal energy capacitor, and such a characteristic produces also a mitigation of some extreme events, in particular of very hot events during summer and very cold events during winter. Hence, the Mediterranean basin determines a peculiar climate situation in the entire Mediterranean region.

The second aspect to be pointed out is that the Mediterranean basin is a closed basin, e.g. more similar to a lake than an open sea. The only possibility of a limited water exchange is restricted to Gibraltar Channel, being negligible the exchange through the Suez Channel. Thus, as a closed sea, the Mediterranean can be considered a concentration basin: the evaporation rate of the seawaters exceeds the fresh water inflow from rivers and precipitation. Since, the production of sea salt water is enhanced as well as the production of dense water, particularly in the eastern part of the basin, the Mediterranean exports toward Atlantic saltier and denser waters through Gibraltar Channel and imports less salt an dense waters. Those processes significantly influence the general water circulation, the mean sea level and the future sea level rise in the Mediterranean, since the climate changes are already modifying the overall equilibrium.

In many research activities of Italian Research Institutions (Marullo et al. 2006, MedCLIVAR 2009,CNR-ISAC 2009, ENEA 2009), it has been observed that the mean surface water temperatures in the Mediterranean have been increasing, since 1960, but particularly since 1994-95, and that the rate of sea level rise in the Mediterranean coast has been decreasing since 1960. The trend of sea level rise is in contrast with the global ocean sea level trends, which is between 10 cm and more than 25 cm in the last century (1,8 mm/year as a general mean up to 3,1 mm/year in the last decade). The explanation is in the complex interaction among different factors, including the increase of water density (e.g. the simultaneous increase of salinity and temperature of the deep waters), the reduction of rainfalls and consequently the fresh water inflow from rivers, with impacts on the thermohaline circulation. The ENEA researches (Struglia et al. 2003) have estimated that the annual mean river discharges into the Mediterranean of about 8100 cubic meter per second, have been decreased since 1960 up to 26% with respect to the seasonal mean, and up to 17% with respect to the long time scales. In the meantime the yearly averaged water temperature is increased at a mean rate of 0.06 -

0.1°C/year, with extreme values of 33 °C during the summer of 2003, in some areas of the eastern and southern Mediterranean basin.

The changes in the water mass characteristics lead to changes in the water mass properties and dynamical characteristics of the sea, including sea level. In particular, the circulation is mainly driven by density differences between eastern and western Mediterranean, where the critical part of this circulation is the Gibraltar Channel. Because of ongoing changes in the temperature and salinity, through the Gibraltar Channel, the Mediterranean Sea has been exporting saltier water during the last decades than in the past, and this, according to some researchers, can produce effects also in the Atlantic seawater circulation (Artale et al. 2006).

The possibility that "marginal seas" (like Mediterranean) can undergo different evolution pattern of sea level rise in comparison with global ocean, and that Mediterranean sea can influence the wide, larger scale Atlantic circulation and therefore the climate, has been pointed out in the last IPCC Fourth Assessment Report (IPCC 2007a). The importance of the latter problem (the influence on Atlantic circulation), and the unknown possible effect of abrupt climate change over northern Europe associated to the Gulf Stream modification, has been recognised, and more efforts for experimental research integrated with regional scale climate modelling activities were recognized as prioritary (WCCC 2003, Artale et al. 2006).

The Mediterranean coasts with relevant flooding risks are not as wide and as critical for population as in other parts of the world (e.g. south east of Asia, many parts of Africa, Pacific and Caribbean small island States. However the Mediterranean coastal zones are among the most vulnerable in the world, in terms of loss of coastal wetlands and of marine and coastal biodiversity, but also for the presence of high density of resident population, significant infrastructures and cultural heritage sites. Saltwater intrusion in the low-lying coastal zones will produce adverse impacts on groundwater resources, which in turn will cause negative effects in the final use of the resources (e.g. agriculture, tourism, civil uses, etc.). Fresh water shortages can also be exacerbated by the decrease in rainfalls on prolonged drought periods, but also by anthropogenic factors, such as an increasing use of water in agriculture and industry, and an increase of water pollution due to urbanisation and water eutrophization due to nutrient pollution in presence of higher temperatures.

It should be remarked that the future risks, following an increase of the sea level, couldn't in general be considered new risks for Italy and the Mediterranean coasts. Rather they should be considered as additional or, in many cases, increased risks with respect to the existing situation, which is characterised by an higher and higher anthropogenic pressure (urbanisation, industrial settlements, harbours, transports, tourism, fishery, etc,)

Finally, any adaptation strategy in Italian coastal zone should take into account that it must be linked and coordinated with international strategies of integrated coastal zone management (European Union 2009) and with national and local water adaptation plans. Sea level rise problems are worsened by other concomitant factors which enhance erosion and flooding of low lying coastal zones (Bonora et al. 2000), including:
- the decreasing sediment load in rivers and reduced sediment transport to the sea for restoration of coastal zones, due to decreasing rains and water flows in rivers and catchment's areas;
- the increasing pollution concentration in rivers that, with the increasing seawater temperature, favour higher eutrophisation conditions in the coastal marine environment;
- the increasing intensity of sea storm surge, that, with the increasing heavy rain frequency and runoff, favour more severe coastal flooding;
- the intrusion of salt water into the coastal fresh groundwater and upstream of rivers.

6.2 Freshwater resources

Water controls any aspect of natural as well as human environment (from drinking supplies to agriculture, from energy to health and sanitation). Water is a key natural resource and economic product, a basic part of any plan or program for environmental, social and economic sustainability. But, freshwater resources are strongly dependent on climate and threaten by climate change. Moreover, their availability depends on the water use and management in human activities.

Climate change in Mediterranean region will cause both a shortening of fresh water resources and an increased variability of available fresh water. In Italy, in particular, the problem is becoming more and more evident by the increased magnitude of winter floods, the recurrent summer drought, the decreasing river's flows and the increasing destructive run-off. The problem is further exacerbated by human activities and in particular by the expansion of urbanized areas, the pollution from soils and from uncontrolled waste disposal, the increasing water stress generated mainly by the raising conflict competition for the different use of water.

In Italy, there is not a national strategy to address the problems of increased pressure on water supply, on water resource shortage and on the frequent crises facing the recurrent drought emergencies in summer (Po river and the Southern Italy regions) as well as the flood emergencies in winter (Northern Italy regions but also other parts of Italy). The water planning and management, in Italy, appears to be an incoherent overlap of fragmented plans and programs, but also of territorial institutional competence and regulatory legislation, which, although recently updated, remains outdated, shows incoherent aspects with the European directives and doesn't consider any current or future climate change influence. The situation is better described by another paper of this Symposium (Zitelli et al. 2009).

Since water availability affects many sectors of natural environment and human development, it appears fundamental a radical change in the water management practices to prevent water scarcity in Italy. It is urgent to define and implement a comprehensive national adaptation strategy for water security and efficient water use including a framework to:
- reduce risks against water shortage and water variability extremes, promoting new technologies for water consumption and conservation, improving water infrastructure for supply and efficient distribution, and introducing sustainable management practices;
- stimulate a strong cooperation among water users (agriculture, industry, domestic and residential) to avoid conflicts, share the different use of water resources, reduce water pollution and combat illegal withdrawals, in order to reach a sustainable water consumption, water recycling and water saving,
- built an efficient system of water governance with well-integrated legal instruments and management roles at various institutional levels, including disaster risk reduction systems, and with the participations of the different users.
- promote scientific and technological research, as well as observation and monitoring systems to fill the existing knowledge gap of the water cycle in Italy.
- increase information, public awareness and public participation

6.3 Settlements and infrastructure systems

Since Italy is just now vulnerable to coastal and hydro geological risks, and will be much more in the future, the human infrastructures and many networks in Italy (such as transport systems, pipelines, electric grid, and energy systems, communication systems, etc), which are very sensitive to climate change, could result inadequate to the evolving land situation and the new climate conditions. Infrastructure systems last considerably longer tan decades (some up to a century or more), additional financial resources will be very likely required to repair damages, to rearrange new protective actions and to proceed with periodic restructuring of the various infrastructural systems.

In spite of these efforts, many infrastructural systems could, in any case, result counterproductive in the new climate situation, especially in comparison with a probable new socio-economic growth and the rising of new social needs. The design and planning of infrastructures, in fact, provide the footprint and direction for future socioeconomic relevant activities and for environmental quality and human well-being.

Many human settlements will very likely exposed to the same difficulties with climate change and the additional risks that will arise according to their territorial location and the corresponding land vulnerability: e.g. more intense and prolonged heat waves in urban area, increased flooding risks in coastal zones and low-lying areas, slope stability change in mountain areas with incremental risks of collapsing landslides, mud flows, flash, debris avalanches, etc.

While adaptation and the prevention of future risks (including the reduction of disaster risk associated with climate change), are generally recognized in the European Union, before an after the EU Green Paper (European Commission 2007a, 2007c), it still remains outside from the strategic governance culture of the decision makers and in particular of the Italian decision makers. Since decision-makers provide policy guidance and make the most infrastructure-related decisions, they play an important role to allow a sustainable development in an evolving environment. It is, hence, fundamental that decision-makers and planners, at any level, understand the importance of adaptation to prevent the short and long term consequences of climate change on infrastructure and settlements.

Those decisions should be supported not only by a process of Environmental Impact Assessment (and Strategic Environmental Assessment) to evaluate the impact of the proposed project (or plan) on the environment (supposed in a steady state), but also by a process of Climate Change Adaptation Assessment to evaluate the impact of climate change, and of the evolving environment, on the proposed project (or plan), as well as, on the future sustainability of proposed infrastructures. The introduction of an adaptation assessment procedure in decisional processes cannot be more delayed.

The implementation of an adaptation planning for infrastructure and settlements imply the definition and setting up of suitable adaptation methodologies, institutional organization and assessment processes on the basis of European strategies an other experiences in Europe and outside Europe, but imply, al national level, also a reviewing of many planning references:
- the planning laws in force and regulatory guides, in order to take account of climate change problems and the importance of adaptation planning;
- the methodologies and planning standards used for building infrastructures and settlements;
- the planning data and information used to determine vulnerability and risks of infrastructures and settlements to climate-related hazard;
- the development of appropriate risk management guidance and strategic assessment manuals for infrastructure systems, to take into account any projected changes as a result of climate change and identify critical vulnerable networks or sub-systems;
- the development of an adaptation planning capacity to support decision makers and institutions.

7. Final remarks

Responding to climate change impact and increasing the resilience of natural and human systems to climate change will mean the choice and implementation of different strategies that integrates the general objective of the climate change mitigation with adaptation strategies as underscored in the first part of this paper. The recommendations that the Italian national Conference on Climate Change, held in Rome on 12 and 13 September 2007, put out, are reported in the Annex 1, here below and could be considered as a useful starting point.

The priorities of adaptation actions should be focused on proactive adaptation, rather than reactive action that, excluding those linked to residual risks, have to be avoided for their very high cost and very low effectiveness, as pointed out by several economic assessments (Cline 1992, ENEA&FEEM 2003, European Commission 2007b, Carfare 2008), including the rather famous cost-benefit balance analysis: The Stern Review (Stern 2007).

- prevention and emergency preparedness against projected adverse effects of climate change
- reduction of expected damages through an appropriate planning, land use and land use change for human activity development and natural resource management with particular attention to water availability and biodiversity protection.

Depending upon the degree of vulnerability of specific sectors in their specific context, various combined strategies of proactive adaptation are possible. The best is to find ways of strengthening local people own coping strategies, and help minimise losses of wealth and productive assets. In the Mediterranean area, climate change will exacerbate existing problems such as coastal flooding and erosion, saltwater intrusion, hydro geological risks and degradation of ecosystems, rather than induce new kind of risks. At the same time, non-climate stresses can be an important cause of increasing vulnerability to climate change and variability. Given such interactive effects, adaptation options to be most effective should be incorporated as soon as possible, with plan and policies in all the relevant

areas of economic and social development, such as land-use, waters management, infrastructure, energy, etc. In other words, adaptation options are best addressed when they are incorporated in integrated environment/development management and sustainable development plans.

Bibliography and References

Artale, V., et al. (2006): The Atlantic and Mediterranean Sea as connected systems. In: Mediterranean climate variability, Lionello, P. et al Eds., Elsevier, Amsterdam, pp. 227-282

Antonioli F., et al., (2001): The risk of sea flooding in 33 Italian coastal plains. Accademia dei Lincei, Congresso: Global changes during the late quaternary, Roma 4-5 maggio 2001. Volume Abstract

Antonioli F., et al., (2007): Recent coastal tectonic movements along the Italian coastline and comparison between long term (geological) and short term (instrumental) relative sea level data. Top Europe Congress, Accademia Nazionale dei Lincei, Roma 2-4 Maggio 2007. Volume Abstract.

Berkhout, F, (2004): Rationales for adaptation in EU climate change policies. European Forum for Integrated Environmental Assessment Workshop, Den Haag, 30-31 August 2004.

Bonora N, et al, (2000): Interaction between catchment's basin management and coastal evolution (Southern Italy). Journal of Coastal Research-NI, Vol. 36, pp.81-88.

Brunetti, M. et al (2004): Changes in daily precipitation frequency and distribution in Italy over the last 120 years. Journal of Geophysical Research-Atmosphere, v.109, D05102, doi: 10.1029/2003JD-004296, p. 16

Brunetti, M. et al (2006): Temperature and precipitation variability in Italy in the last two centuries from homogenized instrumental time series. International Journal of Climatology, vol. 26: 345-381.

Brunetti, M. et al. (2006a): Trends of daily intensity of precipitation in Italy and teleconnections. Il Nuovo Cimento, vol. 29, n.1: 105-116.

Camuffo D, et al. (2002): Improved understanding of past climatic variability from early daily European instrumental sources, Kluwer Academic Publisher.

Carbognin, L., et al., (2009): Global change and relative sea level rise at Venice: what impact in term of flooding. Climate Dynamics, Springer 07.07.2009, DOI 10.1007/s00382-009-0617-5, pp. 9

Carraro, C. Ed. (2008): Cambiamenti climatici e strategie di adattamento in Italia: una valutazione economica. Soc. Ed. Il Mulino, Milano, pp. 520.

Cline, W. R. (1992): The Economics of Global Warming. Institute of International Economics, Washington, DC.

CNR-ISAC, (2009): Gruppo di Oceanografia da satellite. Real time SST images. Web: http://gos.ifa.rm.cnr.it/

Council of Australian Governments, (2006): National Climate Change Adaptation Framework, Australia Parliament Document, Canberra.

EEA, European Environment Agency, (2004): Impacts of Europe's changing climate. EEA Report 2/2004, Copenhagen.

EEA, European Environment Agency, (2005): Vulnerability and adaptation to climate change in Europe. EEA Report 7/2005, Copenhagen.

ENEA (1998): Seconda Comunicazione Nazionale dell'Italia alle Nazioni Unite (UNFCCC), Capitoli 7-8, Ministero dell'Ambiente e del Territorio, Roma

ENEA (2003): Terza Comunicazione Nazionale dell'Italia alle Nazioni Unite (UNFCCC), Capitolo 6, Ministero dell'Ambiente e del Territorio, Roma

ENEA (2009): Sea surface temperature Mediterranean area. ACS-CLIMMOD. Web: http://clima.casaccia.enea.it/sst/?lang=en

ENEA & FEEM (2003): La risposta al cambiamento climatico in Italia, Rapporto ENEA – Ministero Ambiente e Territorio, Roma

European Commission, (2007a): Living with climate change in Europe. Web: http://ec.europa.eu/environment/climat/adaptation/

European Commission, (2007b): The Peseta Project, JRC. Web: http://peseta.jrc.ec.europa.eu/

European Commission, (2007c): Adapting to climate change in Europe: options for EU action. Green Paper from the Commission to the Council, the European Parliament, The European Economic and Social Committee and the Committee of the Regions,. Report COM(2007)354, Brussels.

European Commission, (2009a): Adapting to climate change in Europe: toward a European framework for action. White Paper from the Commission to the Council, the European Parliament, The European Economic and Social Committee and the Committee of the Regions,. Report COM(2009)147, Brussels.

European Commission, (2009b): Integrated coastal zone management. Web: http://ec.europa.eu/environment/iczm/

European Union, (2009): Protocol on Integrated Coastal Zone Management in the Mediterranean. Official Journal of the EU, February 4, 2009, L34, p.19-28, Signed in Madrid

FAO (2007): Adaptation to climate change in agriculture, forestry and fisheries. Food and Agriculture Organization of United Nations, Roma.

Fankhauser, S., et al., (1999): Weathering climate change: some simple rules to guide adaptation decisions, Ecological Economics 30, 67-78..

Ferrara, V. (2005): Vulnerabilità ed adattamento al cambiamento del clima. Energia Ambiente Innovazione, v. 51, n. 1, pp 40-47
Ferrara, V. et al. (2005): An overview of the main findings of the third assessment report of the IPCC. In: Flooding and environmental challenges for Venice and its lagoon. Fletcher, C.A. et al. Eds., Cambridge University Press, Cambridge, pp. 661-669.
Ferrara, V. & Farruggia, A., (2007): Clima, istruzioni per l'uso. Edizioni Ambiente, Milano, pp. 308
Fletcher, C.A. & Spencer, T. (ed.), (2005): Flooding and environmental challenges for Venice and its lagoon: state of knowledge. Cambridge University Press, Cambridge.
Fierro, G. (2006): Il degrado dei litorali. Scienza online , n. 28-29.Anno 3. 17 giugno 2006
Fierro, G. (2007): Lo stato delle conoscenze delle aree costiere nazionali ed ipotesi di adattamento ai cambiamenti climatici previsti. Atti Conferenza Nazionale Cambiamenti Climatici 2007, Roma.
Finland Government, (2005): Finland's National Adaptation Strategy. Ministry of Agriculture and Forestry, Helsinki
Government of Canada, (2004): Climate Change Impacts and Adaptation: a Canadian Perspective, CCIA-Directorate, Natural Resources Canada, Ottawa.
Heinz Centre, (2006): A survey of climate change adaptation planning. The H. Joho Heinz III Centre for Science, Economics and the Environment, Washington D.C.
IPCC, (2001): Climate Change 2001: Impact, Adaptation and Vulnerability, Cambridge University Press, Cambridge.
IPCC, (2007): Publications and data. Intergovernmental Panel on Climate Change, Web: http://www.ipcc.ch/
IPCC, (2007a): Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge.
IPCC, (2007b): Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge.
IPCC, (2007c): Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge.
Lambeck, K. & Bard, E. (2000): Sea level change along the French Mediterranean coast since the time of the Last Glacial Maximum. Earth Planetary Science Letter 175 (3-4), 202-222.
Lambeck, K. & Johnston, P., (1995): Land subsidence and sea-level change: contributions from the melting of the last great ice sheets and the isostatic adjustment of the Earth. In: Barends, F.J. et al. (Eds.), Land Subsidence. Proc. Fifth Int. Symposium on Land Subsidence, The Hague, 16-20 October 1995. Rotterdam, p. 3-18.
Lambeck, K. & Chappel J. (2001): Sea level change through the last glacial cycle, Science, 292, 679-686.
Lovejoy T.E. & Hannah L. (Eds), (2006): Climate Change and Biodiversity. Yale University Press, New York.
Maarten, K. et al., (2007): Community level adaptation to climate change: The potential role of participatory community risk assessment. Global Environmental Change, Vol. 18, n. 1, pp. 165-179
Marullo, S. & Guarracino, M. (2003): L'anomalia termica del 2003 nel mar Mediterraneo osservata da satellite Rapporto ENEA, Roma.
Marullo, S. et al. (2006): Twenty-two years of sea surface temperature in the Mediterranean Sea. ENEA Report. Ocean Science Discussions, Dipartimento ACS, Roma
Maugeri, et al. (2001): Trends in Italian total cloud amount, 1951-1996, Geophysics. Res. Lett., 28, 4551- 4554.
MedCLIVAR (2009): Mediterranean Climate Variability and Predictability. European Science Foundation. Database, information & documents on Web: http://www.medclivar.eu/
Netherlands Environmental Assessment Agency, (2006): Climate Adaptation in the Netherlands. Report 500.102.003, NEEA-WAB, Bilthoven
Nicholis R.J., et al., (1999): Increasing flood risk and wetland losses due to sea level rise - Global Environmental Change, n. 9, pp; 69-87)
OECD, (2007): Climate Change in the European Alps: Adapting Winter Tourism and Natural Hazards Management, Agrawala, S. (ed.), OECD, Paris, France.
ONERC, (2007): Stratégie nationale d'adaptation au changement climatique. Publication ONERC - Observatoire National sur les Effets du Réchauffement Climatique. La documentation française, Paris.
Pasini, a. (ed.), (2006) : Kyoto e dintorni: i cambiamenti climatici come problema globale. Franco Angeli, Milano, pp. 214.
Pirazzoli, P.A., (1997). Sea level changes in the Mediterranean. In: Tooley, M.J., Shennan, I., (Eds.), Sea-level Changes, Institute of British Geographers, Special Publications Series, Page Bros (Norwich) Ltd, pp. 152-181.
Pirazzoli, P.A., (2005): A review of possible eusthatic, isostatic and tectonic contributions in eight late-Holocene relative sea-level histories from the Mediterranean area, Quaternary Science Reviews 24, pp. 1989–2001.
Sciortino, M. et al., 2000: La lotta alla desertificazione in Italia e nel bacino del Mediterraneo, In: Complessità e sviluppo, ENEA-2000, pp. 37-46
Shaw, R. et al. (2007): Climate change adaptation by design: a guide for sustainable communities. TCPA - Town and Country Planning Association, London, pp. 52

Simeoni, U. et al., (2003): Effects of anthropization on the Ferrara Littoral and intervention of re-equilibrium. Proc. of the 16th MEDCOAST, 1605-1616.
Struglia, M.V. et al., (2003): River discharge into the Mediterranean Sea: climatology and aspects of the observed variability. Report ENEA, Progetto CLIM. Accordo ENEA-MATT, Roma
Stern, N., (2007): The Stern Review - Economics of the Climate Change. Cambridge University Press, Cambridge, pp. 712.
Tsimplis, M.N. et al. (2008): 21st century Mediterranean Sea level rise: Steric and atmospheric pressure contributions from a regional model. Global and Planetary Change, Volume 63, Issues 2-3, September 2008, Pages 105-111
UNEP, (1998): Handbook on methods for climate change impact assessments and adaptation strategies. Feenstra, J.F., et al. Editors, United Nations Environmental Program. UNEP/IVM Handbook, Nairobi-Amsterdam
UNFCCC, (2006): Technologies for adaptation to climate change. United Nations Framework Convention on Climate Change, Climate Change Secretariat, Bonn
UNFCCC, (2007): Climate change: Impacts, vulnerability and adaptation in developing countries. United Nations Framework Convention on Climate Change, Climate Change Secretariat, Bonn, pp 68
Valpreda, E. & Simeoni, U. (2003): Coastal erosion susceptibility assessment at national scale: the Italian case JCC.258, 2003
Valpreda, E. (2006): La banca dati geografica delle dune costiere in Italia: uno strumento per valutare l'interazione tra queste morfologie costiere, l'evoluzione di litorali ed il loro utilizzo. Studi Costieri, vol. 11, Firenze
Valpreda, E. & Gabbianelli, G. (2007): Le dune costiere per l'adattamento ai cambiamenti climatici nei litotali italiani. Atti Conferenza Nazionale Cambiamenti Climatici 2007, Roma
WCCC, (2003): Summary and Key messages Sec 1.2, World Climate Change Conference, National Organizing Committee WCCC, Moscow
WMO, (2007): The role of land use planning in flood management. World Meteorological Organization, APFM Technical Document n.12, Associated Programme on Flood Management, Geneva
Zitelli, A. et al., (2009): Adaptation to climate change: land, social and environmental processes in the Northern Adriatic Sea area. Binar 09. International Symposium: Water, Climate Change and Architecture. Venice: September 24-27, 2009

ANNEX 1

Manifesto: The recommendations of the Italian National Conference on Climate Change, held in Rome on 12 and 13 September 2007

A MANIFESTO FOR CLIMATE **A New Deal for sustainable adaptation and environmental security** Conclusions of the Italian National Conference on Climate Change Roma, Fao Headquarters, 12-13 September 2007	**MANIFESTO PER IL CLIMA** **Un New Deal per l'adattamento sostenibile e la sicurezza ambientale** Conclusioni della Conferenza Nazionale Cambiamenti Climatici Roma, Palazzo Fao, 12 e 13 settembre 2007	**UN MANIFESTE POUR LE CLIMAT** **Un New Deal pour l'adaptation durable et la sécurité environnementale** Conclusions de la Conférence Nationale Italienne sur les Changements Climatiques Roma, Siège de la Fao, 12-13 septembre 2007
Climate changes constitute a national problem. Strategies to oppose them have to be considered as a major priority for the Government initiative and for the integration of actions for the reduction of greenhouse gases and of actions for sustainable adaptation into social, economic, financial, agricultural and territorial policies. These actions may and must also represent an important driver for employment. Security, welfare and quality of life of Italian citizens of today and tomorrow depend upon health of the planet and of its climate. Within 2008, the Ministry of Environment, Land & Sea will define a national strategy for the sustainable adaptation to climate change and for the security of the environment.	**I cambiamenti climatici costituiscono un problema nazionale. Le strategie per contrastarli vanno considerate prioritarie per l'iniziativa del Governo e per l'integrazione delle azioni di riduzione delle emissioni di gas serra e delle azioni di adattamento sostenibile nelle politiche sociali, economiche, finanziarie, agricole e territoriali. Queste azioni possono e devono rappresentare anche un importante volano per l'occupazione. La sicurezza, il benessere e la qualità della vita dei cittadini italiani di oggi e domani dipendono dalla salute del pianeta e del suo clima. Il Ministero dell'Ambiente e per la Tutela del Territorio e del Mare entro il 2008 definirà una strategia nazionale per l'adattamento sostenibile ai cambiamenti climatici e per la sicurezza del territorio.**	**Les changements climatiques constituent un problème national. Les stratégies pour les contraster doivent être considérées prioritaires pour l'initiative du Gouvernement et pour l'intégration des actions de réduction des gaz à effet de serre et des actions d'adaptation durable au sein des politiques sociales, économiques, financières, agricoles et territoriales. Ces actions peuvent et doivent représenter en même temps un important volant pour l'emploi. La sécurité, le bien-être et la qualité de la vie des citoyens italiens d'aujourd'hui et de demain dépendent de la santé de la planète et de son climat. Le Ministère de l'Environnement, du Territoire et de la Mer définira, avant la fin de 2008, une stratégie nationale d'adaptation durable aux changements climatiques et pour la sécurité du territoire.**
1. On the basis of the results of the National Conference, consistently with strategies outlined at the United Nations level (in particular the UN Convention on Climate Change – UNFCC) and with those outlined at the European Union level, it is necessary to develop concrete policies for climate change	1. In base ai risultati della Conferenza Nazionale, coerentemente con le strategie delineate in sede Nazioni Unite (in particolare la Convenzione ONU sui Cambiamenti Climatici – UNFCC) e con quelle delineate in sede di Unione Europea, è necessario sviluppare politiche concrete di mitigazione dei	1. Sur la base des résultats de la Conférence Nationale, en cohérence avec les stratégies définies au sein des Nations Unies (en particulier la Convention ONU sur les Changements Climatiques – UNFCC) et avec celles définies au sein de l'Union Européenne, il est nécessaire de développer des politiques concrètes de mitigation

mitigation through the compliance with adopted commitments and working in the appropriate international instances for more significant reductions of emissions of altering climate gases, starting contemporarily concrete initiatives favouring energy savings, energy efficiency and the use of sustainable renewable sources. First of all, the Kyoto Protocol must be implemented before 2012 and, within the near renegotiation of the reduction objectives of climate altering emissions, proceed with the further reductions indicated by the European Union, equal to at least 20% within 2020 (that we wish to become 30% as proposed by the EU, in the frame of a global agreement) and to 60% within 2050, consistently with the indications of the Intergovernmental Panel on Climate Change (IPCC).	cambiamenti climatici rispettando gli impegni assunti e lavorando nelle opportune sedi internazionali per più significative riduzioni dell'emissione di gas climalteranti, avviando contestualmente iniziative concrete a favore del risparmio, dell'efficienza energetica e dell'utilizzo di fonti rinnovabili sostenibili. Si deve, innanzitutto, attuare il Protocollo di Kyoto entro il 2012 e, nell'ambito della prossima rinegoziazione degli obiettivi di riduzione delle emissioni climalteranti, procedere alle ulteriori riduzioni delle emissioni di gas serra indicate dall'Unione Europea, pari ad almeno il 20% entro il 2020 (che auspichiamo diventi del 30% come previsto dalla UE, nel quadro di un accordo globale) e al 60% entro il 2050, coerentemente con le indicazioni dell'Intergovernmental Panel on Climate Change (IPCC).	des changements climatiques en respectant les engagements assumés et en travaillant dans les instances internationales appropriées pour des réductions plus significatives des gaz altérant le climat, en engageant en même temps des initiatives concrètes en faveur des économies et de l'efficience énergétiques, et de l'utilisation de sources renouvelables durables. Il faut, tout d'abord, mettre en œuvre le Protocole de Kyoto avant la fin de 2012 et, dans le cadre de la prochaine renégociation des objectifs de réduction des émissions altérant le climat, procéder aux réductions ultérieures de gaz à effet serre indiquées par l'Union Européenne, égales à au moins 20% d'ici 2020 (que nous souhaitons devenir 30% ainsi que prévu par l'UE, dans le cadre d'un accord global) et à 60% d'ici 2050, cohéremment avec les indications du Intergovernmental Panel on Climate Change (IPCC).
2. It is necessary to coordinate mitigation measures with those adapting to climate change, integrating since now the latter in sector policies for economic development, in the legislation and in the financing programmes for major infrastructures, providing immediate adaptation actions that may already begin today in Italy, starting with policies concerning: o protection of ecosystems and biodiversity (terrestrial and marine); o soil and coastal management; o water resources management; o health safeguard of population; o agriculture and rural development; o industry and energy; o tourism. In this context the full implementation of certain regulation instruments becomes of high priority; among these: a) the Water Framework Directive 2000/60 (water resources) b) the Habitat Directive 92/43/CEE and the Birds Directive 79/409/CEE (biodiversity) c) the International Convention for the Protection of the Alps	2. E' necessario coordinare le misure di mitigazione con quelle di adattamento al cambiamento climatico, integrando da subito queste ultime nelle politiche settoriali di sviluppo economico, nella legislazione e nei programmi di finanziamento delle grandi opere, prevedendo azioni immediate di adattamento che possono già oggi essere avviate in Italia, a partire dalle politiche riguardanti: o la protezione degli ecosistemi e della biodiversità (terrestre e marina); o la gestione del suolo e delle coste; o la gestione delle risorse idriche; o la tutela sanitaria della popolazione; o l'agricoltura e lo sviluppo rurale; o l'industria e l'energia; o il turismo. In questo contesto assume priorità la concreta attuazione di alcuni strumenti normativi, tra i quali: a) la Direttiva Quadro Acque 2000/60 (risorse idriche) b) la Direttiva Habitat 92/43/CEE e Direttiva Uccelli 79/409/CEE (biodiversità) c) la Convenzione	2. Il est nécessaire de coordonner les mesures de mitigation avec celles d'adaptation au changements climatiques, en intégrant dès maintenant ces dernières dans les politiques sectorielles de développement économique, dans la législation et dans les programmes de financement des grandes infrastructures, en prévoyant des actions immédiates d'adaptation qui peuvent être engagées dès aujourd'hui en Italie, à partir des politiques concernant: o la protection des écosystèmes et de la biodiversité (terrestre et marine); o la gestion du sol et des côtes; o la gestion des ressources hydriques; o la tutelle sanitaire de la population; o l'agriculture et le développement rural, o l'industrie et l'énergie, o le tourisme. Dans ce contexte la mise en oeuvre concrète de certains instruments réglementaires devient prioritaire, parmi lesquels: a) la Directive Cadre Eaux 2000/60 (ressources hydriques) b) la Directive Habitat 92/43/CEE

d) the national system of environmental accounting ("delegated" law) and the completion of the reform process for the rules on environmental assessment, especially for what concerns the integration of Strategic Environmental Assessment into new plans.	Internazionale per la Protezione delle Alpi d) il sistema contabilità nazionale ambientale (legge delega) e il completamento del percorso di riforme delle norme sulla valutazione ambientale, soprattutto per quanto riguarda l'integrazione della Valutazione Ambientale Strategica nei nuovi piani.	et la Directive Oiseaux 79/409/CEE (biodiversité) c) la Convention Internationale pour la Protection des Alpes d) le système national de comptabilité environnementale (loi "déléguée") et l'achèvement du parcours de réforme des normes sur l'évaluation environnementale, surtout en ce qui concerne l'intégration de l'Evaluation Stratégique Environnementale dans les nouveaux plans.
3. The immediate definition of a **National plan of adaptation to climate change** is necessary; the whole Government, local and territorial authorities, and social partners, must be involved; the Plan must be connected and integrated with the start up or the concrete implementation of the two plans required by the two great international conventions: - the National plan for biodiversity, with special reference to ecological restoration and defragmentation; - the National plan for fighting drought and desertification. Moreover, in a vision of full environmental sustainability, the Plan shall include the best strategies of intervention for: - soil defence; - coastal integrated management; - tourism adaptation in Italy; - water resources management; - a national programme for participation, information, raising awareness of citizens about climate change. The complexity of the climate change theme and of its interconnections with the aspects of national socio-economic development and with the international aspects (linked to European policies and to the implementation of community directives, as well as to extra-European policies and to the international relations), requires that the National Plan of adaptation to climate change be consistent with mitigation strategies and with research initiatives on climate change and training.	3. E' necessaria la definizione immediata di un **Piano nazionale di adattamento ai cambiamenti climatici**, che veda impegnato l'intero Governo, le istituzioni locali e territoriali e le parti sociali, connesso e integrato con l'avvio o la concreta implementazione dei due piani previsti dalle due grandi Convenzioni internazionali: - il Piano nazionale per la biodiversità, con particolare riferimento al ripristino ecologico e alla deframmentazione; - il Piano nazionale di lotta alla siccità e alla desertificazione. Inoltre, in un'ottica di piena sostenibilità ambientale, il Piano dovrà comprendere le migliori strategie di intervento per: - la difesa del suolo; - la gestione integrata delle coste; - l'adattamento del turismo in Italia; - la gestione delle risorse idriche; - un programma nazionale di partecipazione, informazione, sensibilizzazione dei cittadini sui cambiamenti climatici. La complessità del tema dei cambiamenti del clima e delle sue interconnessioni con gli aspetti di sviluppo socio-economico nazionale e con gli aspetti internazionali (legati alle politiche europee e all'attuazione delle direttive comunitarie, così come alle politiche extraeuropee e alle relazioni internazionali), richiede che il Piano nazionale di adattamento ai cambiamenti climatici sia coerente con le strategie di mitigazione e le iniziative di ricerca sui cambiamenti climatici e la	3. Une définition immédiate d'un **Plan national d'adaptation aux changements climatiques** est nécessaire; le Gouvernement entier, les institutions locales et territoriales, et les partenaires sociaux, doivent être engagés; le Plan doit être lié et intégré avec le démarrage ou la mise en œuvre concrète des deux plans prévus par les deux grandes Conventions internationales: - le Plan national pour la biodiversité, avec référence particulière à la restauration écologique et à la défragmentation; - le Plan national de lutte à la sécheresse et à la désertification. En outre, dans une vision de pleine durabilité environnementale, le Plan devra inclure les meilleures stratégies d'intervention pour: - la défense du sol; - la gestion intégrée des côtes; - l'adaptation du tourisme en Italie; - la gestion des ressources hydriques; - un programme national de participation, information, sensibilisation des citoyens sur les changements climatiques. La complexité du thème des changements climatiques et de ses interconnexions avec les aspects de développement socio-économique national et avec les aspects internationaux (liés aux politiques européennes et à la mise en oeuvre des directives communautaires, ainsi qu'aux politiques extra-européennes et aux relations internationales), requiert que le Plan national d'adaptation aux changements climatiques soit cohérent avec les stratégies de mitigation et les initiatives de

The need to develop adaptation plans and strategies at the different territorial levels requires the availability, for the administrations of such levels, of data, information and documentation, as well as the preparation of periodic reports on the state of implementation of the adopted initiatives. To achieve these aims it is opportune to attribute, following the German model, to the National Agency for the Protection of Environment and for Technical Services (APAT) the functions of competence centre on climate change impacts and adaptation.	formazione. L' esigenza di sviluppare strategie e piani di adattamento ai diversi livelli territoriali richiede la disponibilità, per le amministrazioni di tali ambiti, di dati, informazioni e documentazione, nonché la predisposizione di rapporti periodici sullo stato di attuazione delle iniziative. Per conseguire queste finalità e' opportuno attribuire, sul modello tedesco, all'Agenzia per la protezione dell'ambiente e per i servizi tecnici (APAT) le funzioni di centro di competenza sugli impatti e sull' adattamento ai cambiamenti climatici.	recherche sur les changements climatiques et la formation. L'exigence de développer des stratégies et des plans d'adaptation aux différents niveaux territoriaux requiert la disponibilité, pour les administrations de ces niveaux, de données, informations et documentation, ainsi que la prédisposition de rapports périodiques sur l'état de réalisation des initiatives adoptées. Pour remplir ces objectifs il est opportun d'attribuer, suivant le modèle allemand, à l'Agence pour la Protection de l'Environnement et pour les Services Techniques (APAT) les fonctions de centre de compétence sur les impacts et sur l'adaptation aux changements climatiques.
4. Moreover, initiatives to assist developing countries for the programming and implementation of plans for the sustainable adaptation to climate change must be promoted, also to the aim of preventing social unbalances. To favour sustainability within adaptation policies it seems opportune to propose the setting up of an European Fund for Adaptation which may support assistance initiatives for developing countries, with special attention for those of the Mediterranean basin.	4. Devono inoltre essere promosse iniziative per assistere i paesi in via di sviluppo nella programmazione e nella attuazione di piani di adattamento sostenibile ai cambiamenti climatici anche al fine di prevenire squilibri sociali. Per favorire la sostenibilità nelle politiche di adattamento è opportuno proporre l'istituzione di un Fondo europeo di adattamento che possa supportare le iniziative di assistenza ai paesi in via di sviluppo, con particolare attenzione a quelli del bacino mediterraneo.	4. Il faut de plus promouvoir des initiatives pour assister les pays en voie de développement dans la programmation et la mise en oeuvre de plans d'adaptation durable aux changements climatiques, aussi afin de prévenir les déséquilibres sociaux. Pour favoriser la durabilité dans les politiques d'adaptation il est opportun de proposer l'institution d'un Fond Européen d'Adaptation qui puisse souvenir les initiatives d'assistance aux pays en voie de développement, avec attention particulière à ceux du bassin méditerranéen.
5. We wish that the commitments of the Italian Government for integrating the logics of adaptation to climate change within general and sector policies may be achieved within a timeframe of three years. To monitor progress, as well as to adjust policies to the pressing rhythm of climate modification, we wish the convening of the National Conference on the adaptation to climate change to be at least following the cadence of Ipcc reports and providing for update sessions.	5. Si auspica che gli impegni del governo italiano per integrare le logiche di adattamento ai cambiamenti climatici all'interno delle politiche generali e settoriali possano essere conseguiti entro un arco temporale di tre anni. Per monitorare i progressi, così come per adeguare le politiche al ritmo incalzante del mutamento climatico, si auspica la convocazione della Conferenza Nazionale sull'adattamento ai cambiamenti climatici con una cadenza che segua almeno quella dei rapporti dell'Ipcc e che preveda sessioni di aggiornamento.	5. Il est souhaitable que les engagements du Gouvernement Italien pour intégrer les logiques d'adaptation aux changements climatiques à l'intérieur des politiques générales et sectorielles puissent être obtenus dans un arc temporel de trois ans. Pour le suivi des progrès, ainsi que pour rendre adéquates les politiques au rythme pressant de la mutation climatique, il est souhaitable que la convocation de la Conférence Nationale sur l'adaptation aux changements climatiques ait une cadence qui suive au moins celle des rapports Ipcc et qu'elle prévoit des sessions de mise à jour.