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Overview of key climate change impacts, vulnerabilities and adaptation action in Italy

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SUMMARY This paper presents an extensive desk review of the available knowledge on climate change impacts and vulnerability in Italy and illustrates the state of the art of the adaptation policy and practice in the country, including early information on costs of impacts and costs of adapting to climate change. It aims at providing complete and accessible facts on the Italian approach to face climate change, which helps to frame the existing national adaptation efforts in the European and international arena. Section 1 introduces the expected climate change challenges relevant for the sectors of key national socio-economic and environmental interest in Italy. Section 2 illustrates the range of sectoral adaptation initiatives including legal frameworks and practical measures that have been already implemented in Italy despite the lack of a National Adaptation Strategy. In addition, the paper offers an Executive Summary, a series of Annexes providing supplementary information as well as a glossary of basic terms.

Keywords: climate change, impact assessment, vulnerability, adaptation, climate costing, National Adaptation Strategy, Italy

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Table of Contents

Executive summary	5
Overview of expected key climate change impacts and vulnerabilities for Italy.....	5
State of the art of adaptation to climate change in Italy.....	6
1 Overview of expected key climate change impacts and vulnerabilities for Italy	9
1.1 Introduction	9
1.2 Agriculture and food security	10
1.3 Biodiversity and ecosystems	10
1.4 Coastal zones.....	13
1.5 Areas at risk of drought and desertification	14
1.6 Fisheries and aquaculture	16
1.7 Forests and forestry	17
1.8 Human health	18
1.9 Water and hydro-geological system	18
1.10 Infrastructure and economy.....	20
1.11 Economic impacts of climate change	21
1.12 Summary of key climate change impacts and vulnerabilities for Italy.....	26
2 State of the art of climate change adaptation in Italy	27
2.1 Introduction	27
2.2 Agriculture and food security.....	29
2.3 Biodiversity and ecosystems	31
2.4 Coastal zones.....	33
2.5 Areas at risk of drought and desertification	37
2.6 Fisheries and aquaculture	39
2.7 Forests and forestry	40
2.8 Human health	41
2.9 Water and hydro-geological system	42
2.10 Infrastructure and economy.....	45
2.11 Feasibility study for the Abruzzo region.....	48
2.12 Cost of adapting to climate change	49
2.13 Cooperation in preparing for adaptation.....	52
2.14 Summary of adaptation initiatives in Italy	53
3 Annexes	57
3.1 ESAI Index for Italy.....	57
3.2 National Conference on Climate Change (Rome, September 2007).....	58
3.3 White Paper on rural development and climate change	60
3.4 Actions and measures of the National Action Programme to combat drought and desertification	62
3.5 Structure of the National Biodiversity Strategy and actions related to climate change adaptation	64
3.6 Adaptation to climate change in the Italian Rural Development Programmes (RDPs).....	66
4 Basic glossary	69
5 References	70

Executive summary

Overview of expected key climate change impacts and vulnerabilities for Italy

The **Mediterranean region** is expected to face particularly negative climate change impacts over the next decades, which, combined with the effects of anthropogenic stress on natural resources and relatively lower adaptive capacity, make this region one of the **most vulnerable areas in Europe**.

The projected negative impacts are mainly related to possible extraordinary spells of heat (especially in summer), increased frequency of extreme weather events (heat waves, droughts and severe rainfalls) and reduced annual precipitation and river flow. As a consequence, agricultural productivity decline and natural ecosystems loss are likely to become a reality over the Mediterranean area.

In this context, **Italy expects a number of potential climate change impacts and vulnerabilities** including the following:

- **worsening of the existing conditions of high stress on water resources**, leading to a possible **reduction in water availability and quality**, especially in summer in southern regions and small islands;
- **alterations of the hydro-geological regime**, potentially increasing the risk of landslides, flash mud/debris flows, rock falls and flash floods; areas most exposed to hydro-geological risks include the Po River valley with increased flood risk, and the Alpine

and Apennine areas with increased flash-flood risk;

- **soil degradation, higher risk of soil erosion and desertification**, with a significant part of the South of the country classified at risk of desertification and specific areas in northern regions showing critical conditions;
- **higher risk of forest fires and droughts over Italian forests**, with the most critical areas being the Alpine zone, southern regions (Calabria, Campania and Puglia) and the insular regions (Sicilia and Sardegna);
- **higher risk of biodiversity and natural ecosystems loss**, especially concerning Alpine areas and mountain ecosystems;
- **higher risk of flooding and erosion of coastal zones**, from increased occurrence of extreme weather events and sea level rise (coupled with both natural and human-induced subsidence);
- **reduction of agriculture productivity** especially for wheat, and also for fruit and vegetables; olive, citrus, vine and durum wheat cultivation could become possible in the North of Italy, whereas corn cultivation could suffer in the South;
- **negative effects on human health**, affecting the most vulnerable parts of population, with increased heat-related mortality and morbidity, cardio-respiratory diseases from air pollution, more injuries, deaths and illnesses due to flood and fire events, allergic disorders, as well as effects related to possible changes in the spreading and

occurrence of vector-, water- and food-borne diseases;

- **losses in other key national economic sectors**, such as energy - due to possible reduced hydropower production potential; tourism, in relation to more expensive and/or reduced winter tourism and worsening conditions for summer tourism against improved conditions for spring and autumn tourism flows; fishery, likely to experience declining productivity; infrastructure, transport and human activities, with pressures on urban and rural infrastructures including transport network leading to possible damages to human settlements and the whole socio-economic activity.

In summary, the **most critical national circumstances** with respect to observed and expected climate change impacts include:

- areas with scarce water resources and areas at risk of desertification;
- coastal areas undergoing erosion and flooding and susceptible to alteration of marine ecosystems;
- Alpine regions and mountain ecosystems experiencing glaciers retreat and snow cover loss;
- areas subject to hydro-geological risks (risk of floods, landslides and other mass movements related to soil and land management), in particular, the hydrographical basin of the Po River.

Climate change is likely to magnify the regional differences in terms of quality and availability of natural resources and ecosystems not only at the European scale but also at the national level in Italy.

An early **macro-economic assessment of climate change impacts for Italy**, performed by Foundation Eni Enrico Mattei (FEEM) in collaboration with the Institute for Environmental Protection and Research (ISPRA) and the Euro-Mediterranean Center on Climate Change (CMCC), indicates that the country could experience an **aggregated GDP loss of 0.12%-0.16% in the period 2001-2050 equal to a total loss of EUR 20-30 billion, considering a temperature increase of 0.93°C**. Losses could be larger, of about **0.16%-0.20% GDP, for a +1.2°C temperature rise scenario**. In particular, some economic sectors, such as tourism and the economy of the Alpine regions, could experience significant damages. Additionally, more relevant impacts could be expected in the second half of the century, with **GDP losses in 2100 potentially six times larger than those predicted in 2050**. Huge differences in terms of economic impacts of climate change could also emerge between northern and southern Italy.

State of the art of adaptation to climate change in Italy

To date, Italy has not yet adopted a National Adaptation Strategy (NAS), a National Adaptation Plan (NAP) or any framework to specifically design and implement adaptation action in the country. Following up the early 2007 *National Conference on Climate Change*, a process aimed at developing a NAS has been initiated in July 2012 and it is currently ongoing, under the guidance of the Italian Ministry for the Environment Land and Sea (MATTM) and the scientific coordination of CMCC.

In December 2012, the MATTM put forward a draft document containing “*Strategic*

guidelines for adaptation to climate change, sustainable management and safety of the national territory". The identified priority actions put an emphasis on coping with the hydro-geological risks through a national strategy, complemented by urgent safety measures. The guidelines have to be discussed by the Inter-ministerial Committee for Economic Planning (CIPE) in consultation with other Ministries.

As to estimating national **adaptation costs**, only the above-mentioned joint FEEM-ISPRA-CMCC study can be reported. It covers adaptation measures explored or undertaken in four vulnerable areas: the Alps and glacier ecosystems, coastal zones, arid areas and areas threatened by desertification, and zones prone to floods and landslides.

Despite the lack of a NAS or comprehensive national economic assessments, **some climate change adaptation initiatives have already been implemented** in the context of existing policies for environment protection, natural hazards prevention, sustainable management of natural resources and health protection. Besides their primary objectives, such initiatives are acknowledged to be beneficial also for adapting to climate change.

The most significant efforts at the national level have been undertaken in the domains of human health, agriculture, protection of coastal areas, fight against desertification and management of water resources. These include **legal frameworks, monitoring and surveillance systems, as well as specific measures.**

Noteworthy national legal frameworks that explicitly refer to climate change include:

- the *White Paper "Challenges and opportunities of rural development in mitigating and adapting to climate change"*, aimed *inter alia* at increasing the resilience of the agricultural sector to climate change;
- the *National Biodiversity Strategy*, including action on adaptation to climate change as a priority;
- the *National Action Plan to combat drought and desertification* and related *10 Local Action Programmes*, calling for the creation of links and synergies with climate change issues.

At the regional level, the Abruzzo Region and the National Agency for new technologies, energy and sustainable economic development (ENEA) carried out a cutting-edge *feasibility study* assessing climate change impacts and vulnerabilities for the region and for the definition of potential adaptation actions.

At the local level, some Provinces, Cities and Municipalities have already started addressing climate change adaptation mainly through the implementation of urban adaptation planning initiatives such as *adaptation action plans and incentive programmes*. Some others are in the process of approaching climate change adaptation by developing *guidelines for local adaptation of urban systems* or drafting their adaptation strategies.

The following ones are reported as good practice examples:

- **Ancona Municipality *Local Adaptation Plan***, developed in close collaboration with local stakeholders based on a methodology designed by

ISPRA with the aim to be applied also in other European cities;

- **Genova Province *Adaptation Action Plan***, developed to cope with the territory vulnerabilities that might be worsened by climate change and through planning strategies that increase the natural defences of the environment (e.g. “green” and “blue” infrastructures);
- **Faenza Municipality *Bio-neighbourhood incentive programme for developers***, implemented within the urban planning regulations to cope with rising temperatures associated to climate change, with a focus on enhancing synergies between climate change adaptation and mitigation, quality of life and development;
- **Sustainable Cities network and Coordination of Italian Local Agenda 21 *guidelines for local adaptation of urban systems***.

Italy is also involved in several **research efforts** on climate change adaptation framed at the international, European and national level. **A special focus has been given to research initiatives on coastal zones and related ecosystems, agriculture, urban areas, biodiversity and hazards especially in the mountain areas, desertification processes, water resources and health.** The majority of projects on adaptation in Italy have been supported by the EU through FP7, INTERREG and LIFE schemes. National funds appear to be primarily directed towards adaptation-relevant research for the agricultural sector and coastal zones management.

Moreover, Italy is active in transnational cooperation efforts in Europe (e.g. in the

context of the **Alpine Convention**) and **international cooperation initiatives on climate change-related topics** including **capacity building** in developing countries, jointly supported by the Ministry of Foreign Affairs and the MATTM.

1 Overview of expected key climate change impacts and vulnerabilities for Italy

1.1 Introduction

This section provides an overview of the expected key climate change impacts and vulnerabilities in Italy covering the following key sectors: agriculture and food security, biodiversity and ecosystems, coastal zones, areas at risk of drought and desertification, fisheries and aquaculture, forests and forestry, human health, water and hydro-geological system, infrastructure and economy. Findings are drawn from overall assessment studies on the Mediterranean region and Southern Europe (e.g. IPCC¹, EEA² and EEA-JRC-WHO³ reports) and from national studies and scientific publications (e.g. APAT/ISPRA⁴, ENEA⁵, CMCC/FEEM⁶, CMCC⁷).

Located in the South of Europe, Italy is made up of a boot-shaped peninsula and a number of major islands including Sicilia, Sardegna and about seventy smaller ones. The environmental features of the Italian territory are similar to the other Mediterranean countries in Europe (Spain, Portugal and Greece) with dry and hot summers, North-South variations in soil characteristics, as well

as vegetation quality and cover predominantly influenced by the elevation.⁸

The Mediterranean area where Italy is situated is characterized by widespread anthropogenic stress affecting natural resources. The whole region is expected to be particularly exposed to negative climate change impacts over the next decades. Such impacts are mainly related to: possible exceptional temperature rise, especially in summer; increased frequency of extreme weather events (heat waves, droughts and severe rainfalls); and reduced annual precipitation and river flow. As a consequence of high exposure and relatively low adaptive capacity, the Mediterranean region can be considered one of the most vulnerable areas in Europe.⁹

In this context, **Italy** is expected to undergo a **range of climate change impacts** that would **critically affect** the following **vulnerable national circumstances**:

- water resources and areas at risk of desertification;
- coastal areas prone to erosion and flooding and susceptible to alterations of marine ecosystems;
- Alpine regions and mountain ecosystems experiencing glaciers loss and snow cover loss;
- areas subject to hydro-geological risks (i.e. risk of floods, landslides, mud flows and other mass movements related to soil and land management) and, in particular, the hydrographical

¹ IPCC, 2007a.

² EEA, 2012a; 2012b; 2010b; 2007.

³ EEA-JRC-WHO, 2008.

⁴ Menne & Wolf, 2007.

⁵ Antonioli et al., 2007.

⁶ Carraro, 2008.

⁷ Castellari & Artale, 2009.

⁸ EEA Website, "The European environment – state and outlook 2010 / Country assessments / Italy", <http://www.eea.europa.eu/soer/countries/it>, accessed Jan 2013.

⁹ IPCC, 2007a.

basin of the Po River as well as the Alpine and Apennine regions.

As stated by the Intergovernmental Panel on Climate Change (IPCC), climate change is likely to magnify the regional differences in terms of quality and availability of natural resources and ecosystems at the European level.¹⁰ Such dynamic could hold true also for Italy.

1.2 Agriculture and food security^{11 12 13}

In Italy, as in many areas bordering the Mediterranean basin, **crop yields are considered at risk** in relation to climate change. The following conditions can be expected in the agricultural sector:

- **increasing yield variability and declining average yield**, due to higher temperatures and limited water availability, increase in the frequency of extreme weather-related events (such as heat waves, heavy rainfalls and droughts periods), and also to varying spread of plant diseases and pests;¹⁴
- **reduced crop yields especially in summer** for spring sown crops (e.g. maize, sunflower and soybeans), due to more frequent extreme climate events and reduced water availability;¹⁵

- possible intensification of the competition for water between different sectors and uses, and potential rise of costs related to the irrigation due to **increasing water demand in agriculture**;^{16 17}
- **possible increase in the use of pesticides** to cope with climate change-related variations of the geographic range of pests.¹⁸

Nevertheless, the impacts are highly diversified for different crops and geographical areas. In general, water shortages during specific crop development stages may reduce the productivity of most crops (e.g. corn, soybeans and wheat). The decline in agricultural productivity could especially concern wheat yield and fruit and vegetables production, as a consequence of water scarcity and soil degradation.¹⁹ Conversely, olive, citrus, vine and durum wheat cultivation could become possible in the North of Italy. Wine production, an activity of particular economic relevance in Italy, could undergo major changes too. The suitability of cultivation areas for specific crops might modify, which could lead to displacements of production.²⁰

1.3 Biodiversity and ecosystems

Italy is characterized by one of the most important natural heritage of animal and plant

¹⁰ IPCC, 2007b.

¹¹ IPCC, 2007a.

¹² Cecchi et al., 2007b.

¹³ Miglietta et al., 2009.

¹⁴ Cecchi et al., 2007b.

¹⁵ Cecchi et al., 2007b.

¹⁶ EEA, 2012b.

¹⁷ Miglietta et al., 2009.

¹⁸ Cecchi et al., 2007b.

¹⁹ Miglietta et al., 2009.

²⁰ Miglietta et al., 2009.

species in Europe, in terms of both the total number of specimens and the high rate of endemism.²¹ Furthermore, fifty sites in the country have been recognized as internationally important wetlands in the Ramsar Convention's list.²²

Current major threats to Italian biodiversity at the level of species and habitats include climate change, especially for mountain environments.²³

Since ecosystems are expected to be moving to the north and to a higher elevations as a consequence of climate change (about 100 km northwards and 150 m upwards per 1°C rise in yearly average temperature), possible risks to Italian ecosystems can be expected due to the country's orography limiting the possibility for ecosystems to actually shift, and the fast pace of climate change exceeding the time span necessary for the ecosystems to relocate.²⁴ Therefore, Italy is expected to face **extremely high risk of biodiversity and ecosystems loss.**²⁵

²¹ Compared to the total in Europe, over 30% of animal species and almost 50% of plants species live in Italy, on a surface of about 1/30 of the continent. (MATTM Website: "[Biodiversità](#)").

²² MATTM Website: "[Zone umide di importanza internazionale](#)".

²³ MATTM, 2010.

²⁴ Menne et al., 2009.

²⁵ "Current major threats to biodiversity at the level of species and habitats are:

- soil loss and change of its intended use;
- modification and fragmentation of habitats;
- abandonment of traditional agricultural activities in mountain and sub-mountain areas and simplification of agro-ecosystems in hilly and lowland areas;
- environmental pollution (water, air, soil, light and sound environment);
- dissemination of invasive alien species;
- hunting pressure and indirect disorder arising from it;
- poaching;
- infrastructure located in areas of interest for biodiversity;
- climate change, with particular reference to the mountain environments."

(MATTM, 2010).

Aquatic ecosystems

Marine ecosystems

The anthropization of the Mediterranean coasts in the last century has already led to a progressive decline of marine biodiversity, magnified by the semi-closed basin features of the Mediterranean Sea with slow recharge waters. Mediterranean marine organisms, communities and ecosystems might be altered by climate change, including with the spreading of invasive marine species due to water warming, which would imply a **general decline of marine biodiversity.**²⁶

In particular during summer, the conditions of high water temperature and low food availability in the Mediterranean Sea lead to reduced seasonal activity in many benthic suspension feeders. Under these circumstances, many biological processes are expected to be negatively affected by climate change, which could imply mass mortality of invertebrates among other consequences. Simulations of the effects of these conditions reveal a biomass loss higher than 35%.²⁷

The increasing development of marine mucilage in the Mediterranean waters during the last twenty years can be considered a sign of altered environmental conditions for such aquatic system. This phenomenon, which is linked to sea surface temperature increase, might favour the spreading of pathogenic bacteria.²⁸

²⁶ EEA-JRC-WHO, 2008.

²⁷ Coma et al., 2009.

²⁸ Danovaro et al., 2009.

Freshwater ecosystems

Freshwater ecosystems are also expected to undergo major negative changes such as loss of habitats, decline in biotic components and related processes, with the extent and specific impacts depending on the typology of ecosystems. Increasing temperatures could induce a reduction in species richness in freshwater ecosystems, especially in the Alps.²⁹

Rising temperatures affecting water thermal stratification might increase the risk of overgrowth of algae and cyanobacteria and eventually eutrophication processes in lake ecosystems, especially in late summer.³⁰

Furthermore, the loss of wetlands would cause severe imbalances in the related biotic communities. The variety of reptiles and amphibians is likely to be reduced in some parts of Italy, due to their low spreading ability and the great fragmentation of habitats.³¹

Terrestrial ecosystems

Mediterranean-type terrestrial ecosystems are likely to be especially affected by new climatic conditions. They might experience the following changes:³²

- increased risk of extinction for several terrestrial species, changes in the structure of the biological community and biodiversity loss;

²⁹ Cecchi et al., 2007b.

³⁰ Menne & Wolf, 2007.

³¹ Araújo et al., 2006.

³² IPCC, 2007a.

- potential contraction of forests and biodiversity, especially in the South and in the mountains;
- advancing trends in plant phenology;
- loss of wetlands ecosystems;
- changes in spatial distribution of fauna.

Across Europe, all mountain ecosystems could face a number of negative consequences. **Italian mountains (Alps and Apennines) are considered very fragile environments, hence result especially vulnerable to climate change.**³³

Among the expected impacts there are the following³⁴

- significant changes in the structure of mountain plant communities induced by a 1-2°C temperature increase;
- shift of plant and animal species towards higher elevations, with changes in the composition and structure of alpine and nival communities,³⁵ generally putting mountain flora and fauna at high risk of extinction;
- alteration of the hydro-geological cycle, with consequences on both the

³³ Due to:

- “significant changes caused by even small climatic changes, as evidenced by historically documented fluctuations in the limits of perennial snow and glaciers;
- severe ecological stress, as abiotic factors (in particular climate) prevail over biotic ones;
- high biodiversity and concentration of endemic species and their impossibility to migrate in most of the alpine and Apennine areas;
- the reduced snow cover increasing the frequency of freezing and of frost and thaw cycles of soil, with a consequent increase in the mortality of the radical system and microbial biomass”.

(MATTM, 2010)

³⁴ Castellari, 2008.

³⁵ Cecchi et al., 2007b.

water balance of rain collecting basins and the stability of mountain slopes, resulting in higher risk of soil erosion and rock falls;

- glaciers retreat and permafrost reduction with small Alpine glaciers expected to disappear and larger ones projected to suffer a volume reduction between 30% and 70% by 2050; potential for glacier lake outburst floods as large Alpine lakes might be generated from glaciers retreat;
- significant reductions in snow mass in the Italian Alps,³⁶ with duration of snow cover expected to decrease at middle elevations by several weeks for each degree of temperature increase.

1.4 Coastal zones

With a total length of more than 7,500 km, the Italian coastline constitutes a main national asset for its environmental, social, economic and cultural resources.³⁷

About 53% of the Italian coastal zones (3,952 km) are classified as low and sandy coasts, of which about 42% (1,681 km) have been already suffering from widespread erosion.³⁸ Many Italian coastal plains are areas of high natural landscape value as well as locations of production activities of national importance. The strong anthropization process is negatively affecting these coastal environments with an ever-growing pressure

from urbanization, tourism and industrial activities.³⁹

The expected increase in the frequency and intensity of extreme weather events (floods, storms, etc.) and sea level rise (SLR) may contribute to accelerate the existing erosion processes eventually leading to the degradation or loss of coastal lands, ecosystems, infrastructures and economic assets.⁴⁰

For these reasons, Italian **coastal zones are considered particularly vulnerable to projected climate change**, with potential increasing **flood risk, coastal instability and erosion**.⁴¹

Specifically, about 4,500 km² of Italian coastal areas are at risk of sea flooding associated with SLR by the next century. Most of the endangered areas are located in the North Adriatic Sea, and some Tyrrhenian and Ionian coasts may be at risk too.⁴² **The Northern Adriatic coast, characterized by the Po river delta and the Venice lagoon, is considered particularly at risk**, as this area lies below sea level (due to subsidence) and hosts many residential settlements, cultural heritage sites as well as industrial establishments.⁴³

In general, climate change impacts on coastal zones might include:⁴⁴

- coastal erosion and instability, with risk of coastline regression;

³⁶ Soncini & Bocchiola, 2011

³⁷ Aucelli et al., 2006.

³⁸ Antonioli & Silenzi, 2007.

³⁹ Aucelli et al., 2006.

⁴⁰ Antonioli & Silenzi, 2007.

⁴¹ MATTM, 2009.

⁴² Antonioli & Silenzi, 2007.

⁴³ PRC, 2009.

⁴⁴ IPCC, 2007a.

- loss of coastal land and hence of economic activities, infrastructures, urban settlements, recreational areas and natural heritage sites, mainly where climate change combines with natural and/or anthropogenic subsidence;
- reduction or loss of biodiversity and ecosystems (especially wetlands), and decrease of marine life caused by the combined effect of climate change and anthropogenic stress;
- damages to coastal rural economy, due to salt water intrusion into coastal fresh-water beds;
- negative impacts on tourism and possible displacement of tourism flows from the coasts in summer;
- possible threat to human health posed by flood events.

1.5 Areas at risk of drought and desertification

Climate change impacts and vulnerability of soils are mainly associated to drought, land degradation and desertification. According to the assessment carried out by the project DISMED,⁴⁵ **a significant part of the Italian territory (about 30%) can be classified at risk of desertification**, with key vulnerabilities localized in the South of the country.⁴⁶ Overall, about 1/3 of the country is vulnerable to varying degrees to the processes of land degradation.⁴⁷

A classification of the vulnerability of the Italian territory to land degradation and desertification, based on the *Environmentally Sensitive Area Index* (ESAI)⁴⁸, shows that in 2000 Sicilia was affected by a regional medium-high degree of environmental vulnerability (sensitive areas represented about 70% of the regional territory), followed by Molise (58%), Puglia (57%) and Basilicata (55%). Six regions (Sardegna, Marche, Emilia-Romagna, Umbria, Abruzzo and Campania) shared similar conditions of severity (between 30% and 50% of sensitive territory); for other regions desertification was still an issue but smaller (sensitive areas between 10% and 25% in Calabria, Toscana, Friuli-Venezia-Giulia, Lazio, Lombardia, Veneto and Piemonte) or minor (between 2% and 6% in Liguria, Valle d'Aosta and Trentino-Alto Adige).⁴⁹

⁴⁵ Project *DISMED* - *Desertification Information System for the Mediterranean*.

⁴⁶ MATTM Website "[La desertificazione in Italia](#)".

⁴⁷ Perini et al., 2008.

⁴⁸ See *Annex 3.1 ESAI* Index for Italy.

⁴⁹ Perini et al., 2008.

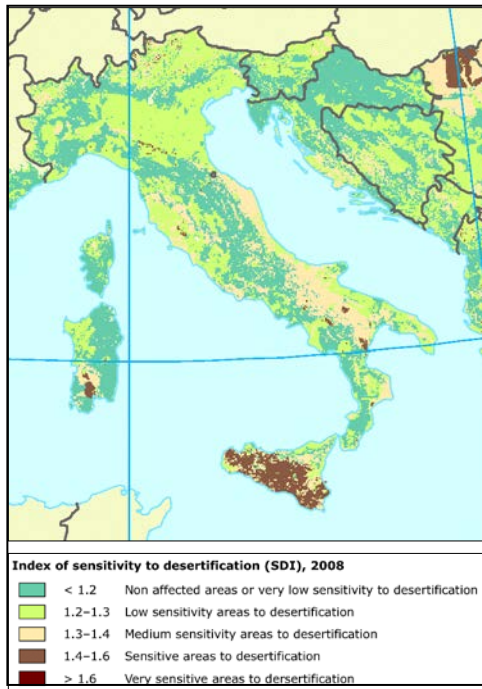


Figure 1. Sensitivity to desertification and drought of Italy⁵⁰

More recent studies carried out within the project DISMED provide the mapping of sensitivity to desertification and drought in Italy (see Fig.1 above) as defined by the *Sensitivity to Desertification Index* (SDI) based on soil quality, climate and vegetation parameters.⁵¹ According to this mapping, the regions that result most sensitive to desertification are Sicilia, Sardegna, Basilicata, Puglia, Molise, Abruzzo, Marche, Toscana and Lazio.

Within those regions and across the whole Italian territory, the **areas that can be considered especially vulnerable to desertification** include:⁵²

- farmlands with intensive and marginal production;

- areas at risk of accelerated erosion;
- areas damaged by contamination, pollution and fires;
- fallow and abandoned lands.

Broadly speaking, **a trend towards a gradual worsening of the existing conditions of vulnerability has been detected across the whole country**, which has been already observed in widespread degradation processes. On one side, land degradation and desertification, particularly prominent in the coastal zones, can be attributed to the changes in climate (annual mean low rainfall and general increase in temperature) leading to the expansion of arid and semi-arid areas. On the other side, they are deemed to be a consequence of increasing human pressure and land use change along with processes of agricultural intensification and soil salinization.⁵³ **Climate change might indeed exacerbate the already observed desertification trends**, by possibly worsening the actions of erosion, salinization, loss of organic matter and drying up of soil.⁵⁴

Furthermore, land degradation and desertification processes may imply serious indirect socio-economic impacts, including:⁵⁵

- decline in agriculture and tourism productivity;
- growing unemployment in rural areas with consequent migration;
- conflicts over water uses;
- harm to properties and people, due to increased frequency of fires;
- overall biodiversity loss.

⁵⁰ EEA Website (2009) "[Sensitivity to desertification index map](#)".

⁵¹ EEA Website (2009) "[Sensitivity to desertification index map](#)".

⁵² CIPE, 1999.

⁵³ Perini et al., 2008.

⁵⁴ Carraro & Sgobbi, 2008.

⁵⁵ Sciortino et al., 2009.

1.6 Fisheries and aquaculture^{56 57}

Marine fishery

The overexploitation of European fishery resources, exceeding in many cases the ability of fish populations to remain stable over time in terms of numbers and biomass, is considered the main reason for the current critical status of exploited fish stocks.⁵⁸ Moreover, such over-exploitation of fishery resources may affect the resilience of fish stocks to climate change.

In the **Mediterranean Sea**, the following negative impacts associated to climate change can be expected for fishery:

- fish stock movements, inducing changes in the composition of biological communities in a given area, also affecting the economic activities related to fishery;
- trans-boundary aquatic infections, with potential increase and expansion of aquatic diseases in aquaculture and expansion of exotic pest species;
- **exceeding of resilience of many water ecosystems** due to anthropogenic stress (e.g. from overfishing, pollution, tourism, fragmentation and loss of habitat) combined with climate change effects on temperature, salinity and density of water, with potential impact on

ecosystems' physiology, biology and ecology;

- effects from expected reduction of sea water pH and anoxia or hypoxia events during summer heat waves on bivalve and gastropod molluscs, shellfish, and like species with calcified shells,⁵⁹ which would put at particular risk all the economic activities based on the collection of these organisms;
- possible general reduction of the productivity of the fished species.⁶⁰

With specific reference to Italy, some studies⁶¹ suggest that by mid century coastal fish populations could shift their distribution area by an average of 70 km to the north and/or deeper areas. In northern and central Adriatic the number of fish species could increase compared to the past (with about 15% of them coming from other sub-areas), while in most of other northern Italian coasts faunal richness would tend to decrease and the processes of species replacement could be less conspicuous.

In particular, the coastal areas close to the mouths of the Po river and other large rivers could undergo a net reduction in primary and secondary productivity, due to the projected decrease in precipitation.

Freshwater fishery

It is very likely that over the short term there could be negative effects on the physiology of freshwater fish communities due to local temperatures increase. This could result in

⁵⁶ FAO, 2008.

⁵⁷ EEA-JRC-WHO, 2008.

⁵⁸ EC, 2009.

⁵⁹ Cebrian et al., 2011; Vaquer-Sunyer & Duarte, 2011.

⁶⁰ Cheung et al., 2010; Cheung et al., 2012.

⁶¹ Albouy et al., 2012.

negative changes in distribution and abundance of freshwater species, with significant impacts on aquaculture.

Italian aquaculture could be particularly affected in North-Adriatic coastal wetlands and lagoon areas due to possible water heating and acidification, extreme weather conditions, increasing incidence of diseases and SLR.

1.7 Forests and forestry

Forests cover about 1/3 of the Italian territory.⁶² Despite the lack of comprehensive analyses, existing studies^{63 64 65} indicate that climate change could induce overall changes in the composition of species and habitats of **Italian forests**, resulting in local losses of biodiversity. Possible effects of climate change include:

- **northwards and altitudinal shift** of the range of climatic and environmental conditions typical of the Mediterranean area;
- **reduction of growth and productivity rates in central-Southern Italy**, where about 1/3 of the woodland could be threatened by reduced water supply and extended drought periods;
- **changes in the distribution of the main tree forest species in central Italy** mostly located in the central

Apennines, over 1,500 m, by 2080; these include:

- a general shift of the distributional area towards higher altitudes;
- a strong reduction of the distributional area of the most mesophile⁶⁶ and microtherm⁶⁷ species;
- a significant expansion of the range of the Mediterranean species into the inner pre-Apennine zones;
- a slight expansion of the distributional area of Turkey oaks and elms;
- phenologic changes in the timing of growth, with earlier onset of spring events;
- **higher soil aridity, risk of drought and forest fires**, with possible extension of fire areas, more ignition events and longer fire seasons, in the most critical areas of the Alps and the Calabria, Campania, Sicilia and Sardegna regions;
- **some potential positive impacts**, such as an increase in forest productivity in the Alps in relation to the expansion of the growing season.

The actual possibilities for the forest ecosystems to shift are scarce, because climate change rate far exceeds the rate of colonization of new areas and the potential corridors are often obstructed by human-induced territorial fragmentation. Hence, a

⁶² MiPAAF & CRA, 2005.

⁶³ Valentini et al., 2009.

⁶⁴ EEA-JRC-WHO, 2008.

⁶⁵ Petriccione et al., 2009.

Further information at [BioRefugia](#) project Website.

⁶⁶ An organism that grows best in moderate temperature, neither too hot nor too cold (typically between 20 and 45 °C).

⁶⁷ Plant species or community adapted to living in cool temperate environments (temperature range of 0-14°C for optimum growth).

progressive disruption of forest ecosystems could be expected.⁶⁸

Preliminary results of a recent study⁶⁹ on scenarios for the spreading of forest species in response to climate change with a special reference to the Alps show a possible reduction of about 50% of the habitats at the national level, with a progressive decline of mountain habitats for high altitude conifers (red fir, larch, Swiss pine) in favour of beech, oak chestnut and deciduous oaks.⁷⁰

1.8 Human health⁷¹

Expected effects of climate change on human health in Italy might include:

- increased heat-related mortality and morbidity, associated to summer heat waves;⁷²
- slight reduction of cold-related mortality, linked to expected milder winter temperatures (but the extent is not known);⁷³
- increased risk of injuries, morbidity (e.g. enteric infections, post traumatic stress disorder and vector-borne diseases) and fatalities, from expected increasing floods, heavy precipitation and fires events;⁷⁴
- increased respiratory diseases and allergic disorders, as a result of the effects of changes in air pollution

⁶⁸ Valentini et al., 2009.

⁶⁹ Valentini & Santini, 2008.

⁷⁰ Valentini et al., 2009.

⁷¹ Menne & Wolf, 2007.

⁷² Michelozzi et al., 2007.

⁷³ Michelozzi et al., 2007.

⁷⁴ Funari et al., 2007.

concentrations that may be aggravated by climate change;⁷⁵

- adverse consequences of potentially more frequent and prolonged extreme ozone events and increasing toxicity of pollutants particularly in summertime;⁷⁶
- possible increase in the incidence of West Nile fever and leishmaniasis, risks of malaria and dengue fever and spreading of vector-borne diseases.⁷⁷

Such impacts are likely to be perceived more among **key vulnerable groups of population** such as the elderly, the children, people suffering from different diseases and marginalized people.

1.9 Water and hydro-geological system

Water resources (in terms of annual precipitation and river discharge) are projected to decrease over Southern Europe, and this regional pattern could intensify in the last decades of this century. Population growth and climate change could lead to an increase in the number of people living in river basins characterised by water shortage located in various European areas, including Italy.⁷⁸

The existing conditions of high stress on water resources and of hydro-geologic disturbance in some Italian regions could be

⁷⁵ Forestiere, 2007.

⁷⁶ Menne et al., 2009.

⁷⁷ Majori, 2007.

⁷⁸ EEA, 2010b.

exacerbated by projected climatic change, through the following processes:⁷⁹

- reduced water availability and quality;
- increase in frequency and intensity of droughts, especially in summer;
- more frequency and severity of reductions of summer river flows, and decline of annual river flow;
- limited groundwater recharge.

Such conditions could compromise the ability to moderate the effects of extreme events and to regenerate the water reservoirs.

Water quantity and quality^{80 81 82}

The quantity and quality of water resources in Italy could be subject to the following adverse situations:

- reduced water availability, especially in summer;
- increased water stress by 25% in the present century;
- severe negative impacts in the South, where vegetation and territory have already been experiencing a marginal water supply regime (safe water supply is becoming a social and economic emergency);
- increased seasonal water deficit due to significant pressures of summer tourism peaks on already scarce water resources, especially in small Mediterranean islands;

- potential increased conflicts among multiple uses of water resources.

Hydro-geological system^{83 84 85}

A 2006 **mapping of the hydrological risks in Italy** shows that 5.2% of the Italian territory is exposed to the risk of landslides, the areas at risk of flooding correspond to 4.1% of the national territory, and 0.5% of the country is prone to avalanches.⁸⁶

According to a more recent **assessment of the hydro-geological instability of the Italian territory** carried out in 2008,⁸⁷ such risks affect 9.8% of the national territory (conditions of “high” and “very high” risk and hazard), of which 6.8% involves built-up areas with exposed properties such as urban centres, infrastructure, and industrial areas.

Climate change impacts on the Italian hydro-geological system might include the following:

- **variations in the hydrologic regime** related to e.g.:
 - progressive melting of the glaciers and reduction of seasonal snow cover in Alpine catchments, due to rising temperatures and changing precipitation patterns;
 - increase in the aridity of soils and in the frequency of drought events in the plain areas;

⁷⁹ Portoghese et al., 2009.

⁸⁰ Portoghese et al., 2009.

⁸¹ EEA-JRC-WHO, 2008.

⁸² Funari et al., 2007.

⁸³ Portoghese et al., 2009.

⁸⁴ EEA-JRC-WHO, 2008.

⁸⁵ MATTM - Direzione Generale per difesa del suolo, 2008.

⁸⁶ Bigano & Pauli, 2007.

⁸⁷ MATTM - Direzione Generale per difesa del suolo, 2008.

- changes in groundwater, resulting in increased saltwater intrusion in coastal aquifers due to SLR, and lower capacity of beach nourishment associated with both anthropogenic interventions and climate-related processes;
- **increased risk of inland flooding**, due to increased events of river flood heights in relation to heavy precipitation events, with possible consequent onset of regional “hot spots” for impacts on physical structures;⁸⁸
- **increased winter run-off** by 90% and **decreased summer run-off** by 45% in central Europe Alpine rivers,⁸⁹ with consequent greater risk of flooding and drought in the respective seasons;
- **significant changes in the hydrologic balance (and water quality) of some assessed river basins** (Rio Mulargia, Sardegna and Alento river, Campania),⁹⁰ with an estimated reduction in annual discharge, nutrients and sediments transport in the next decades;⁹¹
- **increased risk of flash mud/debris flows**, due to a potential increase of extreme weather events;
- **increased risk of landslides** in the Alps, due to a progressive temperature warming and ice melting; **generalized risk of rock falls** in the Apennine region, because of more frequent and sudden temperature changes,

especially in winter; risk of **flash floods** in both areas, due to severe precipitation events.

The **areas most exposed to hydro-geological risks** include: the hydrographical basin of the Po River subject to increased flood risk, and the Alpine and Apennine areas subject to increased flash flood risk.

1.10 Infrastructure and economy

The Italian infrastructure and the national economy as a whole could face a variety of climate change impacts that are hereby presented by relevant socio-economic sectors.

- **Energy:** potential reduction of hydropower production due to expected scarce water availability;⁹² summer cooling needs might increase up to 50% in Italy by 2080;⁹³ increasing energy demand for cooling needs in summertime could exceed the decreasing energy demand for heating needs in winter;⁹⁴
- **Tourism:** direct impacts are expected to be diversified for the various Italian regions, including possible reduced summer tourism flows due to high temperatures and water scarcity, more expensive and/or reduced winter tourism due to the reduction of natural snow cover, but improved conditions for spring and autumn tourism. Overall, the most affected regions

⁸⁸ EEA 2012b.

⁸⁹ Beniston, 2006.

⁹⁰ Lo Porto et al., 2007.

⁹¹ Portoghesi & Vurro, 2009.

⁹² Gaudioso & Masullo, 2009.

⁹³ Cecchi et al., 2007a.

⁹⁴ Mima et al., 2011.

could be: Sicilia, Lazio, Toscana and Umbria, Alto Adige, and to a lesser extent Friuli-Venezia Giulia and Valle d'Aosta;⁹⁵

- **Transport:** climate change might negatively affect a number of elements of the Italian transport system, leading to an overall deterioration of the transport network. These include: stability of roads, rails and ports, due to higher temperatures, higher frequency of extreme precipitation events and sea level rise; endurance of road asphalts and railroad tracks, due to temperature increase; accessibility of roads, railways and ports in relation to damages and temporary disruption of infrastructures, due to higher frequency of extreme precipitation events and SLR; navigation in maritime and inland waterways, due to ice melting; shifts in the modalities of transport in relation to temperature increase.⁹⁶
- **Urban settlements:** possible damages to settlements and disruption of socio-economic activities, mainly due to extreme events like floods (with an increasing risk especially for northern Italy coastal cities due to sea level rise combined with storm surges)⁹⁷, storms and to a lesser extent heat waves and droughts, as well as melting of permafrost affecting soil stability in some Alpine areas. Also, water availability and quality as well as air quality may be reduced, thus affecting urban population and settlements;⁹⁸

- **Infrastructure:** pressures on urban and rural infrastructures and built-up areas, and damages or loss of properties may take place, mainly due to extreme events such as flooding.⁹⁹ A risk mapping developed within the (1992-1995) national project *The risk map of cultural heritage* coordinated by *Istituto Centrale per il Restauro* (ICR) of the former Ministry for Cultural Heritage and Environment, covering architectural, archaeological, historical and artistic assets, considers climate and hydro-geological risks among the main environmental risk factors that may harm cultural heritage.¹⁰⁰

An assessment of the infrastructural capacity to adapt to climate change for Italy (as a combination of indicators on the road network density, hospital beds and sustainable water use)¹⁰¹ carried out by the project ESPON CLIMATE¹⁰² shows how infrastructural capacity varies in the country depending on the different regions, spanning from the “lowest capacity” (mainly insular and some south-eastern regions) to the “highest capacity” (mainly north-western regions).

1.11 Economic impacts of climate change

This sub-section provides examples of the few studies assessing the sector- or site-specific economic impacts of climate change currently existing for Italy. However, it should be considered that, as scenarios,

⁹⁵ Bigano & Bosello, 2007.

⁹⁶ Caserini & Pignatelli, 2009.

⁹⁷ EEA, 2012b.

⁹⁸ EEA-JRC-WHO, 2008; EEA, 2012b.

⁹⁹ EEA-JRC-WHO, 2008.

¹⁰⁰ Project “[The risk map of cultural heritage](#)”.

¹⁰¹ EEA 2012b.

¹⁰² Greiving et al., 2011.

approaches and methodologies used in these studies are different, the associated cost estimates show a great variability and are generally not comparable between them.

Agriculture

The DG CLIMA EUAdaptStrat study provides an estimate of the potential economic impacts on the Italian GDP due to loss of productivity of agricultural soils. The average yield reduction evaluated is 9.3% for a +2°C and 23% respectively for a +4°C temperature rise scenario in 2050. The value of lost production is estimated in the range of EUR 13-30 billion/year in 2050, with a negative impact on the GDP of around 0.1%.¹⁰³

According to another analysis¹⁰⁴ the economic impacts of climate change on the Italian agricultural sector in terms of decrease in the value of agricultural land is estimated between EUR 87 and 162 billion in 2100 under the IPCC A2 scenario.

Coastal areas¹⁰⁵

Existing studies¹⁰⁶ on the **expected costs of climate change for the coastal areas** were carried out by Foundation Eni Enrico Mattei (FEEM) and the National Agency for new technologies, energy and sustainable economic development (ENEA). These are, however, mainly limited to a few vulnerable areas (such as the Fondi Plains, the Sangro River basin,¹⁰⁷ and Grado and Marano Plains)

for which the **direct costs of climate change were calculated in terms of land loss**.

In the case of the Sangro River basin, for example, the estimated costs are about EUR 14 million for the 2100 reference scenario¹⁰⁸; considering higher hydro-geological vulnerability besides SLR, the estimated costs would increase to about EUR 73 million.¹⁰⁹

The European project CIRCE¹¹⁰ estimated that the loss of coastal areas in Italy in 2050 under the IPCC A1B scenario could be around 0.7% of the national territory. The indirect economic impact on the Italian GDP resulting from the loss of coastal infrastructures and agricultural productive land was assessed at -0.18%.¹¹¹

Some studies addressing **climate change impacts on coastal tourism**, highlighted that while extremely hot summers could reduce tourism inflow to Italian regions on average by 1.22%, they would possibly slightly increase tourism inflow towards Italian coastal zones.^{112 113}

Areas at risk of drought and desertification¹¹⁴

As to the economic impacts of climate change related to desertification and drought, the **costs of desertification over the Italian territory** were estimated as a first

¹⁰³ Courtesy of Francesco Bosello (CMCC), 2013.

¹⁰⁴ Van Passel et al., 2012.

¹⁰⁵ Carraro, 2008.

¹⁰⁶ Cited in Carraro, 2008.

¹⁰⁷ Breil et al., 2007.

¹⁰⁸ The used reference scenario is representative of the state of the environmental, economic and social system at the local level (as of 2007).

¹⁰⁹ Carraro, 2008.

¹¹⁰ EU FP6 project [CIRCE](#) - *Climate Change Impact Research: The Mediterranean Environment*.

¹¹¹ Courtesy of Francesco Bosello (CMCC), 2013.

¹¹² Galeotti et al., 2004.

¹¹³ Gambarelli & Goria, 2004.

¹¹⁴ Carraro, 2008.

approximation at USD 60-412 million/year, considering 16,500 km² of land at risk.¹¹⁵

Fisheries

Concerning the economic assessment of climate change impacts on fisheries, some site-specific studies on Sacca di Goro Lagoon (one of the major European sites of **aquaculture** for the production of Philippine clams) assessed the consequences of reduced rainfall and the incidence of certain seaweed. It resulted that such impacts could induce a reduction in clam production corresponding to an annual monetary loss in the range of EUR 10.4-16.5 million on average.¹¹⁶

The project SESAME¹¹⁷ estimated the loss of aggregated productivity of fish stocks in Italy at about 8% in 2030 under the IPCC A1B scenario. This would negatively impact Italy's GDP by 0.04% in 2030 (equivalent to a loss of EUR 25 million/year in the period 2001-2030), considering only the potential impact of the reduced fish availability on the ability to produce goods and services in the future. The fishing industry would suffer a loss of production of around 4% in 2030.¹¹⁸

Human health

Two examples of economic assessment of climate change impacts on public health can be provided, that can be helpful to gain an initial picture of the total costs:

- the **costs of heat waves for Italy** in the absence of any adaptation strategy

¹¹⁵ Carraro & Sgobbi, 2008.

¹¹⁶ Viaroli et al., 2007; cited in Carraro, 2008.

¹¹⁷ EU FP6 project [SESAME](#) - *Southern European Seas: Assessing and Modelling Ecosystem Changes*.

¹¹⁸ Courtesy of Francesco Bosello (CMCC), 2013.

are estimated around EUR 281 million for 2020 in the city of Rome alone by 2020;¹¹⁹

- the damages caused by **floods** in the Mediterranean Europe in the last decade are estimated at EUR 12.3 billion, of which 96% are considered attributable to events that took place in Italy.¹²⁰

Water and hydro-geological system

Compared to other European regions, river flooding costs related to climate change are expected to be higher in Italy.¹²¹

An early attempt to assess the costs of climate change impacts on the hydro-geological system in Italy estimated the **direct costs of increased hydro-geologic risks (floods and landslides) for three Italian regions** (Lombardia, Calabria and Lazio) to be about EUR 103 million as the value of the land at risk of floods, and around EUR 187 million¹²² as the value of the land at risk of landslides.¹²³

According to the DG ENV ClimWatAdapt¹²⁴ study, the expected direct costs of floods for Italy in 2050 under the IPCC A1B scenario could be around EUR 1.6 billion. The related impact on the national GDP would amount to EUR 457 million in 2050.¹²⁵

¹¹⁹ Alberini & Chiabai, 2007; cited in Carraro, 2008.

¹²⁰ Sinisi, 2009.

¹²¹ EEA, 2012b.

¹²² Indeed, climate change impacts on hydro-geological system were huge in the past decades: 28 major floods (occurred in the country between 1939 and 2004) caused damages for USD 32.7 M and 13 main landslides (occurred between 1991 and 2003) generated a material damage around USD 1.2 bn (Carraro & Sgobbi, 2008).

¹²³ Carraro & Sgobbi, 2008.

¹²⁴ Flörke et al., 2011.

¹²⁵ Courtesy of Francesco Bosello (CMCC), 2013.

Tourism¹²⁶

The SESAME¹²⁷ project estimated that the reduction of tourism demand for Italy due to the potential loss of attractiveness resulting from the possible deterioration of marine ecosystems could be of 1.65% in 2030 under the IPCC A1B scenario.

The reduction of tourist inflows in Italy potentially induced by increasing temperature was estimated by the CIRCE¹²⁸ project at about 15% in 2050 in the IPCC A1B scenario; this could be partially offset by an increased domestic tourism demand, with a net negative impact on the sector of around 8.9%. The consequent potential reduction of the country's GDP would be of 0.25% in 2050.

The direct impacts on tourism estimated by the DG CLIMA EUAdaptStrat study were -6.6% and -8.9% in 2050 for a 2°C and a 4°C temperature rise scenario respectively, based on the variations of international arrivals, domestic tourism and tourism expenditure resulting from changes in climate attractiveness. The induced GDP loss in 2050 would be respectively of 0.25% and 1.05%.¹²⁹

Macro-economic impacts of climate change in Italy¹³⁰

The only available study assessing the costs of climate change impacts for the Italian economy in an aggregated way was carried

out by FEEM in collaboration with the Institute for Environmental Protection and Research (ISPRA) and the Euro-Mediterranean Center on Climate Change (CMCC). The study focuses on four vulnerable areas: the Alps and glacier ecosystems; coastal zones; arid areas and areas threatened by desertification; areas prone to floods and landslides. Given its limited scope, this study is not intended to be a comprehensive national assessment. However, it provides useful information on the economic impacts at the national level, as the following:¹³¹

- **Italy could experience aggregated GDP losses induced by climate change of 0.12%-0.16% in the period 2001-2050 with an equivalent loss of around EUR 20-30 billion, considering a temperature increase of 0.93°C; larger losses in the range of 0.16%-0.20% GDP could be expected for a +1.2°C temperature rise scenario (as shown in Tab.1);¹³²**
- some economic sectors e.g. tourism and the economy of Alpine regions could suffer significant damages;
- **higher economic impacts could be expected in the second half of the century;**

¹²⁶ Courtesy of Francesco Bosello (CMCC), 2013.

¹²⁷ FP6 project [SESAME](#) - *Southern European Seas: Assessing and Modelling Ecosystem Changes*.

¹²⁸ Bosello et al., 2010.

¹²⁹ Courtesy of Francesco Bosello (CMCC), 2013.

¹³⁰ Carraro, 2008.

¹³¹ The analysis is based on a general equilibrium model of the world economy and two warming scenarios for the years 2001-2050, considering a temperature increase of 0.93°C and of 1.2°C in line with IPCC scenarios B1 and A2 respectively. The study examines the adjustments induced by several climate change effects (e.g. sea level rise, desertification, energy demand) on the directly affected sectors, as well as on the global trade structure and its feedback mechanisms. A macroeconomic estimate captures all the interactions of national and international climate change impacts on different sectors and the associated redistribution effect. The model, however, does not take into account non-market costs (like ecosystems and biodiversity loss) nor damage to artistic and architectural heritage (Carraro, 2008).

¹³² Carraro et al., 2008.

- **huge North-South differences could emerge in Italy in terms of economic impacts of climate change.**

Increase in temperature in 2050	Economic sector most affected	GDP variation in 2050
Scenario B1 +0.93 °C in 2050	Services (from -0.71% to -0.87%) Energy (Oil -1.88%, Gas: -3.72%, Electricity: + 1.8%) Cereals (-1.45%)	-0.12% to -0.16% equal to a loss of EUR 20-30 bn
Scenario A2 +1.2 °C in 2050	n.a.	-0.16% to -0.20%

*Table 1. Macro-economic impacts of climate change in Italy*¹³³

¹³³ Carraro, 2008.

1.12 Summary of key climate change impacts and vulnerabilities for Italy

Sector	Key climate change impacts and vulnerabilities for Italy
Agriculture and food security	Possible reduction of agriculture productivity especially for wheat, and also for fruit and vegetables crops; olive, citrus, vine and durum wheat production could become possible in the North; corn cultivation could suffer in the South.
Biodiversity and ecosystems	Possible higher risk of biodiversity and natural ecosystems loss , especially in Alpine areas and mountain ecosystems.
Coastal zones	Potential increased risk of flood and erosion of coastal zones from increased occurrence of extreme weather events and sea level rise (especially where coupled with both natural and human-induced subsidence).
Areas at risk of drought and desertification	Potential soil degradation and higher risk of soil erosion and desertification , with a significant share of the South of the country at risk of desertification and specific areas in some northern regions showing some critical conditions.
Fisheries and aquaculture	Potential overall decline in productivity of fished species due to fish stocks movements, aquatic infections, effects of warming temperature on bivalve and gastropod molluscs or shellfish. Possible reduction in aquaculture output in North-Adriatic coastal wetlands and lagoon areas.
Forests and forestry	Possible higher risk of forest fires and droughts threatening Italian forests , with the most critical areas being the Alpine zone, Southern regions, and the Sicilia and Sardegna regions.
Human health	Possible effects on human health , particularly affecting the most vulnerable parts of population, including increased heat-related mortality and morbidity, cardio-respiratory diseases from air pollution, more injuries, deaths and illnesses due to flood and fire events, allergic disorders, as well as changes in the spreading and occurrence of vector-, water- and food-borne diseases.
Water and hydro-geological system	Water availability and quality: higher stress on water resources which could lead to reduced water availability and quality, especially in summer, in southern regions and small islands. Hydro-geological system: alterations of the hydro-geologic regime could increase the risk of landslides, flash mud/debris flows, rock falls and flash floods; areas most exposed to the hydro-geological risk include the hydrographical basin of the Po River (increased flood risk) and the Alpine and Apennine areas (flash flood risk).
Infrastructure and economy	Potential damages to key national economic sectors , due to reduced hydropower production potential; more expensive or reduced winter tourism, as well as reduced summer tourist flows, but improved conditions for spring and autumn tourism. Pressures to urban and rural infrastructures with possible inaccessibility or disruption of transport network, human settlements and socio-economic activity.
Economic costs of climate change impacts	Aggregated GDP losses in the first half of the present century could be in the order of EUR 20-30 bn; some economic sectors (tourism and the economy of Alpine regions) could suffer significant damages; more relevant economic losses could be expected in the second half of the century; huge differences could potentially emerge between northern and southern Italy in terms of economic impacts.

Table 2. Summary of key climate change impacts and vulnerabilities for Italy

2 State of the art of climate change adaptation in Italy

2.1 Introduction

This section presents the current situation with respect to adaptation initiatives designed and undertaken at the national, regional and local scale across Italy. In the following subsections the existing frameworks and implemented measures that are relevant for adaptation are illustrated by sector, along with meaningful research initiatives. Information on costs of adapting to climate change and international cooperation on adaptation are presented subsequently.

To date, the Italian government has not yet adopted a National Adaptation Strategy (NAS), a National Adaptation Plan (NAP) or any framework to design and implement adaptation action in the country. Only recently, a process to design a NAS has been initiated and it is currently ongoing.

The Italian Ministry for the Environment Land and Sea (*Ministero dell'Ambiente e della Tutela del Territorio e del Mare* - MATTM) has the main responsibility for the preparation and establishment of a strategy and a plan of action for adaptation to climate change of national scope. While the MATTM deals with the integration (*mainstreaming*) of adaptation into the sectoral policies, the Regional Governments would be entrusted with the implementation of a NAP.

In 2002 the Inter-ministerial Committee for Economic Planning (CIPE)¹³⁴ adopted the “*National strategy for sustainable*

development”¹³⁵ highlighting the need to adapt to climate change.

Preparatory activities towards a NAS started in 2007 in the framework of the *National Conference on Climate Change* (Rome, 12-13 September).¹³⁶ In this context the existing countrywide climate change vulnerabilities were analyzed from a scientific as well as socio-economic point of view and some high priority adaptation actions to be taken were identified.

Follow-up activities took place in July 2012, when the MATTM resumed the process aimed at developing a NAS,¹³⁷ and assigned the scientific coordination to CMCC. The process included the establishment of a technical panel of experts (“*Tavolo Tecnico*”) and an inter-ministerial advisory group (“*Tavolo Istituzionale*”). At about the same time the comprehensive EU Adaptation Strategy was being developed.

In support to the preparation of the Italian NAS, a participatory process has been envisaged involving stakeholders and citizens through an ex-ante survey on the perception of adaptation in the country¹³⁸ and public consultations on the draft strategy document.

In December 2012, the MATTM put forward a draft document containing “*Strategic guidelines for adaptation to climate change, sustainable management and safety of the national territory*”. The identified priority actions put an emphasis on copying with the

¹³⁴ <http://www.cipecomitato.it/en/>.

¹³⁵ MATTM Website “[Strategia d'azione ambientale per lo Sviluppo Sostenibile in Italia](#)”.

¹³⁶ For further information see: *Annex 3.2 National Conference on Climate Change (Rome, September 2007)*.

¹³⁷ MATTM Website “[Adattamento ai cambiamenti climatici](#)”.

¹³⁸ An on-line questionnaire was open to the public from the 1st of October to 15th of November 2012, at <https://www.cmcc.it/questionario/questionario>.

hydro-geological risk through a national strategy, complemented by urgent safety measures. The guidelines have to be discussed by the CIPE in consultation with the Ministry of Agricultural, Food and Forestry Policies, the Ministry of Infrastructure and Transport, and the Ministry of Economy and Finance.

As to national **adaptation cost estimates**, the only existing reference for countrywide adaptation cost-benefit assessment is the above-cited FEEM-ISPRA-CMCC study, covering adaptation measures explored and undertaken in four key vulnerable areas.

Despite the current lack of a NAS or a NAP, or comprehensive economic assessments, **some adaptation initiatives have already been implemented** in the context of the existing policies for environment protection, natural hazards prevention, sustainable management of natural resources and health protection.

The most relevant efforts at the national level have been **especially focused on the domains of human health, agriculture, management of coastal areas, fight against desertification and management of water resources**. These include **legal frameworks such as the *White Paper on Rural Development*, the *National Biodiversity Strategy* and the *National Action Plan to combat drought and desertification*; health-related monitoring and surveillance systems; as well as a variety of specific practical measures**.

At the sub-national level, a range of initiatives have been designed and implemented by Regions, Provinces, Cities and Municipalities.

Italy is involved in several **research efforts on climate change adaptation** at the

international, European and the national level. A special focus is given to research on coastal zones and related ecosystems, agriculture, urban areas, biodiversity and hazards particularly in the mountain areas, desertification processes, water resources and health.

Furthermore, Italy is active in **international cooperation initiatives on climate change-related topics**, including transnational cooperation efforts in Europe and **capacity building** activities in developing countries.

2.2 Agriculture and food security

White Paper on rural development and climate change¹³⁹

In September 2011 the Italian Ministry of Agriculture, Food and Forestry Policies (*Ministero delle Politiche Agricole Alimentari e Forestali* - MiPAAF) published the **White Paper on rural development and climate change** titled “*Challenges and opportunities of rural development for mitigation and adaptation to climate change*”.¹⁴⁰ The White Paper aims at increasing the resilience of the agricultural sector to climate change as well as the investments in a low-carbon economy through the development and diffusion of renewable energy and green products.

The White Paper provides **general recommendations** (e.g. exchange and free access to climate data; maintaining monitoring networks; realizing an Italian Atlas of climate change; building a database of figures related to future climate; establishing a National Council on climate change)¹⁴¹, and identifies **specific types of adaptation actions to be implemented in the agriculture sector at different levels in four main areas**: technology development; adoption of technologies; government programmes and insurance services; financial management of farms.

Legal frameworks

Further to a *National plan for water use* (approved by the CIPE in 2005), Italy

implemented a *National Plan for irrigation in support to the agricultural sector (2007-2010)*¹⁴² and allocated specific funds to alleviate the effects of extreme events, including droughts.¹⁴³

Furthermore, specific adaptation actions are financially supported by the *21 regional Rural Development Programmes (RDPs) 2007-2013*.¹⁴⁴ This occurs primarily through **water management measures** (including activities targeted at improving the efficiency of irrigation infrastructures, enhancing the capacity to store water and coping with extreme weather events), and secondly through **forestry measures** (reducing the consequences of forest fires and preventing soil deterioration).¹⁴⁵

Risk management

Concerning risk management and the economic and structural tools for preventive adaptation actions, Italy has implemented specific support **to the costs of insurance premiums covering the risks of climate change on crop production, animal diseases of livestock, diseases and pest infestations**

¹⁴² Further information: RRN “[Attuazione Piano Irriguo Nazionale 2007-2010](#)”.

¹⁴³ EEA, 2007.

¹⁴⁴ Following the review process of the *Common Agriculture Policy* (CAP) (CAP Health Check, agreed upon on the 20 November 2008) and the implementation of the *European Economic Recovery Package* (EERP), the second pillar of *Rural Development* (European Agricultural Fund for Rural Development - EAFRD) has obtained additional resources to meet “new challenges” including “climate change”. These issues have been implemented by the MiPAAF into the [National Strategic Plan for Rural Development](#) and devolved to the 21 regional [Rural Development Programmes \(RDPs\) 2007-2013](#). “A screening undertaken to identify how the issue of climate change is being tackled in recent RDPs, shows that **15 out of 21 Italian Regional Governments have allocated new funds to the challenge of climate change, employing 17.3% of additional resources, amounting to about 128.87 millions Euro**” (RRN, 2010).

¹⁴⁵ Further information on specific measures of RDPs addressing climate change adaptation: [Annex 3.6 Adaptation to climate change in the Italian Rural Development Programmes \(RDPs\)](#).

¹³⁹ For further info see [Annex 3.3 White Paper on rural development and climate change](#).

¹⁴⁰ MiPAAF & RRN, 2011.

¹⁴¹ Pasqui et al., 2011.

of plants since 2010.¹⁴⁶ For this purpose, a single funding system was created collecting all the relevant funds, including the *CMO Wine funds* providing contributions to insurance for wine grapes crops, and the *National Solidarity Fund for natural disasters in agriculture*. The latter promotes preventive measures to cope with the damages to agricultural production and livestock, farm structures, production facilities and rural infrastructures in areas affected by natural disasters or exceptional events, through measures encouraging the stipulation of insurance contracts or compensatory actions.¹⁴⁷

Research

Research efforts on climate change adaptation in agriculture in Italy include the following projects:

- *Climagri - Climate change and agriculture* project¹⁴⁸ (2001-2004), the first specific Italian effort aimed at improving the knowledge on potential climate change impacts on Italian agriculture with a view to recommend adaptation actions and to support the implementation of response measures;
- *AgroScenari - Adaptation scenarios of Italian agriculture to climate change* programme¹⁴⁹ (2008-2012), a

national adaptation research plan for Italy, following up on *Climagri* and addressing more specifically the subject of adaptation to current and projected climate change;

- *Climesco - Evolution of cropping systems as affected by climate change*¹⁵⁰ project (2006-2010), a national project aimed *inter alia* at defining agronomic corrective actions to maintain or possibly increase the sustainability of the cropping systems used in Southern Italian regions;
- *Soilsink - Climate change and agricultural and forestry systems: impact on the carbon reservoirs and on the soil microbial diversity*¹⁵¹ project (2006-2010), a national project aimed *inter alia* at providing advice to agricultural technicians and planners on the most appropriate decisions for agricultural land management;

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4. analysis of climate change impacts on farming systems, with specific reference to herbaceous crops;
 5. alternative production systems scenarios with emphasis on typical crops and varieties;
 6. new scenarios in the agro-zootecnical D.O.P products;
 7. irrigation and climate change;
 8. land degradation processes and climate change;
 9. climatic scenarios, crop diseases and pests;
 10. phenology and climate change;
 11. economic adaptation strategies of farmers to climate change and agricultural policy support tools”.

¹⁵⁰ The aim of the *Climesco* project is to “identify integrated approaches for optimizing water resources use by maximizing the cropping systems Water Use Efficiency (WUE), approaches that could be utilized by political stakeholders in spatial planning activity, in a context characterized by climate change, high evaporative and transpirative demands, poor availability of water resources and/or decreasing of water quality for irrigation. The water use optimization involves several agronomical practices in order to ensure high productive levels by maximizing the WUE in periods long enough to include the forecast climatic scenarios”.

¹⁵¹ The aim of the *Soilsink* project is to “identify the most efficient production systems in terms of soil carbon storage and organic matter increase in two case studies in the Mediterranean area (with different pedoclimatic, agricultural and contextual characteristics: Agugliano, in Marche Region, and Berchidda in Sardegna Region Italy). The main areas of research are:

1. agro-forestry production systems;
2. simulation models and land evaluation;
3. genetic and functional microbial diversity;
4. carbon sink and biogeochemical cycles”.

¹⁴⁶ Thanks to Reg. (EC) 73/2009 issued after the CAP Health Check, allowing the use of Community funds for insurance benefits.

¹⁴⁷ MiPAAF & RRN, 2011.

¹⁴⁸ The *Climagri* Project consists in the following four sub-projects:

1. “climatic analysis and future scenarios;
2. Italian agriculture and climate change;
3. drought, desertification and water resources management;
4. data dissemination and communication”.

¹⁴⁹ The *AgroScenari* Programme has the following research lines:

1. “climate change and meteo-climatology;
2. acquisition, adaptation and downscaling of future climatic scenarios at the local scale;
3. modelling to forecast farm soil trafficability;

- ***Icarus - IWRM for Climate Change Adaptation in Rural Social Ecosystems in Southern Europe***¹⁵² (2010-2012) international project, aimed at addressing efficient water use in agriculture and identifying innovative adaptation strategies, practices and tools for saving water in irrigated productions systems.

2.3 Biodiversity and ecosystems

Conservation and management of fauna and flora¹⁵³

At the international level, the MATTM Directorate for the protection of nature and the sea (*Direzione Protezione della Natura e del Mare* - DPNM) takes part in several initiatives for the safeguard of species and habitats and pursues the goal of protecting biodiversity through the implementation of ***International Conventions, Agreements and Protocols***.¹⁵⁴

¹⁵² The [Icarus](#) project aims at “increasing efficient water use in agriculture in selected areas of Italy, Portugal and Spain by analysing biophysical, socio-economic and institutional dimensions of sustainable water management and identifying innovative adaptation strategies, practices and tools for saving water in irrigated productions systems, which could be disseminated in other Mediterranean countries”.

¹⁵³ MATTM Website, “[Biodiversità - Conservazione e gestione della fauna e della flora](#)”.

¹⁵⁴ ***International Conventions, Agreements and Protocols:***

- Convention on Biological Diversity - CBD (Protocol of Cartagena, Protocol Nagoya);
- Ramsar Convention on Wetlands;
- Convention on migratory species of wild animals – CMS/Bonn Convention) (ACCOBAMS, AEWA, EUROBATS);
- Convention on international trade of species of wild fauna and flora threatened with extinction (CITES – Convention of Washington);
- Convention for the conservation of European wildlife and natural habitats - Berne Convention (European Diploma of protected areas);

At the national level, conservation and management actions are addressed by the DPNM by promoting the establishment of nature reserves and national parks (currently covering about 1,300,000 ha) and the definition of relative management criteria, as well as by developing national action plans, guidelines and guidance documents for the conservation of species and habitats, and by generating publications and databases on the natural heritage. Indeed, the variety of **initiatives implemented on terrestrial¹⁵⁵ and marine¹⁵⁶ protected areas¹⁵⁷, national parks¹⁵⁸ (24), landscape, terrestrial fauna and flora, and actions for limiting the impacts of alien invasive species** can be considered beneficial also for adapting to climate change.¹⁵⁹

-
- Convention for the Alps (for a global policy for Alps protection and preservation, including consideration of climate change, Convention for the protection of the Mediterranean (Barcelona Convention) (Protocol concerning Specially Protected Areas and biodiversity in Mediterranean – ASP Protocol);
 - International agreement on the *International marine mammal sanctuary*, also known as *Cetacean Sanctuary*
 - Nature 2000 Network.

(MATTM Website, “[Biodiversità - Convenzioni, Accordi e Protocolli internazionali](#)”).

¹⁵⁵ ***Italian Terrestrial Protected areas:*** MATTM Website “[Aree naturali protette terrestri](#)”.

¹⁵⁶ Interactive ***map of the Italian Marine Protected areas:*** MATTM E-Book “[Aree Marine Protette](#)“. Further information: MATTM Website, “[Mare - Tutela della biodiversità marina - Azioni](#)“ and “[Tutela del Mare](#)”.

¹⁵⁷ ***Official List of Natural Protected Areas*** (including all national marine and terrestrial parks): MATTM (2010) “[Elenco ufficiale delle aree naturali protette](#)” (Gazzetta Ufficiale n. 125 del 31.05.2010).

¹⁵⁸ ***List of National Parks:*** MATTM (2011) “[Elenco dei Parchi Nazionali](#)”.

¹⁵⁹ They include:

- **legal frameworks**, e.g. *Framework Law on protected areas* (L. 394/91) and the *Law for sea defence* (L. 979/82);
- **national Action Plans, Guidelines and Guidance Documents** (*Action Plans and Guidelines:* MATTM Website, “[Conservazione e gestione della fauna e della flora](#)”);
- **specific initiatives** for conservation of fauna and flora and for conservation and management of endangered species and/or representative of national fauna and flora (***Specific initiatives:*** MATTM Website, “[Conservazione e gestione della fauna e della flora](#)”);
- **actions aimed at the protection and management of species and biodiversity** (e.g. activities underway on

Italian National Biodiversity Strategy

In order to ensure the integration of the preservation of the priceless national biodiversity heritage into the development objectives of the country, in 2010¹⁶⁰ the MATTM launched the *Italian National Biodiversity Strategy* to be implemented in the period 2011-2020. The Strategy is built on **three pillars**: 1) biodiversity and ecosystem services; 2) **biodiversity and climate change**; 3) biodiversity and economic policies.

The Strategy provides indications on **priorities for action based on intervention tools** for the different working areas,¹⁶¹ either directly or implicitly linked to climate change adaptation. With respect to biodiversity and climate change, **the Strategy explicitly aims at reducing substantially the impact of climate change on biodiversity by 2020, by defining appropriate measures of adaptation and mitigation, also targeted at**

marine biodiversity covering all cetaceans present in Italian waters, sea turtles, the prairies of Posidonia and alien invasive species);

- **monitoring of water and coastal marine environment** aimed at improving knowledge and protection of the sea and marine ecosystems, the identification of the causes of possible situations of deterioration and at preventing and combating pollution; the data collected during the monitoring feed the *Database for the sea defence* (Sea Defence System - Si.Di.Mar) of the MATTM and are available to users;
- **databases** relating to the natural heritage and measures for the conservation of species and habitats, e.g. the *Checklist of Italian fauna*, the *Directory of protected Italian fauna*, the *Directory of protected Italian flora*, the *Natura 2000 Database* and the *Sea Defence System - Si.Di.Mar. Database* (**Publications and databases**: MATTM Website, "[Biodiversità - Pubblicazioni e banche dati](#)");
- **publications**¹⁵⁹, ranging from general ones, e.g. the *State of Biodiversity in Italy*, to those dedicated to specific issues of management and conservation of individual species (**Publications and databases**: MATTM Website, "[Biodiversità - Pubblicazioni e banche dati](#)").

¹⁶⁰ By approval in October 2010 by the *Standing Conference for relations between the State, Regions and autonomous Provinces*.

¹⁶¹ For details on the Strategy's structure see *Annex 3.5 Structure of the Italian National Biodiversity Strategy and actions related to climate change adaptation*.

increasing the resilience of natural and semi-natural ecosystems to climate change.

Such identified **adaptation actions**¹⁶² are aimed, for instance, at maintaining the range and variability of ecological habitats and species; facilitating the spread of species into new favourable habitats; maintaining the existing ecological networks; and controlling the spread of invasive species.

Furthermore, the Strategy underlines the importance of increasing the understanding of the impacts of climate change on biodiversity by analysing the effects of climate change on species, habitats and ecosystems, in support to implementing adaptation (and mitigation) measures. However, the Strategy also points out that the speed and scale of climate change require immediate action despite the existence of knowledge gaps, and suggests to "plan for the future with the information available today".

This action preceded the launch of the EU 2020 Biodiversity Strategy¹⁶³ that took place in 2011, to protect and improve the state of biodiversity in Europe in the following decade. Importantly, the Council of the EU¹⁶⁴ endorsing the implementation of the Strategy, stressed the need to "integrate biodiversity concerns into all EU and national sectoral policies, in order to reverse the continuing trends of biodiversity loss and ecosystem degradation".

¹⁶² For details on the Strategy's measures see *Annex 3.5 Structure of the Italian National Biodiversity Strategy and actions related to climate change adaptation*.

¹⁶³ EC, 2011.

¹⁶⁴ Council of the European Union, 2011.

Research

Italy participated to the following international projects related to biodiversity and climate change:

- **nature and biodiversity protection projects**¹⁶⁵ within the **LIFE+ programme**¹⁶⁶ – 40 Italian projects of which 14 specifically on biodiversity protection in 2008;
- **ClimChAlp - Climate change, impacts and adaptation strategies in the Alpine Space**¹⁶⁷ project (2006-2008) providing *inter alia* methodology and recommendations for adaptation in the Alpine Space;
- **AdaptAlp - Adaptation to climate change in the Alpine Space**¹⁶⁸ project

¹⁶⁵ Further information at: MATTM Website, "[Progetti Natura italiani finanziati 2001-2009](#)".

¹⁶⁶ Further information at: MATTM Website, "[LIFE+ per la protezione della natura e la biodiversità](#)".

¹⁶⁷ The **ClimChAlp** project "aimed to be a concrete input for a future Alpine Space Program which considers alpine climate changes and their potential effects. The scientific activities were organized in the following four Work Packages:

- climate Change and Resulting Natural Hazard;
- monitoring, Prevention & Management of Specific Effects of Climate Change on Nature;
- impacts of Climate Change on Spatial Development and Economy;
- flexible Response Network".

¹⁶⁸ **AdaptAlp** is an *Alpine Space Programme* project with the "overall aim of assessing impacts and adaptation to climate change in the Alpine Space. Activities focussed on:

- the consolidation of the cooperation in the Alpine space on risk prevention and on the methods of risk management;
- the supply of data for the European Floods directive and the European INSPIRE directive;
- the supply of data from models and observations in the Alpine area in order to produce more accurate forecasts of natural disasters and estimates of impacts;
- the formulation of a transnational cognitive platform in the Alpine area about the evaluation of the risks and the mapping of natural disasters in order to elaborate some transnational guidelines by taking into account the impacts of climate change;
- the support of adaptation actions on a transnational, national, regional and local level, through the opening of coordinated campaigns on the risks management and communication;
- the implementation of activities connected to adaptation to climate change in the Alpine area".

(2007-2013) on natural hazard management and climate change adaptation in the Alpine arc.

- **STRADA - Climate change adaptation strategies for the management of natural hazards in the trans-boundary areas**¹⁶⁹ project (2010-2013), developing adaptation strategies in the Italy-Switzerland trans-boundary territory, with a focus on the management of water resources and the adaptation to hydro-geological hazards in the context of climate change in Alpine environment.

2.4 Coastal zones

The main competences and responsibilities for organising and managing coastal defence passed recently (2001) from the Italian national government to the fifteen coastal regions. The former, through the MATTM and ISPRA, is responsible for the provision of policy guidance and financial support, beside a legal framework for environment protection¹⁷⁰ that covers also the coastal zones. The Regions are entrusted with coastal planning, protection and management, including independently organizing the related sharing of responsibilities with Provinces and Municipalities.¹⁷¹

¹⁶⁹ **STRADA** is an INTERREG IV A project in the framework of the 2007–2013 Italy-Switzerland Trans-boundary Cooperation Programme. It aims at developing adaptation strategies in the Italy-Switzerland trans-boundary territory, with a focus on:

- water management;
 - optimizing the use of lakes water resources;
 - management of mountain springs;
- hydro-geological hazards;
 - analysis of small to medium size avalanches;
 - characterization of extreme precipitation.

¹⁷⁰ Environmental Code (Legislative Decree 3 April 2006, n. 152).

¹⁷¹ PRC, 2009.

Integrated coastal Zone Management (ICZM)¹⁷²

At the national level, Italy is required by various international agreements¹⁷³ to prepare a strategy on *Integrated coastal Zone Management (ICZM)*, the current European tool for the governance of marine-coastal zones, which includes prevention and/or reduction of the effects of natural hazards and of climate change. The MATTM has already started an overall institutional coordination, through the involvement of regional and local authorities dealing with planning and management of coastal areas, with a view to define the required ICZM Strategy and to prepare the relevant Plans/Programs or Guidelines. In this process, appropriate consultation of economic as well as social stakeholders is envisaged, to ensure proper input and consideration of all relevant interests. The most recent status of activities is contained in the 2011 MATTM report on national progresses on ICZM in the period 2006-2010.¹⁷⁴

At the regional level, **some Italian regional governments have started approaching the ICZM** to different extents e.g.: Emilia-Romagna and Marche (2005) and Liguria (2002), with the adoption of instruments having reference to the ICZM; Toscana, Lazio, Abruzzo, Sardegna and Puglia with

preliminary testing of the ICZM approach or plans for land protection and spatial planning. Basilicata and Sicilia just started preparatory activities for their regional coastal plans.

Implemented adaptation actions and measures

Over the years, regional action focused on **interventions and provisions aimed at stabilizing and fixing the coastline to protect coastal zones from increased erosion and flooding** mainly in the framework of regional coastal plans. Although these initiatives were designed and planned without explicit consideration of climate change, the implementation of several of them is also beneficial for adapting to climate change. These include the following:^{175 176}

- **traditional coastal defence measures**, such as artificial reefs (rock mound structures, flood walls), near-shore breakwaters, bulkheads, artificial channelling and drainage and, more recently, beach nourishment generally in high-profit touristic areas and dune restoration (e.g. Campania, Lazio, Emilia-Romagna, Toscana);
- a cutting-edge **system of mobile barriers** against exceptionally high tides (Veneto);
- a **real-time wave monitoring network** in support to civil protection decision-making during extreme weather events (Campania) and/or other monitoring systems (Emilia-Romagna);

¹⁷² MATTM Website, "[Gestione Integrata delle Zone Costiere – GIZC](#)".

¹⁷³ Pursuant to:

- Recommendation on the implementation of Integrated Coastal Zone Management in Europe ((2002/413/EC) of 30 May 2002);
- Framework Directive on Marine Strategy (2008/56/EC);
- Protocol on Integrated Coastal Zone Management in the Mediterranean of the Barcelona Convention and its Resolution (interim arrangements);
- Siracusa Chart on biodiversity (signed on 24 April 2009, in the framework of the G8 Environment).

¹⁷⁴ MATTM - Direzione Generale per la Protezione della Natura e del Mare, 2011.

¹⁷⁵ Carraro & Sgobbi, 2008.

¹⁷⁶ PRC, 2009.

- **political decisions**, such as land use planning;
- **managerial interventions**, such as changing agricultural practices in areas prone to floods;
- **behavioural strategies**, such as changing location of recreational facilities.

Examples of advanced coastal protection

Two cases are emblematic for coastal protection: Venice MO.S.E. and Emilia-Romagna Coastal Plans. These are illustrated below.

Venice (Veneto region)¹⁷⁷ - Following a 1984 national law, the Venice Water Authority (under the Ministry of Infrastructure and Transport), through the Consorzio Venezia Nuova, is implementing a *General Plan of Interventions* financed by the government, to achieve protection measures to safeguard the city and its lagoon from sea tides. In addition, a specific project called **MO.S.E. - Modulo Sperimentale Elettromeccanico**, was designed to temporarily divide the sea from the lagoon during high tides. For this purpose, a system of mobile barriers was built at three lagoon inlets to be activated during exceptionally high tides. The defence structure, whose works started in 2003, was designed to cope with an increase of up to 60 cm in sea level. This is the only region taking into account a climate scenario indicator (i.e. SLR) in the planning and implementation of coastal protection measures.

Emilia-Romagna¹⁷⁸ - Emilia-Romagna is the first Italian region to have implemented beach nourishment (a “soft” kind of intervention) in

1983 as an alternative to the environmentally unsustainable “hard” protection works. Later, in 2002 and 2007, two major beach nourishment interventions were carried out using off-shore submerged sand deposits.

In 1983 the region also approved its first *Coastal Plan* and established a *subsidence monitoring network* for the coastal territory and shoreline movements. The second Coastal Plan was issued in 1995 which was followed by two *Coastal Status Reports* in 2000 and 2007. The latest Coastal Plan, including a ten-year Management Plan (2010-2019), contains some considerations on climate change.

Since 2000, a GIS-based Coastal Information System has been developed in support to coastal studies, monitoring and planning.

In 2002 the Region started testing a pilot video monitoring system of the littoral processes in support of coastal zone management through the development of video-derived Coastal State Indicators (CSI).¹⁷⁹

Furthermore, the region is the only one, according to the available information, that developed and adopted *Guidelines* for an ICZM, back in 2005.

Research

Italy is involved in international research efforts relevant to some extent to adaptation to climate change over its regional coasts, including the following initiatives and projects:

¹⁷⁷ PRC, 2009.

¹⁷⁸ PRC, 2009.

¹⁷⁹ Within the EU 5th FWP RTD Project [CoastView](#) (2002-2005).

- INTERREG IIC *Beachmed-e MedPlan* subproject¹⁸⁰, focussing on risk assessment and integrated plans establishment for Mediterranean coastlines;
- *MEDCOAST*¹⁸¹ network, with a focus on improving coastal management practices for coastal and marine conservation of the Mediterranean and the Black Seas;
- *COASTANCE*¹⁸² - *regional Common Action Strategy Against Coastal Erosion and climate change effects for a sustainable coastal planning in the Mediterranean basin* project (2009-2012), on regional action strategies for adaptation to climate change in the coastal zones;
- *MedLab - Mediterranean Living Lab for Territorial Innovation*¹⁸³ project (2009-2011), on innovative Information and Communication Technology (ICT) services in support to regional policy;
- *EMMA - Environmental Management through Monitoring and Modelling of Anoxia*¹⁸⁴ project (2004-2007) with the aim of turning scientific knowledge into concerted operational local strategies able to prevent and reduce the (environmental and socio-economic) causes of seasonal hypoxic and anoxic events in the Adriatic coastal area, especially in its Central and Northern parts;
- *SHAPE*¹⁸⁵ - *Shaping an Holistic Approach to Protect the Adriatic Environment between coast and sea* project (2011-2014), a project for the Adriatic Region aimed at creating the basis for the protection and the sustainable development of the coastal-marine environment, by

¹⁸⁰ *MedPlan* (2005-2008) focussed on the “analysis and management process for coastal zones: risk, impact mitigation and area planning assessment methods”.

¹⁸¹ *MEDCOAST* aims to “contribute to coastal and marine conservation in the Mediterranean and the Black Seas through improved coastal management practices. This goal is pursued by enhancing scientific and professional collaboration among individuals and institutes in the Mediterranean and Black Seas countries, or elsewhere, through three components:

1. conference series and scientific workshops;
2. human resource development (conferences, training programs, networking);
3. collaborated research”.

¹⁸² The *COASTANCE* project focuses on the following three lines:

- “coastal risks : submersion and erosion;
- territorial action plans for coastal protection management;
- guidelines for environmental impacts studies focused on coastal protection works and plans”.

¹⁸³ *MedLab*’s objective is to “implement the Living Lab (LL) model for in situ co-design of innovative ICT services approach from the demand side of regional policy. The end result of MedLab is a permanent trans-Mediterranean structure that increases the competitiveness of the MED space through a virtuous circle whereby regional development authorities apply the Living Lab model in an increasing array of fields”.

¹⁸⁴ Using automated stations to study the marine environment, the *EMMA* innovative monitoring (LIFE-Environment) project “developed a local integrated strategy for reducing the environmental and socio-economic impacts of hypoxia and/or anoxic seasonal events in the marine and coastal zones of the Northern Adriatic Sea. The project hit the target of transferring the scientific and technical knowledge to local authorities in support to the fight against the marine ecosystem degradation”. The main elements of the project were:

- “the *E1 buoy*, a fixed monitoring station installed in the Adriatic Sea (6 km offshore Rimini); operating since August 2006, it daily records in continuum meteorological and oceanographic parameters that are daily validated and analysed in order to identify and forecast hypo-anoxic events;
- the *EMMA’s monitoring network* along the Adriatic coast of the Emilia-Romagna region; it surveyed hypo-anoxia phenomena, improved the sensitivity of the forecasting system as input to the Decision Supporting System (DSS);
- the *Forecasting Model*, a numerical 3-D model for the Adriatic Sea implemented to follow and to forecast hypo-anoxic events;
- the *Decision Supporting System (DSS)*, operating on both the scientific and managerial/socio-economic levels and including a module for multi-criteria analysis for the evaluation of different management options and their refinement”.

¹⁸⁵ The strategic objective of the *SHAPE* project is the “development of a multilevel and cross-sector governance system, based on a holistic approach and aiming to the integrated management of the natural resources, risk’s prevention and conflicts resolution among uses and users”. The activities are structured in five Work Packages (WP):

1. Crossborder Project Management and Coordination
2. Communication and dissemination;
3. Integrated Coastal Zone Management;
4. “Shipping” towards Maritime Spatial Planning;
5. Within land and sea.

promoting the implementation of the ICZM Protocol and the Roadmap for Maritime Spatial Planning (MSP), in the Adriatic region.

Furthermore, the following national projects were carried out:

- **CAMP - Coastal Area Management Programme Italia**¹⁸⁶ project (2009), supporting also the ICZM;
- **VECTOR - VulnErability of the Italian coastal area and marine Ecosystems to Climatic changes and Their rOle in the Mediterranean caRbon cycles**¹⁸⁷ project (2006-2009), studying the most significant “impacts of climate change on the Mediterranean marine environment and the role of this basin on the planetary CO₂ cycle”.

2.5 Areas at risk of drought and desertification¹⁸⁸

National Action Programme (NAP) to Combat Drought and Desertification¹⁸⁹

As requested by the *United Nation Convention on Combating Desertification* (UNCCD),¹⁹⁰ Italy developed and approved

the *National Action Programme (NAP) to Combat Drought and Desertification*¹⁹¹ in 1999 aimed at reducing losses of soil productivity caused by climatic changes and human activities in the context of sustainable development, following the *ad hoc Guidelines*¹⁹² elaborated by the *National Committee to Combat Desertification (CNLS)*.¹⁹³ The NAP, which calls for the creation of links and synergies with other global conventions on climate, biodiversity and the protection of international waters, provides a coherent set of indications that are beneficial also to adapting to climate change.

The NAP top priorities are:¹⁹⁴ 1) soil protection, 2) sustainable management of water resources, 3) reduction of the environmental impact from productive activities, and 4) land restoration. Secondly it focuses on information, training and research, and programs and measures to combat drought and desertification in vulnerable areas within Italy and in developing countries, according to development cooperation priorities. Most of the proposed actions and measures¹⁹⁵ identified for the four top priority sectors are indirectly beneficial to adapting to climate change.

¹⁸⁶ The *CAMP Italia* project is carried out in the framework of the *Barcelona Convention*, which is accomplished through national projects that each member State can present.

¹⁸⁷ The *VECTOR* project is articulated in three research lines related to Ocean carbon measurements, devoted respectively to exploring:

1. “the role of plant and animal populations of the Mediterranean continental shelf in the carbon cycle;
2. the carbon cycle in the pelagic Mediterranean area;
3. the carbon cycle in oceanic environment with a special emphasis on the Southern Ocean”.

¹⁸⁸ MATTM Website, “[La desertificazione](#)”.

¹⁸⁹ MATTM Website, “[La desertificazione](#)”.

¹⁹⁰ Italy ratified the *United Nation Convention on Combating Desertification* (UNCCD) in 1997.

¹⁹¹ CIPE, 1999.

¹⁹² “[Linee guida del piano d'azione nazionale per la lotta alla desertificazione](#)”.

¹⁹³ The *Comitato Nazionale per la Lotta alla Siccità e alla Desertificazione (CNLS)* was established by the Council of Ministers’ Decree on 26 September 1997.

¹⁹⁴ MATTM Website, “[La desertificazione in Italia, scheda tematica n. 10. “Settori prioritari di azione”](#)”.

¹⁹⁵ For further details see *Annex 3.4 Actions and measures of the National Action Programme to combat drought and desertification*.

Local Action Programmes (LAPs) to Combat Drought and Desertification¹⁹⁶

In order to achieve its goals, the NAP entrusted the Regional Governments and Watershed Authorities¹⁹⁷ with the responsibility to accordingly develop *Local Action Programmes (LAPs) to Combat Drought and Desertification*.

LAPs are tools that: 1) **identify specific regional areas sensitive and/or at risk of desertification** through the application of a methodology supported by an appropriate set of indicators at the regional scale; 2) **define specific action plans for the prevention, mitigation and adaptation to drought and desertification**; and 3) provide guidance for quantification of the financial needs and the identification of funding sources.

Currently, **ten Italian Regional Governments adopted their LAP**:¹⁹⁸ Campania (2010), Liguria (2010), Toscana (2010), Emilia-Romagna (2009), Puglia (2008), Sardegna (2008), Calabria (2008), Abruzzo (2007), Basilicata (2007) and Sicilia (2007).

Pilot projects to combat desertification

With the guidance of the CNLSD, the MATTM promoted a number of *Pilot projects to combat desertification*¹⁹⁹ that go beyond the LAPs. In fact, they also make use of experimental techniques and methods for actions aimed at improving knowledge (e.g. environmental monitoring, maps and boundaries of sensitive areas/at risk of

desertification of different phenomena and indicators) and directly intervening in the territory. To date, **six Italian Regional Governments carried out such pilot projects**: Abruzzo (2010), Piemonte (2010), Sardegna (2009), Sicilia (2009), Calabria (2009) and Puglia (2008).

Other initiatives

Further **initiatives aimed at protecting soil and restoring its stability** are included in the 2007-2013 *Rural Development Plans (RDPs)*, such as: improving soil quality and reducing the organic content loss (Puglia); restoring dry stone walls and relative works to support steep slopes (Liguria); renewable energy production plants from biomass and other renewable sources (Sardegna, Basilicata and Puglia); water resources management and water saving technologies (Sardegna, Basilicata, Puglia and Calabria).

Moreover, in 2009, the **report: “Good practices for combating desertification”**²⁰⁰ was published by the MATTM in collaboration with the *Research Nucleus on desertification* of Sassari University, providing a **methodological and operational tool for the identification of good practices for combating desertification**.²⁰¹

²⁰⁰ Seddaiu et al., 2009.

²⁰¹ The study is articulated in the following five phases:

1. identification of a conceptual framework for the detection and description of good practices;
2. identification of appropriate criteria for the definition of “effectiveness” of adopting good practices;
3. collection and analysis of documentation and case studies about good practices related to four areas of competence (defined by CIPE 229/99 deliberation);
4. description and evaluation of reference cases for combating desertification;
5. creation of a glossary of terms related to the topic of desertification and to analytical reference framework.

¹⁹⁶ MATTM Website, “[Progetti azione locale](#)”.

¹⁹⁷ [Autorità di Bacino](#).

¹⁹⁸ MATTM Website, “[Progetti azione locale](#)”.

¹⁹⁹ MATTM Website, “[Progetti pilota](#)”.

Research

Italy participated to the following international projects on combating drought and desertification:

- **MEDALUS** - *Mediterranean Desertification and Land Use*²⁰² project (1991-1999), investigating the relationship between desertification and land use in Mediterranean Europe;
- **DISMED** - *Desertification Information System for the Mediterranean*²⁰³ project (2000-2003), focussed on capacity building for national administrations of Mediterranean countries to effectively program measures and policies to combat desertification and drought;
- **DesertWatch**²⁰⁴ project (2004-2006), developing an Information System in support to national and local authorities in fulfilling their reporting obligations under the UNCCD as well

²⁰² The specific objectives of the [MEDALUS](#) international research project were the following:

1. “to investigate, using detailed field work and mathematical modelling, the physical processes in the soil and plants that determine how the environment will react to climatic and man-induced desertification over Mediterranean Europe;
2. to examine the likelihood of a worsening situation in the near future as a result of both climatic and socio-economic changes;
3. to evaluate the impact such a worsening of conditions could have on physical conditions and society in the Mediterranean;
4. to suggest mechanisms and policies for the amelioration of these effects in the light of the Community Agricultural Policy”.

²⁰³ The purpose of the [DISMED](#) project was pursued by “reinforcing the communication amongst the national administrations of Mediterranean countries, facilitating the exchange of information and establishing a common information system to monitor the physical and socio-economic conditions of the areas at risk, and to assess the extent, severity and the trend of land degradation”.

²⁰⁴ [DesertWatch](#) aimed at “developing a user-tailored, standardised, commonly accepted and operational information system based on Earth Observation (EO) technology to support national and regional authorities of Northern Mediterranean countries in commonly reporting to the UNCCD and assessing and monitoring desertification and its trends over time”.

as in monitoring land degradation trends over time.

It is worth mentioning also the **national project Desert Arte**²⁰⁵ (2007-2009), that focussed on education and awareness rising in schools on the issues of soil degradation through participatory action.

2.6 Fisheries and aquaculture²⁰⁶

Existing adaptation strategies for the fisheries sector focus mainly on the **sustainable management of fisheries** at national and international level, and on the enhancement of complementary activities such as aquaculture.

Concerning the initiatives implemented at the national level, it is worth mentioning the **Operational Programme for the Italian fisheries sector** for the period 2007-2013, approved by the European Commission (in December 2007), covering the whole Italian territory. The Programme is run under the responsibility of the MiPAAF and is built on 5 priority lines that entail measures involving some degree of **adaptation and sustainability** (e.g. interventions directed to the protection of the marine ecosystem and the competitiveness of national fisheries).²⁰⁷

²⁰⁵ [DESERT ARTE](#): *Educazione, formazione, sensibilizzazione dei giovani ai temi della lotta alla desertificazione* (Education, training, awareness raising on issues of the fight against desertification among the young) was realized in the framework of an MATTM-ENEA agreement.

²⁰⁶ MiPAAF Website, [Pesca e Acquacoltura](#).

²⁰⁷ The priorities of the “[programma Operativo per il settore pesca in Italia](#)” are: “1) adaptation of the EU fishing fleet, for the promotion of sustainable and profitable fishing in maritime areas; 2) aquaculture, inland fishing, processing and marketing of fishery and aquaculture products, for sustainable business; 3) measures of common interest, comprising measures intended to protect and develop aquatic fauna and flora; 4) sustainable development of fisheries areas, based on a bottom-up local development approach; 5) technical assistance”.

As another example, the eight *National Plans for trawling management* (covering the Italian seas), adopted by the MiPAAF in 2011, include measures to further limit the national fishing efforts, both in terms of allowed annual number of fishing days and fishing areas.²⁰⁸

2.7 Forests and forestry²⁰⁹

Adaptation in the forest sector in Italy is mainly related to the **protection of forests from wild fires**.

The MATTM, through the DPNM, developed the following initiatives for the protection of forests from fires:

- “*Framework law on forest fires*” (2000);²¹⁰
- Guidelines for sustainable forest management in State natural parks and reserves (2005);²¹¹
- Schemes for plans against forest fires for State natural protected areas (2002/2009);²¹²
- specific plans for State natural reserves;
- provision of scientific and technical support to planning the detection of wild fire in State protected natural areas and national parks of priority

²⁰⁸ MiPAAF Website, “[Decreto 20 maggio 2011 - Adozione Piani di gestione della flotta a strascico in sostituzione del decreto direttoriale n. 44 del 17 giugno 2010 - Gazzetta Ufficiale 5 luglio 2011 n. 154 - Suppl. Ordinario n. 163](#)”.

²⁰⁹ MATTM Website, “[Aree naturali protette - Attività antincendi boschivi](#)”.

²¹⁰ Italian Parliament “[Legge-quadro in materia di incendi boschivi](#)”.

²¹¹ MATTM Website, “[Linee guida per la gestione sostenibile delle risorse forestali e pastorali nei Parchi Nazionali](#)”.

²¹² MATTM Website, “[Schema di Piano A.I.B.](#)”.

intervention areas (including on-line GIS-bases cartography²¹³).

Awareness raising campaigns were also carried out and the organization of the national and regional fire prevention systems was improved.²¹⁴

Furthermore, the Ministerial Decree on “*Minimum criteria concerning good forestry practices*”, issued on 21 January 2010 by the MiPAAF for the purposes of the “forest payments”, is intended to compensate voluntary commitments for the mitigation of climate change, among others.²¹⁵

Research

Italy is involved in the following international project on managing the risk of wild fires and restoring landscapes under change:

- ***FUME – Forest fires under climate, social and economic changes***²¹⁶

²¹³ MATTM Website, “[Supporto tecnico-scientifico alla Pianificazione Antincendi Boschivi nelle Aree Naturali Protette Statali e individuazione nei Parchi Nazionali delle zone di intervento prioritario](#)”.

²¹⁴ Cecchi et al., 2007b.

²¹⁵ MiPAAF (2010) “[I criteri minimi concernenti le buone pratiche forestali ai fini dell'applicazione della misura «pagamenti silvo-ambientali»](#)”.

²¹⁶ The EU FP7 project **FUME** has adopted the following strategy to determine future fire regime and impacts:

- 1) “Documenting the recent past: it will assess how landscapes changed in the past and what influence these changes had on past fires in interaction with climate. Required are models of land-use land cover change and fire risk that can be projected under future scenarios of change;
- 2) Scenarios of change and future impacts: it will set up scenarios of change (socioeconomics, land-use and land-cover, vegetation and climate) following IPCC methodologies, including the forthcoming scenarios for IPCC-AR5. With these, and aided with results from 1, an assessment of the likely impacts on fire regime will be made. Modeling, complemented with field experiments, will evaluate future impacts on fire and on vegetation and landscapes. The assessment will comprehend current-, as well as new fire-areas, wild-land areas and the rural-urban interface (RUI). Extreme climatology will be a particular focus;
- 3) Adapting to change: once the range of future conditions are known, the capacity to cope with them will be

European project (2010-2013), based on a better quantification of future impacts on fire regime, it aims at assessing the coping capacity and future vulnerabilities of ecosystems and societies in Europe, the Mediterranean and other fire-affected areas of the world.

2.8 Human health

Efforts undertaken in the national health sector that are beneficial also for adapting to climate change are most developed in the field of **protection from the health effects of heat waves**, implemented mainly under the direction of the Department for Civil Protection and the Italian Ministry of Health.

Prevention of and response to heat health effects from heat waves²¹⁷

After the heat wave of summer 2003 which had serious impacts on the elderly population in different regions and municipalities, the health agencies took a number of actions to respond to the effects of heat waves. In order to provide a framework for the implementation of prevention plans at the local level, the Ministry of Health launched the *National Programme for the prevention*

evaluated focusing on how future risks can be reduced through preventive or reactive measures. The economic costs and policy implications of the expected changes will be analyzed;

- 4) Organizing the research and insuring the transfer of knowledge: FUME will use large amounts of data. This requires building a common data base. Further, a network of sites will be organized for model testing and validation. Bridging the gap of knowledge transfer, particularly with managers, more so from North Africa, will be realized by training and specific actions with users."

²¹⁷ Ministry of Health Website, "[Ondate di calore](#)"; Department for Civil Protection Website, "[Ondate di calore](#)".

of effects of heat waves on health,²¹⁸ with the technical support by the Department for Civil Protection. The main objective of this initiative is the implementation of a Heat Health Watch Warning System (HHWWS) and the national system of rapid detection of daily mortality.

Implemented adaptation actions and measures

- **National network of city-based Heat-Health Watch/Warning systems (HHWWSs)**,^{219 220} covering 34 cities (in February 2012), including:
 - daily mortality surveillance system;
 - *vulnerability registry*;
 - local action plans;
 - national working group of experts for the preparation of local surveillance and response plans and the vulnerability registry;
- **National Operational Plan for the prevention of the effects of heat on health**,²²¹ extending the city-specific

²¹⁸ Ministry of Health Website, "[Programma Nazionale per la prevenzione degli effetti sulla salute da ondate di calore - Estate 2011](#)".

²¹⁹ Ministry of Health Website, "[Sistema nazionale di previsione allarme](#)".

²²⁰ On the basis of a forecasting model, daily bulletins are disseminated to local administrations that are responsible for launching specific interventions on the population at risk. Ex-ante emergency planning and ex-post evaluation of the effectiveness of the system are also envisaged.

Operating from May 15 to September 15, the heat waves bulletins of cities and information on how to protect themselves from the effects of heat on health, are available in the [heat waves website](#) of the Ministry of Health.

For the year 2012 the national forecasting and warning system for the prevention of the effects of heat waves on the population is coordinated by the Ministry of Health. (From 2004, the date of activation, to 2011, the system has been coordinated by the Department of Civil Protection).

²²¹ Ministero della Salute (2005) "[Piano Operativo Nazionale per la Prevenzione degli Effetti del Caldo sulla Salute](#)".

forecasting systems, defining the mortality surveillance system and the local response plan and identifying the categories at risk (for the vulnerability registry) and the reference centres;

- 2006 “*Guidelines for preparing monitoring and response plans for the health effects of heat waves*”;²²²
- **Regional initiatives**²²³ against heat waves, including specific programs of active surveillance for co-infection HIV/leishmaniasis by Campania, Sicilia and Liguria, and measures concerning heat waves, depletion of the stratospheric ozone layer, vector-borne diseases, water and food quality, and pollen species by Emilia-Romagna.

Awareness raising initiatives

- *Ministry of Health* [HEAT LAB](#) Website (2004), providing an overview of practical local experiences to facilitate the exchange of knowledge between stakeholders;
- *Ministry of Health Social Guardians Service* (2004-2006) pilot project in four large cities,²²⁴ to verify the effectiveness of the assistance model of the “social guardian”;
- “*For a safe summer*” initiative, disseminating information and

recommendations to the citizens,²²⁵ including a National Call Centre Service,²²⁶ booklets²²⁷ for advice and special TV programmes.

Research

Research on adaptation to heat waves in Italy includes epidemiologic studies carried out:

- by *Istituto Superiore di Sanità*'s Office of Statistics, in order to calculate the excess mortality due to the summer 2003 heat wave;
- in the context of the international *cCASHh – Climate Change and Adaptation Strategies for Human Health in Europe*²²⁸ project (2001-2004), investigating some of the many ways in which climate change could affect health and how the environment and health sector can adapt.

2.9 Water and hydro-geological system

Adaptation in the water sector in Italy mainly covers initiatives addressing **water scarcity and drought** and the **hydro-geological risks**.

Water scarcity and drought²²⁹

The projected increase of drought frequency and water scarcity, especially localized in the South of the country, are very high on the

²²² Ministero della Salute - CCM (2006) “[Linee guida per preparare piani di sorveglianza e risposta verso gli effetti sulla salute di ondate di calore anomalo](#)”.

In 2006, the *National Centre for prevention and monitoring of diseases (Centro nazionale per la prevenzione e il controllo delle malattie – CCM)* of the *Italian Ministry of Health* started a national prevention program for the definition of heat health effects. It involves all the cities where warning system are operating and it is aimed at identifying susceptible populations, defining the local network for the distribution of warning bulletins, review and provision of local and national guidelines.

²²³ Ministry of Health Website, “[Piani operativi locali](#)”.

²²⁴ Roma, Torino, Milano and Genova.

²²⁵ Ministry of Health Website, “[Linee guida e raccomandazioni](#)”.

²²⁶ Ministry of Health Website, “[Attivo dal 20 giugno 2012 il Numero verde 1500 ‘Estate sicura, come vincere il caldo’](#)”.

²²⁷ Ministry of Health Website, “[Archivio Opuscoli](#)”.

²²⁸ The *cCASHh* Web site is not available anymore; results of the *cCASHh* project are reported in Menne, B.; Ebi, K. L. (Eds.) (2006) “[Climate Change and Adaptation Strategies for Human Health](#)”.

²²⁹ EEA, 2007.

policy agenda. Such issues are driving the development of suitable responses in combination with the other components of EU water regulation.²³⁰ Implemented initiatives include the following:

- according to the (2000) EU *Water Framework Directive* (WFD), Italy issued **water emergencies regulations to address water crises**, providing both technical and financial support for emergency measures;²³¹
²³²
- the Council of Ministers approved “*Practical guidelines to deal with possible water crises*” in March 2007, that provide indications for all the authorities involved in water management for undertaking monitoring and appropriate enforcement activities;²³³
- *ad hoc organizations for crisis management* were established in order to regulate the use of water and take the necessary measures to prevent water crises, like a “*Drought control room*” for drought events in the Po River basin, and a “*Coordination Unit for the management of water resources*” shared between Puglia and Basilicata Regions;
- a number of national **structural funds** include support to irrigation networks as well as drinking-water distribution networks, not only for water emergencies.

- with reference to **cohesion funds**, Italy runs a water programme, that includes the provision of information for water crisis prevention.

In addition, national initiatives in other sectors also serve the purpose of water resources conservation, like the following:

- the *National Plan for irrigation*, involving water management and allocating *specific funds* to tackle the effects of extreme hydro-meteorological events including droughts; since November 2008, the new RDPs introduced adaptation to the effects of climate change among their priorities, including water related issues;
- the *NAP* and 10 *LAPs* to combat drought and desertification.

Local initiatives exist at the river catchment level:

- the **River Basin Management Plan of the Po River catchment** adopted in 2010 and approved in 2013²³⁴ aims, among other objectives, at the identification of shared strategies for water management and adaptation to climate change;²³⁵
- the Watershed Authority of the **Arno River Basin** took into account climate change impacts in **mapping flood hazard and risk in support to river Basin planning** (pursuant to Directive

²³⁰ EEA, 2007.

²³¹ [Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.](#)

²³² MATTM Website, “[Attuazione della Direttiva Quadro sulle Acque \(2000/60/CE\)](#)”.

²³³ Gaudioso & Masullo, 2009.

²³⁴ Website of Autorità di Bacino del fiume Po: “[Il Consiglio dei Ministri approva il Piano di Gestione del distretto idrografico del fiume Po](#)”;

Decreto del Presidente del Consiglio dei Ministri (DPCM) (8 February 2013) “[Approvazione del Piano di Gestione del distretto idrografico Po](#)”.

²³⁵ Autorità di bacino del fiume Po, 2010.

2007/60/EC on flood risks assessment and management).²³⁶

hydrological, geological and geomorphological data.²³⁹

Hydro-geological risks

Legal frameworks

National legislation that set the context for the protection from the risk of landslides and river floods include the following:

- Law 267/1998, also known as *Legge Sarno*,²³⁷ as the main legal mechanism involving the implementation of **hydro-geological protection**, in line with the WFD requires the authorities responsible for hydrological basins management to detect risk areas, set up prevention plans and establish regulations to avoid additional risk due to anthropogenic factors; this is also the legal basis for the identification and funding of urgent preventive measures;
- 2004 “*Prime Minister Directive*”²³⁸ provides operational guidelines for the organizational and functional management of the national and regional warning systems for the hydro-geological and hydraulic risks, for the purpose of civil protection; it requires the establishment of an **integrated warning system at the national and regional level**, based on the activities of *functional centres* devoted to the collection, processing and assimilation of climate-related,

Implemented adaptation actions and measures

The main **activities** coping with the hydro-geological risks are implemented at the national level by the Department of Civil Protection, including:²⁴⁰

- **monitoring of hydro-pluviometric data and water availability**, in order to anticipate possible future critical situations, in collaboration with Regional and Watershed Authorities;
- establishment (in January 2007) of a **technical-scientific group of key national experts in seasonal weather forecasting and climatology** with the aim to update the scenarios for the next three-month period;
- managing, in accordance with the Regional governments, the **network** of functional centres, regional structures and competence centres for the collection, monitoring, and sharing of weather, hydro-geological and hydraulic data (the **National System for early warning and monitoring**), a key support tool for decision-making for civil protection and warning for hydro-geologic and hydrologic risks;
- promotion, financing and coordination of technical and scientific initiatives aimed at widening knowledge base on extreme weather events and their application to the development of **early warning, evaluation and real-time monitoring tools**;

²³⁶ Distretto Appennino Settentrionale Website: “[Predisposte le mappe di pericolosità e rischio alluvioni per il bacino dell’Arno](#)”.

²³⁷ Named after the major mud-flow event in Sarno area in May 1998.

²³⁸ Protezione Civile “[Direttiva 27 febbraio 2004: indirizzi operativi per la gestione del sistema di allertamento nazionale per il rischio idrogeologico e idraulico](#)”.

²³⁹ Protezione Civile Website, “[Hydro-geological risk](#)”.

²⁴⁰ Protezione Civile Website, “[Hydro-geological risk](#)”.

- implementation of a **national Radar Plan for nowcasting**.

Research

The main research initiatives on adaptation to climate change in the water sector in Italy include the ones conducted under the following international projects:

- **CLIMWATADAPT** - *Climate Adaptation - Modelling water scenarios and sectoral impacts*²⁴¹ project (2010-2011) addressing *inter alia* vulnerability assessment and potential key adaptation measures assessment;
- **TRUST** - *Tool for regional scale assessment of groundwater storage improvement in adaptation to climate change*²⁴² project (2009-2011) addressing *inter alia* the development of adaptation strategies for the ground water as well as of innovative actions to stop the slow but progressive decline of the level of ground water of the Veneto and Friuli-Venezia Giulia regions.

²⁴¹ The [CLIMWATADAPT](#) project aimed at “assessing both vulnerability to climate change impacts and adaptation measures with a specific focus on water, providing the basis for the identification of adaptation measures to be either promoted at EU level. Project results include models, frameworks, scenarios and tools for decision support; the assessment of vulnerability and key adaptation measures are also addressed”.

²⁴² The general objectives of the [TRUST](#) project include:

- “development of adaptation strategies for the ground water of the Veneto and Friuli regions;
- development of innovative actions to arrest the slow but progressive decline of the level of ground water in Veneto and Friuli regions;
- creation of a group of stakeholders for the management of water in Friuli and Veneto regions;
- increasing the knowledge of the effects of climate change on ground waters”.

2.10 Infrastructure and economy²⁴³

Some examples of adaptation actions are provided per sector of socio-economic relevance.

Energy

The promotion of solar energy as a viable alternative energy source started in Italy in February 2007.²⁴⁴

Tourism

Among the implemented adaptation measures in the infrastructure and economy sector it is worth mentioning the ones existing for **winter tourism**. **Artificial snowmaking systems** are still the most applied response of the Italian winter tourism industry to the decrease in the snow-reliable ski zones. About 77% of Italian ski areas are already covered with artificial snow, reaching 100% in Friuli-Venezia Giulia and Alto Adige regions. However this kind of intervention has high costs and it is not considered a sustainable option due to energy consumption, water resources use, installation and maintenance.

New and promising business models, including both snow-related and non snow-related offer (health tourism, congress tourism, other sports and popular activities, etc.) have been developed to some extent, leading to the diversification of winter tourism revenue.

²⁴³ Carraro et al., 2008.

²⁴⁴ Gaudioso & Masullo, 2009.

Transport services and infrastructure

The motorway authority of the “Milano Serravalle” infrastructure network, serving the territory of Milan and Lombardia region with more than 180 km of highways, has been considering climate change related flood risks in revising the design criteria for the crossing of watercourses.²⁴⁵

Urban settlements

As to the urban sector, some Provinces, Cities and Municipalities started addressing adaptation to climate change mainly through the implementation of urban adaptation planning initiatives, the development of guidelines for climate change adaptation for urban systems and the drafting of their adaptation plans and strategies.

The following ones are reported as good practice examples.

Local Adaptation Plan of Ancona Municipality

In the framework of the European project LIFE ACT,²⁴⁶ the Municipality of Ancona²⁴⁷ applied a participatory model for the development of its *Local Adaptation Plan* (LAP) to climate change. The LAP was defined by the Municipality in close collaboration with the *Local Adaptation Board* (LAB), consisting of key stakeholders from the most vulnerable areas as identified by the local climate change impacts assessment carried out within the project. The methodology on which the LAP is based was defined by ISPRA and designed in such a way

to ensure its transferability to other European cities. The peer review evaluation of the project results is currently underway, in order to define guidelines that could be used by other local authorities interested in developing a plan for local adaptation.²⁴⁸

Adaptation Action Plan of the Genova Province

The Genova Province (Liguria region) implemented a series of initiatives on climate change adaptation under the GRaBS project.²⁴⁹ Within this framework advanced methods of planning for new urban settlements, both residential and public, were developed based on the principles and methods of environmental protection. Also, best practices on urban green spaces were defined and a tool for climate change risks and vulnerability assessment of the territory (as a planning support tool to adapt to climate change) was produced. The involvement of local stakeholders and citizens was a core pillar of the project.²⁵⁰ In particular, Genova developed an *Adaptation Action Plan* for its Province.²⁵¹ The plan aims *inter alia* at addressing in practice the natural vulnerability of the territory that might be worsened by climate change, through planning strategies which increase the land natural defences. This includes innovating the design criteria for the urban space in order to harmonize the development needs of the region with the principles of environmental sustainability in the context of adaptation to climate change (e.g. by promoting “green and blue”

²⁴⁸ Comune di Ancona “[Un progetto su Piani partecipati di adattamento ai cambiamenti climatici](#)”.

²⁴⁹ EU Interreg IV C [GRaBS - GRaBS - GRaBS](#) - *GRaBS - GRaBS - GRaBS* adaptation for urban areas and eco towns. “The GRaBS project is a network of leading pan-European organisations involved in integrating climate change adaptation into regional planning and development.”

²⁵⁰ Provincia di Genova – Turismo, 2011 “[GRaBS](#)”.

²⁵¹ EEA, 2012b.

²⁴⁵ EEA ETC/CCA, 2013.

²⁴⁶ EC LIFE Project [ACT](#) - *Adapting to climate Change in Time*.

²⁴⁷ <http://www.actlife.eu/EN/project-partners/municipality-of-ancona.xhtml>

infrastructures i.e. the water and vegetation components as primary elements of thermoregulation and ecological continuity).²⁵²

Bio-neighbourhood incentive programme for developers” of Faenza Municipality²⁵³

In order to respond to current high temperatures as well as to prepare for coping with future possible increasing temperatures related to climate change, the Municipality of Faenza implemented an “incentive programme for developers” embedded in the urban planning regulations. The aim of the initiative is to deploy synergic measures for climate change adaptation and mitigation, improving the quality of life and attractiveness of the town while pursuing development needs.

For this purpose, the incentive programme authorises possible additional building capacity with respect to the approved standards for buildings having distinctive features of environmental sustainability. The flexible building development conditions are agreed upon by the town authorities with the developers on a case-by-case basis, thus considerably accelerating the traditional process of releasing building permissions.

“Sustainable Cities” and Local Agenda 21 guidelines for “local adaptation action plans of urban systems to climate change”

In 2011 the “Sustainable Cities” Working Group in collaboration with the Coordination of Italian Local Agenda 21 developed ***draft guidelines for “local adaptation action plans***

²⁵² Provincia di Genova – Turismo (2011) “[Progetto Eu “GRaBS”: i cambiamenti climatici e l’adattamento dei piani](#)”.

²⁵³ “[Faenza: Extra cubature for developers in return for green space](#)”. In Kazmierczak & Carter, 2010.

of urban systems to climate change”.²⁵⁴ The document aims at facilitating the integration of mitigation and adaptation actions in local planning for resilient cities and territories in Italy. The identified areas of intervention include: spatial planning (land use and territorial government); prediction, reduction and management of land vulnerability (hydro-geological assets); adapting urban planning, settlements and buildings; water cycle (conservation of resources and quality); multifunctional urban green spaces; health, social services and civil protection. The document was prepared also based on the outcomes of two National workshops related to adaptation to climate change for the urban environment organized by the above mentioned network. A national survey of best practices in Italian urban and regional planning was also launched, with the aim to support the process of adapting the territories and cities to climate change.²⁵⁵

Research

Research on urban adaptation to climate change in Italy includes the ones carried out under the following international projects:

- ***ACT - Adapting to Climate change in Time***²⁵⁶ project (2010-2012)

²⁵⁴ Città sostenibili; Coordinamento Agende 21 Locali Italiane (2012) “[Documento di indirizzo del Coordinamento Agende 21 locali italiane per i Piani di azione Locale di adattamento dei sistemi urbani al cambiamento climatico](#)”.

²⁵⁵ Comune di Modena “[Città Resilienti – L’adattamento delle città e dei territori al cambiamento climatico in atto](#)”.

²⁵⁶ The main objective of the (Life Environment) ***ACT*** project is “developing a process able to draw and implement an effective municipal strategy for local climate change adaptation, easily applicable to a wide range of local authorities. This is achieved by involving (thus increasing their awareness) local actors (local industries, citizens, the health system, civil protection, etc.) in the development of the local adaptation strategy in a consultation process determining appropriate and cost-effective adaptation measures. A key feature of the project is the development and dissemination of guidelines potentially encouraging other European communities (in particular in the Mediterranean basin) to adopt the same process and to develop their own local adaptation strategies”.

supporting local authorities, in particular the ones of the European cities in the Mediterranean basin (carried out in Italy by the Municipality of Ancona) in developing a concerted Local Adaptation Strategy to increase the city resilience to climate change, taking into account environmental, social and economic impacts of climate change;

- ***UHI - Urban Heat Island***²⁵⁷ project (2011-2014) aiming at developing strategies to mitigate, adapt to, prevent and manage the risks related to the urban heat island phenomenon, involving agencies, departments and directorates of Emilia-Romagna and Veneto Regions. The areas of intervention are the metropolitan cluster of Bologna–Modena and the urban corridor of Venezia–Padova. In this context the Veneto Region organized an international Conference on climate adaptation in urban areas (Venice, 23-24 May 2013);²⁵⁸
- ***CHAMP - Local Climate Change Response*** project²⁵⁹ (2009-2012)

aimed at training and supporting local and sub-regional authorities in implementing an integrated management system for climate change mitigation and adaptation, and to promoting the model European-wide;

- ***EU Cities Adapt - Adaptation Strategies for European Cities***²⁶⁰ project (2012-2013). Three Italian cities ([Alba](#), [Padova](#) and Ancona) were selected to participate to the training and capacity building phase for ***developing and implementing an adaptation strategy***. In particular, within the project, Ancona is considered a “peer city” that is advanced in its adaptation process and will support the other “starting cities”.

2.11 Feasibility study for the Abruzzo region²⁶¹

At the regional level, the Abruzzo Regional Government and ENEA set up a joint project aimed at providing the information necessary to identify the most vulnerable environmental and socio-economic sectors for the Abruzzo Region to expected climate change in support of adaptation planning, titled: ***Feasibility study for the assessment of climate change impacts and vulnerabilities for the Abruzzo region and possible adaptation actions***”.

²⁵⁷ The [UHI](#) project is here relevant to the extent that “the UHI effects are directly related to - and worsened by - climate change: an increase of the average temperature is expected to have “a stronger and immediate effect on the health of people living in cities, and particularly in weak categories (diseased and aged citizens, etc.)”.

²⁵⁸ Veneto region “[Il clima cambia le città](#)”.

²⁵⁹ The [CHAMP](#) project activities include the following actions:

1. “the creation of focused and up-to-date content and methods for capacity development for local and regional governments “Towards an integrated management response to climate change in EU27”;
2. the demonstration of training capacity in four EU Member States (Finland, Germany, Hungary and Italy) through the establishment of National hubs for training and support of IMS to the local level;
3. carrying out pilot capacity development programmes on integrated management for local and sub-regional authorities in four EU Member states with a specific focus on climate change;
4. development and implementation of a training module for third parties and especially EMAS competent bodies and EMAS auditors;

5. development of EU27 wide network structures including cities, regions and organizations working with integrated management;
6. dissemination, awareness raising and promotion of project experiences on a European and regional level”.

²⁶⁰ The [EU Cities Adapt](#) project is being carried out for EC DG CLIMA to “provide capacity building and assistance for cities in developing and implementing an adaptation strategy.”

²⁶¹ ENEA, 2011.

This collaborative effort led to an evaluation of critical situations in the various sectors and to the formulation of possible working hypotheses concerning regional adaptation actions, with a focus on four themes, based on the available climate change knowledge and on the geo-morphological, meteorological, climatic and economic features of the region: 1) coastal marine environment, 2) coastal zone, 3) mountain area, and 4) production activities.

This feasibility study can be considered a **cutting-edge action in Italy** as it aimed at identifying technical, scientific, methodological, procedural and public elements needed to tailor the methodologies and procedures put forward by the United Nations (IPCC and UNEP) to the Italian context for the identification of adaptation options. The ultimate goal includes building a field-tested prototype that could be taken up as a reference method for analysis of climate change adaptation at the national level.

2.12 Cost of adapting to climate change²⁶²

With respect to measuring the potential cost of adapting to climate change at the national scale, only the already mentioned **early joint effort by FEEM-ISPRA-CMCC can be reported.**²⁶³ This study covers a few specific adaptation measures that have been explored or undertaken in four vulnerable areas: the Alps and glacier ecosystems, coastal zones, arid areas and areas threatened by desertification, and zones prone to floods and

landslides. Some of the main conclusions of this study are reported hereunder.

Alps and glacier ecosystems

Despite a lack of comprehensive economic evaluations over the Italian Alpine zones, some estimates for adjusting the tourism industry to climate change were performed. The most common adaptation strategy regards artificial snowmaking for **winter tourism**; however, this kind of intervention implies high costs linked to energy consumption, water resources use, installation and maintenance and it is therefore not considered a sustainable adaptation option.

Coastal zones

Economic assessments of coastal adaptation measures do not exist in Italy, with the exception of very specific issues (e.g. MO.S.E. project in the Venice lagoon). According to the estimates by the PESETA project, **damages due to sea level rise** could amount to EUR 9-42 billion/year, depending on the sea level scenario. In addition, adaptation could reduce the costs of adverse climate change impacts in the possible range of 7% - 50% in the medium run and up to 70% in the long period.

Areas threatened by desertification

At present, there are no available estimates for Italy concerning the adaptation costs related to drought and desertification. This is mainly due to the overall lack of scientific literature on the phenomenon as well as to some specific features of it, that hamper the identification of measures to combat desertification and their economic assessment.

²⁶² Carraro, 2008.

²⁶³ Carraro, 2008.

Zones prone to floods and landslides

Urgent measures financed by Italy until 2006 for the hydro-geological risk amounted to EUR 447.36 million for flood risk and EUR 667.88 million for landslide risk. These

figures could give an idea of the costs needed for the defence of the Italian territory from hydro-geological disasters. Nevertheless, they do not represent at all the cost of protection in the light of the increased risk associated with climate change.

Examples of cost estimates of inaction and adaptation²⁶⁴

The following table shows other available examples of cost estimates of inaction and adaptation.

Sector	Climate scenario	Impact	Cost of inaction	Adaptation measure	Adaptation cost	
Coastal areas	IPCC A2 in 2085	Loss of land due to flooding and erosion equal to 0.6% of the national territory	N.A.	Dams and beach nourishment	0.006% of GDP (EUR 432 M) calculated in 2085 ²⁶⁵	
	IPCC A1B in 2050	Loss of land due to flooding and erosion equal to 0.7% of the national territory	0.18% (EUR 6.34 bn) induced GDP loss calculated in 2050 ²⁶⁶	N.A.	N.A.	
	Area: Fondi Plain (in Lazio region)					
	1m sea level rise in the period 2002-2100	N.A.	EUR 131-270 M (total discounted at 3% in the period 2002-2100)	Improvement of irrigation and draining systems	EUR 50-100 M ²⁶⁷	
	Area: City of Venice					
60 years (10 for construction + 50 for operation)	N.A.	EUR 1.5-3.4 bn (calculated over 60 years with 5-3% discount rate respectively)	System of mobile barriers	EUR 1.7-2 bn (calculated over 60 years with 5-3% discount rate respectively) ²⁶⁸		
Hydro-geological instability	IPCC A1B in 2050	Loss of agricultural land and infrastructures due to floods only	EUR 1.6 bn/year in 2050 of direct costs (equivalent to three times the losses compared to the current climatic conditions and level of protection) ²⁶⁹	N.A.	N.A.	

²⁶⁴ Courtesy of Francesco Bosello (CMCC), 2013.

²⁶⁵ Bosello et al., 2012; PESETA Project.

²⁶⁶ Vafeidis et al., 2008; CIRCE Project.

²⁶⁷ Gambarelli & Gorla, 2004.

²⁶⁸ “*Aspetti economici del progetto delle barriere mobili*” of the [M.O.S.E](#) Project.

²⁶⁹ Flörke et al., 2011.

	IPCC A1B in 2050	Loss of agricultural land and infrastructures due to floods only	EUR 457 bn/year in 2050 of GDP induced impacts (equivalent to triple losses compared to the current climatic conditions and level of protection) ²⁷⁰	N.A.	N.A.
	N.A.	N.A.	N.A.	Various	EUR 44 bn ²⁷¹
Agriculture	+2°C +4°C	-9.3% and -23% yields reduction (for +2°C and +4°C respectively)	EUR 13-30 bn/year in 2050 (value of the lost production) ²⁷²	N.A.	N.A.
	IPCC A2 in 2100	Yields reduction	EUR 87-162 bn in 2100 (land value depletion) ²⁷³	N.A.	N.A.
Tourism	+2°C +4°C	-6.6% and -8.9% reduction net balance international arrivals national tourism due to less attractive climate in 2050 (for +2°C and +4°C respectively)	0.25% (EUR 8 bn) and 1.05% (EUR 44 bn) induced GDP loss calculated in 2050 ²⁷⁴	N.A.	N.A.

*Table 3. Examples of cost estimates of inaction and adaptation*²⁷⁵

²⁷⁰ Flörke et al., 2011.

²⁷¹ Courtesy of Francesco Bosello (CMCC) on "Piani di assetto idrogeologico (PAI)".

²⁷² Courtesy of Francesco Bosello (CMCC).

²⁷³ Van Passel et al., 2012.

²⁷⁴ Courtesy of Francesco Bosello (CMCC).

²⁷⁵ Courtesy of Francesco Bosello (CMCC), 2013.

2.13 Cooperation in preparing for adaptation²⁷⁶

Italy participates to a variety of EU-funded projects on climate change adaptation, as reported in the previous paragraphs of this Section for each sector.

Numerous European trans-boundary initiatives have also been undertaken in the context of the **Alpine Convention**.

In addition, several bilateral and multilateral **initiatives (projects and programmes)** were funded for climate change research on impacts, adaptation and mitigation, including *capacity building* activities in developing countries, through the financial resources provided by the *Italian Ministry of Foreign Affairs* and the MATTM. The objectives of these initiatives are various and ambitious. They include, among others: efficient use of energy, implementation of innovative financial mechanisms, efficient water management, carbon sequestration, professional training and exchange of know-how, promotion of eco-efficient technologies, and aerosol monitoring.

MATTM's cooperation initiatives on climate change adaptation with industrialized countries as well as with developing countries in support of **technology transfer** (in the period 2006-2008) include: multilateral cooperation on climate change, bilateral cooperation with developing countries and scientific and technological cooperation.

²⁷⁶ MATTM, 2009.

2.14 Summary of adaptation initiatives in Italy

Vulnerable area	Vulnerability	Reported implemented adaptation initiatives
Agriculture and food security	Water scarcity leading to crop yield reduction	<ul style="list-style-type: none"> • <i>National Plan for irrigation</i> in support of the agricultural sector • MiPAAF (2011) <i>White Paper on rural development and climate change</i>, aimed at increasing the resilience of the agricultural sector to climate change
	Extreme weather events, pest damages, forest loss, forest fires leading to sudden loss of crops, water scarcity causing yield decline	<ul style="list-style-type: none"> • <i>National Strategic Plan for Rural Development and 21 regional Rural Development Programmes (RDs) 2007-2013</i>, with activities targeted at water management efficiency improvements in irrigation infrastructures and enhancement in the capacity to store water, conservation of plant and animal species and preventive actions against extreme weather events • A single funding system since 2010, supporting: <ul style="list-style-type: none"> – the costs of insurance premiums covering the risks of climate change on crop production, animal diseases in livestock, diseases and pest infestations of plants – the costs of insurance for wine grapes crops – preventive measures to cope with the damage to agricultural production and livestock, farm structures, production facilities and rural infrastructures in areas affected by natural disasters or exceptional events.
	Overall climate change vulnerability of the agriculture sector	<p>Scientific research</p> <ul style="list-style-type: none"> • <i>AgroScenari - Adaptation scenarios of Italian agriculture to climate change</i> programme (2008-2012) • <i>CLIMESCO - Evolution of cropping systems as affected by climate change</i> project (2006-2010) • <i>SOILSINK - Climate change and agricultural and forestry systems: impact on the carbon reservoirs and on the soil microbic diversity</i> project (2006-2010) • <i>Climagri – Climate change and agriculture</i> project (2001-2004) • <i>Icarus – IWRM for Climate Change Adaptation in Rural Social Ecosystems in Southern Europe</i> international project (2010-2012)
Biodiversity and ecosystems	Overall biodiversity reduction	<p><i>National Biodiversity Strategy 2011-2020</i>, for biodiversity protection by and beyond 2010, including adaptation to climate change.</p> <ul style="list-style-type: none"> • Strategic aim: reducing substantially the impact of climate change on biodiversity by 2020, by defining appropriate measures of adaptation and mitigation, as well as by increasing the resilience to climate change of natural and semi-natural ecosystems. • Adaptation measures to be implemented: actions aimed specifically at keeping the range and variability of ecological habitats and species, favouring the spread of species into new habitats favourable, maintaining the existing ecological networks, and controlling the spread of invasive species.
	Conservation and management of fauna and flora	<p>Initiatives for the protection of species and habitats:</p> <ul style="list-style-type: none"> • International Conventions, Agreements and Protocols • national initiatives (legal frameworks, Action Plans and Guidelines, publications and databases) concerning terrestrial and marine protected areas, national parks, landscape, terrestrial fauna and flora, and actions for limiting the impacts of alien invasive species. • <i>Nature 2000</i> Network of protected terrestrial and marine sites • <i>LIFE+ programme</i> (14 specific new projects for biodiversity protection in 2008).

	Natural hazards and overall climate change vulnerability of the Alpine space	Scientific research <ul style="list-style-type: none"> • <i>AdaptAlp - Adaptation to climate change in the Alpine Space</i> project (2007-2013) • <i>ClimChAlp - Climate change, impacts and adaptation strategies in the Alpine Space</i> project (2006-2008) • <i>STRADA - Climate change adaptation strategies for the management of natural hazards in the trans-boundary areas</i> project (2010-2013)
Coastal zones	Flooding from sea level rise and extreme events, coupled with coastal erosion and subsidence, anthropogenic pressures and fragmentation of institutional competences, saltwater intrusion in the coastal aquifer waters	<ul style="list-style-type: none"> • Implemented measures: traditionally coastal defence measures, behavioural strategies, managerial interventions, political decisions • National level: on-going institutional coordination by MATTM towards the development of a National Strategy on Integrated Coastal Zone Management (ICZM) and relative Plans, Programmes or Guidelines. • Regional level: some Italian Regional Governments have already started approaching the ICZM (e.g. Emilia-Romagna and Marche (2005) and Liguria (2002), with the adoption of instruments having reference to the ICZM; Toscana, Lazio, Abruzzo and Sardegna with testing activities of the ICZM approach or plans for land protection and spatial planning).
	Coastal erosion, alteration of marine and coastal ecosystems	Scientific research <ul style="list-style-type: none"> • INTERREG IIIC Beachmed-e <i>MedPlan</i> (2005-2008) subproject • <i>MEDCOAST</i> network • <i>COASTANCE - regional COmmon Action STrategy Against Coastal Erosion and climate change effects for a sustainable coastal planning in the Mediterranean basin</i> project (2009-2012) • <i>MedLab - Mediterranean Living Lab for Territorial Innovation</i> project (2009-2011) • <i>EMMA - Environmental Management through Monitoring and Modelling of Anoxia</i> project (2004-2007) • <i>SHAPE - Shaping an Holistic Approach to Protect the Adriatic Environment between coast and sea</i> project (2011-2014) • <i>CAMP - Coastal Area Management Programme Italia</i> project (2009) • <i>VECTOR - VulnErability of the Italian coastal area and marine Ecosystems to Climatic changes and Their rOlE in the Mediterranean caRbon cycles</i> project (2006-2009)
Areas at risk of drought and desertification	Prolonged periods of drought, run-off erosion (due to increased intense precipitations and floods), erosion caused by dryness, salinization and nutrients loss (due to decreasing precipitations and increasing droughts), increased fire frequency and severity.	Fight against drought and desertification <ul style="list-style-type: none"> • <i>National Committee to combat drought and desertification</i> (1997) • <i>National Action Plan (NAP) to combat drought and desertification</i> (1999) • 10 Local Action Plans (LAPs) to combat drought and desertification: Campania (2010), Liguria (2010), Toscana (2010), Emilia-Romagna (2009), Puglia (2008), Sardegna (2008), Calabria (2008), Abruzzo (2007), Basilicata (2007), Sicilia (2007) • 6 Regional Pilot Projects to combat drought and desertification: Abruzzo (2010), Piemonte (2010), Sardegna (2009), Sicilia (2009), Calabria (2009), Puglia (2008) • Methodological and operational report: MATTM (2009) “<i>Good practices for combating desertification</i>”, for the identification of good practices for combating desertification.
	Soil degradation and instability	<i>Rural Development Programmes (RDPs) 2007-2013</i> , including actions aimed at protecting soil and restoring its stability
	Desertification	International scientific research <ul style="list-style-type: none"> • <i>MEDALUS - Mediterranean Desertification and Land Use</i> project

		<p>(1991-1999)</p> <ul style="list-style-type: none"> • DISMED - Desertification Information System for the Mediterranean project (2000-2003) • DesertWatch project (2004-2006)
Fisheries and aquaculture	Combination of climate change and anthropic pressure on fisheries	MiPAAF (2007) Operational Programme for the Italian fisheries sector for the period 2007-2013, on sustainable management of fisheries.
Forests and forestry	Risk of forest fires and related biodiversity loss	<p>Protection of forests from wild fires</p> <ul style="list-style-type: none"> • (2000) Plan for the State natural parks and reserves • (2002) Scheme for plans against forest fires for the State natural protected areas • (2006) Specific plan for the State natural reserves <p>Technical-scientific support to the forests managers.</p> <p>International scientific research</p> <ul style="list-style-type: none"> • FUME – Forest fires under climate, social and economic changes project (2010-2013)
Human health	Summer heat waves	<p>Prevention of and response to heat health effects from heat waves</p> <ul style="list-style-type: none"> • National network of city based Heat Health Watch Warning Systems (HHWWSs) covering 34 cities in Feb. 2012, with <ul style="list-style-type: none"> – <i>Daily mortality surveillance system</i> – <i>Vulnerability registry</i> – <i>Local Action Plans</i> – <i>National working group of experts for the preparation of local surveillance and response plans and of the Vulnerability registry</i> • Heat Health Prevention National Operative Plan • Regional initiatives against heat waves <p>Dissemination of information</p> <ul style="list-style-type: none"> • HEAT LAB website • Social Guardians Service project • For a safe summer communication initiative <p>Scientific research</p> <ul style="list-style-type: none"> • Epidemiologic studies • cCASHh - Climate Change and Adaptation Strategies for Human Health in Europe project (2001-2004)
	Risk of spreading of vector-, water- and food-borne diseases	<p>Regional initiatives</p> <ul style="list-style-type: none"> • Specific programs of active surveillance for co-infection HIV/leishmaniasis (e.g. Campania, Sicilia and Liguria) • Surveillance and monitoring of the increase of pathogenic agents in water, of a possible alteration of water and food quality, of the increase of the vectors of some diseases and monitoring of various pollen species (e.g. Emilia-Romagna).
	Depletion and delayed recovery of the ozone layer	Regional Initiatives: monitoring of the increase in concentrations of air pollutants, including ozone (e.g. Emilia-Romagna)
Water and hydro-geological system	Water scarcity and increased drought frequency, also inducing competition for available resources	<p>Management of water emergencies/crisis</p> <ul style="list-style-type: none"> • National water emergencies regulations providing technical & financial support for addressing water crisis • Ad hoc organizations for crisis management, e.g. <ul style="list-style-type: none"> – Drought control room for drought events in the Po River basin – Coordination Unit for the management of water resources shared between the Puglia and Basilicata regions. <p>Water management</p> <ul style="list-style-type: none"> • Irrigation and drinking water networks (structural funds)

		<ul style="list-style-type: none"> • <i>Water programme</i> (cohesion funds) • National plan for irrigation (agriculture) • <i>Specific funds for droughts, National Action Plan (NAP) and 10 Local Action Plans (LAPs) to combat drought and desertification</i> (drought) • <i>River Basin Management Plan</i> of the Po River catchment • Arno River Basin Authority <i>mapping of flood hazard and risk</i> in support to river Basin planning.
	Increased hydro-geological risk (floods, landslides)	Management of hydro-geological risk <ul style="list-style-type: none"> • National legislation <ul style="list-style-type: none"> – <i>Legge Sarno</i> (Law 267/1998), for the implementation of hydro-geological protection – <i>Government directive</i> (27 Feb. 2004), for the prediction and prevention activities, and the establishment of an integrated warning system at the national and regional level. • Civil protection activities <ul style="list-style-type: none"> – Monitoring of hydro-pluviometric data and water availability – Monthly updating of scenarios for the next three-month period by a technical-scientific group – Network of Functional Centres for data assimilation, and processing – Widening knowledge base on extreme weather events and its application to early warning and monitoring tools – National Radar Plan for nowcasting.
	Floods, droughts, water scarcity and cross-sectoral vulnerabilities. Reduction of quality and quantity of groundwater resources	International scientific research <ul style="list-style-type: none"> • CLIMWATADAPT - Climate Adaptation – Modelling water scenarios and sectoral impacts project (2010-2011) • TRUST- Tool for regional scale assessment of groundwater storage improvement in adaptation to climate change project (2009-2011)
Infrastructure and economy	Snow-cover reduction and decreasing length of winter touristic season	Winter tourism adaptation Artificial snow-making systems (covering 77% of Italian ski areas) Diversification of tourism supply.
	Urban environment vulnerabilities worsened by climate change	Implemented initiatives <ul style="list-style-type: none"> • Municipality of Ancona <i>Local Adaptation Plan</i> • Genova Province <i>Adaptation Action Plan</i> • Faenza Municipality “<i>Bio-neighborhood incentive programme for developers</i>” • “Sustainable Cities” and Coordination of Italian Local Agenda 21 guidelines for <i>Local adaptation action plans of urban systems to climate change</i> • Emilia Romagna and Veneto Regions <i>strategies to mitigate, adapt to, prevent and manage the risks related to the urban heat island phenomenon</i> (under development) International scientific research <ul style="list-style-type: none"> • ACT - Adapting to Climate change in Time project (2010-2012) • UHI - Urban Heat Island project (2011-2014) • CHAMP – Local Climate Change Response project (2009-2012) • EU Cities Adapt - Adaptation Strategies for European Cities project (2012-2013)

Table 4. Summary of adaptation initiatives in Italy

3 Annexes

3.1 ESAI Index for Italy

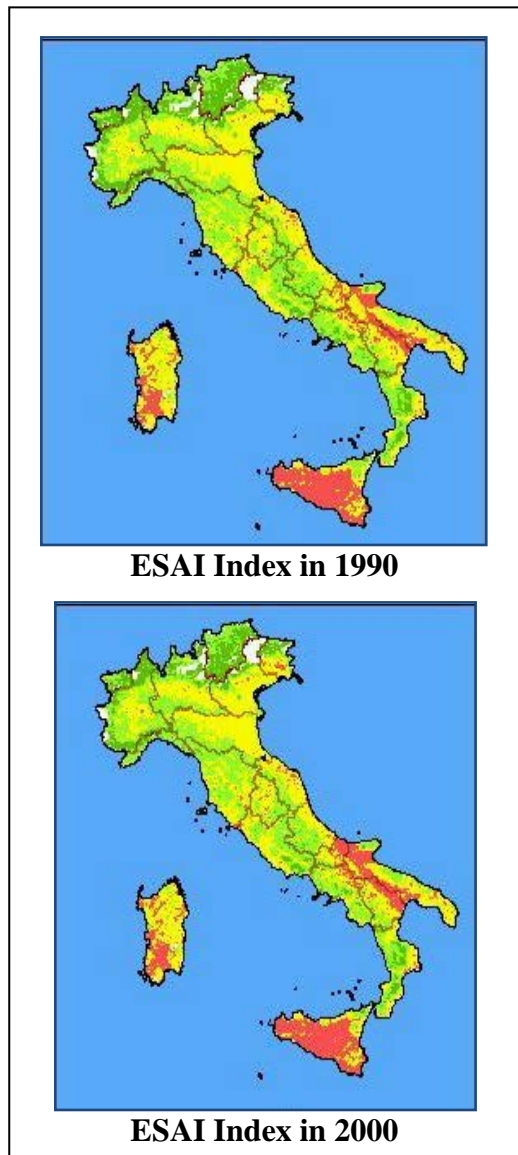
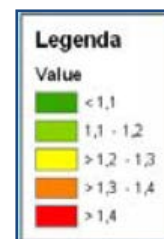


Figure 2. Vulnerability of the Italian territory to land degradation and desertification²⁷⁷

Fig. 2 shows the classification of the vulnerability of the Italian territory to land degradation and desertification processes, conducted on the basis of the *Environmentally Sensitive Area Index (ESAI)*, shows that the area of the Italian land belonging to the highest vulnerability classes corresponds to a **32.5%** of the whole national surface.²⁷⁸

Legend: increasing values of the index, and hence of the vulnerability, span from dark green to red, with 5 classes of increasing vulnerability.



²⁷⁷ Perini et al., 2008.

²⁷⁸ Perini et al., 2008.

3.2 National Conference on Climate Change (Rome, September 2007)²⁷⁹

In September 2007, the MATTM, supported by the Agency for Environmental Protection and Technical Services (APAT) and the Environment Agencies' System (ARPA), organized a *National Conference on Climate Change* that addressed the countrywide key vulnerabilities to climate change and the possible adaptation options.

Based on the key vulnerabilities, a number of **policy sectors were identified for high priority adaptation action:**

- water resources management;
- agriculture and rural development;
- (marine and terrestrial) ecosystems and biodiversity protection;
- soil and coastal management;
- health protection;
- industry and energy;
- tourism.

The Conference raised the awareness that only through the development and implementation of a *National Adaptation Strategy* (NAS) it would be possible to respond to climate change in an integrated and long-term pro-active way, which is the only approach widely acknowledged being successful and cost-effective. Furthermore the importance for such a NAS to be consistent with international recommendations and complementary to national, European and international mitigation strategies was highlighted.

²⁷⁹ ISPRA Website, "[Conferenza Nazionale sui cambiamenti climatici 2007 - Sintesi dei lavori](#)".

The *outcomes*²⁸⁰ and *conclusions*²⁸¹ of the conference recommend that the NAS should be preparatory to the implementation of a *National Adaptation Plan* (NAP) to climate change, involving the Government as a whole, the local and regional institutions and the civil society, and allowing a more effective coordination among the relevant sectoral policies and partners.

According to the conference outcomes, the NAP should be inter-linked with the *National Strategy for Biodiversity* and with the *National Action Plan to Combat Drought and Desertification*. Furthermore, to mainstream adaptation into environmental policies, the NAP should be strongly embedded in **spatial planning** and consistent with and complementary to the **mitigation strategies** and **the research programmes on climate change** at the national, European and international level.

In addition, the implementation of the following legal frameworks is considered essential for a comprehensive NAS and NAP: *Water Framework Directive* 2000/60 (water resources), *Habitat Directive* 92/43/EEC and *Birds Directive* 79/409/EEC (biodiversity), *International Convention for the Protection of Alps* (Alps), *National System on Environmental Accounting* (proxy law).

The **recommended priority actions for adaptation for Italy** include:

- "improving research on climate change impacts;

²⁸⁰ ISPRA Website, "[Conferenza Nazionale sui cambiamenti climatici 2007 - Sintesi dei lavori](#)".

²⁸¹ Conclusions of the Italian National Conference on Climate Change (Rome, September 2007): "A *MANIFESTO FOR CLIMATE. A New Deal for Sustainable adaptation and environmental security*".

- adjusting water resources management to climate change (e.g. by promoting water savings, water conservation and efficient water distribution, and a sustainable management of marine resources);
- responding to the impacts of climate change in agriculture (e.g. by promoting traditional cultivations tolerating reduced availability of water, and supporting the cultivation of forests for land maintenance);
- securing Italian coasts (e.g. by adjusting urban plans and rethinking infrastructures localization in relation to the modification of the coastline, and restoring the coastal dunes and wetlands);
- being prepared to the expected increase in the frequency and intensity of extreme events (e.g. by setting in security the areas under major hydro-geological risk, and setting up more efficient early warning systems in the areas under high risk for floods and landslides);
- promoting the mountain natural heritage and a tourism less based on ski-related activities;
- considering climate risks (e.g. increasing frequency of summer heat waves) in the development of health strategies;
- improving public involvement and awareness on policies for mitigation and adaptation to climate change;
- promoting new sustainable forms of consumption (starting from water labelling of goods and products) and environmental incentives for labour and enterprises also in relation to the new regulation on environmental accountability;
- providing an incentives system for energy savings in the residential sector”.

3.3 White Paper on rural development and climate change²⁸²

The 2011 White Paper on rural development and climate change: *“Challenges and opportunities of rural development for mitigation and adaptation to climate change”* by the MiPAAF provides an overview of the climate change political agreements that currently rule the commitments made by countries at international, EU and national level and analyses the phenomenon of climate change in different areas of the agricultural sector, in order to identify the challenges faced by the Italian agriculture sector, and, where possible, turn them into opportunities.

According to the White Paper, **agriculture in Italy is particularly affected by climate change** as in the whole Mediterranean region. Therefore, an extraordinary effort is needed to improve adaptive capacity of Italian rural sector to the expected reduced water resources, climate extremes, alterations of seasonal productions, with a consequent displacement of production areas and related economic as well as social impacts that are still difficult to quantify.

For this purpose the financial support for research and technology and for disseminating information in the agricultural world is considered crucial and the protection of quality and of typical regional products is even more urgent and necessary.²⁸³

Considering the outcomes of studies in the agriculture and forestry sector and the possible climate scenarios that could be expected for the involved areas, the White Paper presents the possible strategies to be implemented for the purpose of (mitigation and) adaptation to climate change, including:²⁸⁴

- “strategies addressing future climate scenarios on the national territory;
- strategies increasing the resilience of agricultural systems, livestock and forestry;
- adaptation and mitigation strategies for agriculture and livestock;
- adaptation and mitigation strategies for forestry;
- agro-food markets and climate politics;
- political and economic tools for mitigation and adaptation in agriculture and forestry”.

Beside general recommendations, the White Paper identifies specific types and examples of adaptation options in four intervention areas: technology development; adoption of technologies; government programs and insurance services; financial management of farms. Those areas are further differentiated with respect to the responsibility for their implementation (private or public) and the time of their implementation (ex-ante or ex post), thus generating different methods of action.²⁸⁵

²⁸² MiPAAF & RRN, 2011.

²⁸³ Morelli et al., 2007.

²⁸⁴ Morelli et al., 2007.

²⁸⁵ Pasqui et al., 2011.

In particular, the identified **main agriculture adaptation strategies for public action** include:²⁸⁶

- “increase the adaptive capacity (instead of reducing the vulnerability);
- provide appropriate and high quality information, knowledge and training (on risks, vulnerabilities, etc.);
- integrate adaptation into existing policies, avoiding any overlapping and exploiting the potential for adaptation of some already operational instruments;
- develop and enhance early warning and post-disaster emergency systems;
- facilitate the adjustment of the market;
- plan and develop the appropriate infrastructure;
- regulate the *spillovers* of adaptation;
- compensate for the uneven distribution of climate impacts;
- evaluate the externalities in the long term and avoid the phenomena of *maladaptation*, and better assess the possible synergies and trade-offs between the various measures put in place.”

²⁸⁶ Bonati et al., 2011.

3.4 Actions and measures of the National Action Programme to combat drought and desertification²⁸⁷

An extract of actions and measures identified in the **National Action Programme to combat drought and desertification** is reported hereunder.

Soil protection

- Creation of adequately scaled soil maps;
- sustainable management and increase of forest asset;
- update of forestry inventories and reference regulations in order to bring Italian forestry policy in line with the national commitments taken within Europe and internationally;
- development of greenhouse production to disseminate Mediterranean species;
- fire prevention and fighting;
- slope protection and flood control measures with low environmental impact;

Sustainable management of water resources

- adoption of water protection plans and definition of the water balance in watersheds (or for more limited but significant areas);
- definition of water needs and control of its demand;

- update and revision of tools for monitoring and verifying authorisations for discharges and diversion in order to pursue greater protection of surface and underground water bodies;
- improvement of the efficiency of the water distribution systems to reduce wastages and losses;
- optimization of irrigation activities, by adoption of techniques for efficient distribution, and correct planning of irrigation measures that favour typical Mediterranean crops;
- control and rationalisation of water runoff;
- provision of incentives for research in multiple uses of water in rural and urban areas;
- development of reuse of sewage in agriculture;
- development of plans for prevention, mitigation and adaptation in terms of the effects of droughts;
- collection and reuse of rainwater in new urban areas and restoration of abandoned collection systems in historic centres;

Reduction of impact from productive activities

- mitigation of the impacts of productive activities to reduce consumption of non-renewable resources;
- implementation of measures aimed at adopting agricultural, animal-husbandry and forestry production systems able to prevent physical, chemical and biological soil damage;
- reduction in water consumption and reduction of pressures from tourism

²⁸⁷ CIPE, 1999.

activities in vulnerable areas by means of incentives for diversification of the offer, relieving it from seasonal fluctuations;

Land restoration

- recovery of soils damaged by erosion, salinization, etc.;
- reclamation and re-naturalisation of contaminated disposal sites in abandoned mining areas;
- landscape reconstruction and implementation of integrated planning policies for regional systems, in particular along the coast and on the small islands;
- incentives for sustainable production and tourism in marginal hilly and mountainous areas;
- re-naturalisation and environmental transformation of areas subjected to deterioration in urban and industrial environments;
- incentives for adoption of urban-development plans that call for the use of technologies aimed at the renewal and appropriate use of natural resources.

3.5 Structure of the National Biodiversity Strategy and actions related to climate change adaptation²⁸⁸

The Italian National Biodiversity Strategy is based on the **three pillars**: “biodiversity and ecosystem services”, “**biodiversity and climate change**” and “biodiversity and economic policies”.

The achievement of the relative **three strategic objectives** is addressed within **fifteen working areas**: “1. species, habitat, landscape; 2. protected areas; 3. genetic resources; 4. agriculture; 5. forests; 6. inland waters; 7. marine environment; 8. infrastructure and transport; 9. urban areas; 10. health; 11. energy; 12. tourism; 13. research and innovation; 14. education, information, communication and participation; 15 Italy and biodiversity in the world”.

Each working area is in turn articulated in different actions: “identification of the main threats and/or critical situations; identification of specific objectives to counteract those threats; **definition of priorities for action based on intervention tools**”.

Several objectives and priorities for action identified in the above areas of work are directly or implicitly linked to climate change adaptation.

The actions **explicitly related to adaptation to climate change** are reported in the following list.

Species, habitats and landscape

- Integrate the issues of biodiversity at the regulatory level within the planning tools at national as well as local scale, in order to ensure the continued flow of ecosystem services and the ability of mitigation and adaptation to climate change;
- implement policies able to remove or mitigate the anthropogenic causes of climate change and implement an adaptation strategy reducing the impact of climate change on species and habitats, especially for migratory species and mountain environments;
- develop a permanent monitoring of migratory species in relation to climate change;
- implement policies integrating the different levels of spatial planning, to ensure the maintenance of biodiversity for its intrinsic value, of ecosystem services and of the ability to mitigate and adapt to climate change;

Agriculture

- promote the use of lands based on their aptitude/vocation and encourage the protection and enrichment of local and indigenous species, also considering the need and the opportunity to grow different crops and varieties on the basis of climatic trends;

Forests

- reconstitute the forest potential damaged by climatic events;

²⁸⁸ MATTM, 2010.

- promote interdisciplinary research projects to better understand the impact of climate change on forests;
- fully use the programmes and instruments aimed at combating climate change;

Water

- protect and preserve the ecosystems of the inland waters at the river basin scale, also for their ability to mitigate the effects of climate change;
- improve overall knowledge of the state of aquatic systems, to understand the effects of the impacts arising from human activities and climate change on physical systems and their associated biological processes, including through management plans for river basins districts;

Marine environment

- protect and preserve the marine and coastal environment, thus preventing its degradation and loss of biodiversity, and also improving the ability of mitigate and adapt to the effects of climate change;
- optimize and develop research infrastructures and strengthen scientific networks to address global challenges such as adaptation to climate change under the new EU Integrated Maritime Policy and its strategic research agenda;

Urban environment

- improve knowledge on the ecological status of the urban environment;

- involve citizens in the understanding of the impacts arising from human activities and climate change on biodiversity;

Human health

- deepening the knowledge of risks and impacts for health effects on biodiversity that are related to climate variability and change.

Overall, the Strategy recommends to improve the scientific knowledge on climate change and biodiversity, and in particular advises to:

- “incorporate the monitoring, evaluation and quantification of the net effects of climate change in projects and programmes concerning the protection and management of biodiversity, thus overcoming knowledge gaps;
- understand the role of communities and ecosystems in climate change adaptation, to build their resilience and adaptive capacity while generating additional economic benefits;
- develop synergic policies that take into account the contribution of biodiversity and ecosystems to climate change adaptation and mitigation, at the local, national and global level;
- implement the conservation and sustainable use of biodiversity to promote adaptation to climate change in priority sectors such as agriculture, inland waters, forests and coastal-marine environment.

3.6 Adaptation to climate change in the Italian Rural Development Programmes (RDPs)²⁸⁹

According to the report “*Climate Change and Renewable Energy measures in EU RDPs 2007 – 2013 Member state profile - ITALY*” by *Rete Rurale Nazionale - RRN (2010)* adaptation to climate change is well supported by the Italian Rural Development Programmes (RDPs) mainly through **water management measures** aimed at achieving water savings and improving the efficiency of irrigation systems, especially the refurbishment of farms and the adjustment of agriculture and forestry infrastructures, and secondly by **forestry measures**, aimed at reducing the consequences of forest fires and preventing soil deterioration from negative climate conditions and risks (irregular rainfalls and droughts). Some **Landscape management** actions are also supporting climate change adaptation, as they restore and preserve the forestry potential. Finally, measures relating to **training, advice and dissemination** also indirectly contribute to prevention of, and coping with, potential impacts of climate change on agriculture as they enable farmers increasing their knowledge and awareness in relation to sustainable agriculture issues.

The following extracts from *Rete Rurale Nazionale - RRN (2010)* describe in details the actions supported by the RDPs of the 21 Italian regions addressing climate change adaptation.

Measure 125: infrastructure related to the development and adaptation of agriculture and forestry

The main measure through which RDPs seek to support efforts to adapt to climate change is **measure 125 – infrastructure related to the development and adaptation of agriculture and forestry** which covers operations related to water supply and efficiency. This is an important measure as it is implemented in 12 RDPs. Under this measure explicit reference is made to supporting investments in irrigation infrastructures for better management and sustainable use of water resources in agriculture. Examples of supported actions include improvement of hydraulic structures to reduce water losses, modification of pumping, transport and distribution systems, installation of water consumption meters, communication technology to improve information on irrigation and energy networks, investments in waste water treatment systems and improvement of electric installations for irrigation.

Measure 214: agri-environment payments

Even if the main objective of **Measure 214 – agri-environment payments** is to mitigate climate change, the actions under this framework show synergies between climate change mitigation and adaptation.

Actions include integrated pest management and water saving production techniques, such as diversification of crop rotations, introduction of new crops and irrigation systems.

Measure 121: modernisation of agricultural holdings

²⁸⁹ RRN, 2010.

Activities that could support adaptation to climate change include those under **measure 121 – modernisation of agricultural holdings**. Specific reference to climate change adaptation is more limited in comparison to climate change mitigation under this measure; however, in some cases explicit reference is made to supporting investments in new processes and technologies which aim at addressing environmental and climate change challenges. In particular, measure 121 targets investments that promote preventive actions against extreme weather events caused by climate change.

Measures 226: restoring forestry potential and introducing prevention actions & 227: non-productive investments

Measure 226 - restoring forestry potential and introducing prevention actions and **measure 227 - non-productive investments** target preventive actions in order to avert natural risks, such as forest fires. Measure 226 includes actions for fighting erosion and desertification from natural catastrophes such as forest fires and floods. Measure 227 includes actions such as hydro-forest restoration to address adverse effects of heavy rainfalls in some areas, restoration of green cover and activities of re-plantation, construction of structures like ditches, fences and bays, and restoration of forest lanes when there is a need to deter erosive processes. Both measures are found in the majority of RDPs (15 and 14 respectively).

Measure 124: cooperation for development of new products

Measure 124 – cooperation for development of new products processes and technologies in the agriculture and food sector and the

forestry sector also makes reference (in 9 RDPs) to supporting initiatives that promote innovative technologies, products and processes with respect to improving water management.

Measures 111: vocation training and information actions & 114: use of advisory services

Other actions that indirectly also contribute to climate change adaptation are measures relating to training, advice and information, **measure 111 – vocation training and information actions** and **measure 114 – use of advisory services**. They are included in most of the RDPs (12 and 8 respectively) and play an important role in enabling farmers to increase their knowledge and awareness in relation to sustainable agriculture issues. Topics covered take into account environmental and climatic effects, with particular reference to preventive actions concerning adverse weather effects, including flooding, improved water efficiency and landscape management.

Measure 216: non-productive investments

Finally, **measure 216 – non-productive investments** is activated in relation to climate change (in 7 RDPs) and supports measure 214. It contributes to climate change adaptation by supporting actions aiming at improving soil quality and preventing erosion, and improving surface and deep waters.

4 Basic glossary²⁹⁰

Adaptation

“Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation:

- **anticipatory adaptation** – adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation;
- **autonomous adaptation** – adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation;
- **planned adaptation** – adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state”.

Adaptation benefits

“The avoided damage costs or the accrued benefits following the adoption and implementation of adaptation measures”.

Adaptation costs

“Costs of planning, preparing for, facilitating, and implementing adaptation measures, including transition costs”.

Adaptive capacity (in relation to climate change impacts)

“The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences”.

(climate change) Impacts

“The effects of climate change on natural and human systems.

Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts:

- **potential impacts**: all impacts that may occur given a projected change in climate, without considering adaptation;
- **residual impacts**: the impacts of climate change that would occur after adaptation”.

Vulnerability

“Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity”.

²⁹⁰ Cf. IPCC, 2007, Appendix I: Glossary.

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75

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