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Suggested Structure on Climate Adaptation Chapter
CES MED Internal Guidelines

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1. Introduction

The current document aims to serve as an internal guidance document for the municipalities and the consultants implementing SECAP studies in the Maghreb – Mashreq regions, regarding the Climate Adaptation Study.

In the next sections, a suggested structure is being proposed as a basis for the consultants, while specific texts that can be utilized in any way considered applicable, have been developed based on extensive literature review.

This study is intended to be included in the SECAP in the form of a chapter, comprising of three main parts, dedicated to analyse the existing situation in each country and local/ regional level, to conduct a Risk Analysis and Vulnerability Assessment and to define the adaptation actions that the municipality will follow.

The outline of the current guidelines can be summarized as below:

- Suggested Structure of the Climate Adaptation Chapter.
- Section A – Current status analysis
- Section B - Risk Assessment and Vulnerability Analysis
- Section C – Adaptation Actions

2. Proposed Structure

An indicative structure of the Climate Adaptation Chapter is suggested as follows:

Section A – Current Status Analysis

1) Introduction – Climate Change. This sub-chapter focuses on an introduction note on climate change in general, as well as its impact on the Mediterranean countries.
2) National and regional strategy on Climate Change Adaptation. This section focuses on the description of climate change impacts on the country itself in a series of sectors, as well as the region, and describes in detail all the recent studies that have been realized at the country or regional level, as well as the measures that have been adopted within the framework of the National and/ or Regional Strategy, if in place.
3) Climate data and Clima projections. In this sub-chapter, a detailed analysis of climate data time-series should be realized for the specific municipality, or if data at this local level is not available, at the regional or national one correspondingly. Besides strictly quantitative data such as the temperatures' evolution over time, as well as the rain levels etc., additional qualitative data could include a calendar of extreme weather incidents that have taken place within the last years. It also includes estimations of the climate change impacts in the future, as well the evolution of the climate conditions in the area (temperature increase, rainfalls etc.).
4) Adaptation scoreboard. Self-assessment of the municipality's status against the standard adaptation scoreboard in the SECAP template. Analysis of the information to be included in the filled in template.

Section B – Risk Analysis and Vulnerability Assessment

Section B focuses on a detailed analysis of the risks that the municipality encounters from a series of climate hazard types, as well as an assessment of the municipality's vulnerability against these threats.

Section C – Suggested adaptation actions

Adopted adaptation actions per sector

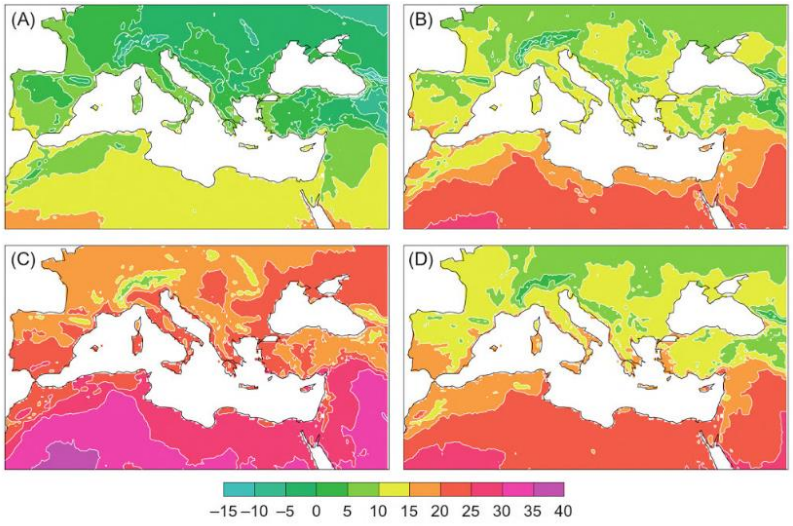
3. Section A – Current Status Analysis

3.1 Introduction text on climate change impact

The Mediterranean region is rich in a large variety of complex climatic phenomena, caused by its morphology and its geographical location. The location of the Mediterranean Sea in a transitional band between subtropical and midlatitude regimes produces a large climate variability at multiple timescales and a strong seasonal variability of precipitation in many areas (Lionello 2012). The Mediterranean has been identified as one of the most prominent "Hot-Spots" in future climate change projections (Giorgi 2006). The water cycle and its extremes are one of the major concerns, since there are many countries that are over exploiting the water resources, a problem that is expected to deteriorate in the future. Episodes of extreme precipitation are also taking place and disastrous floods are a major threat for the region and especially the coastal areas. In addition to the above, phenomena taking place especially in the Southern Mediterranean Countries, such as cultivation of marginal land, overgrazing and firewood harvesting, put more pressure on the environment (Lionello 2012).

The Mediterranean region has experienced drastic changes in its climate over the years and according to Luterbacher et al. (2006), has shown large climate shifts in the past. Twenty thousand years ago, cold steppes (with sparse forests) extended from the south of Spain to Caucasus. In the northern part of the Mediterranean basin, the temperature of the coldest month was 15°C lower than it is today (Peyron et al., 1998). Less water was available for vegetation. Over the last 2000 years, the climate over the Mediterranean has experienced a sequence of humid/dry and warm/cold periods that have produced effects on environmental conditions.

In the Figure 1 presented below, the seasonal mean temperature for the period 1961-1990 is being depicted in panels A-D, while the total precipitation maps for the same period are depicted in panels E-H.



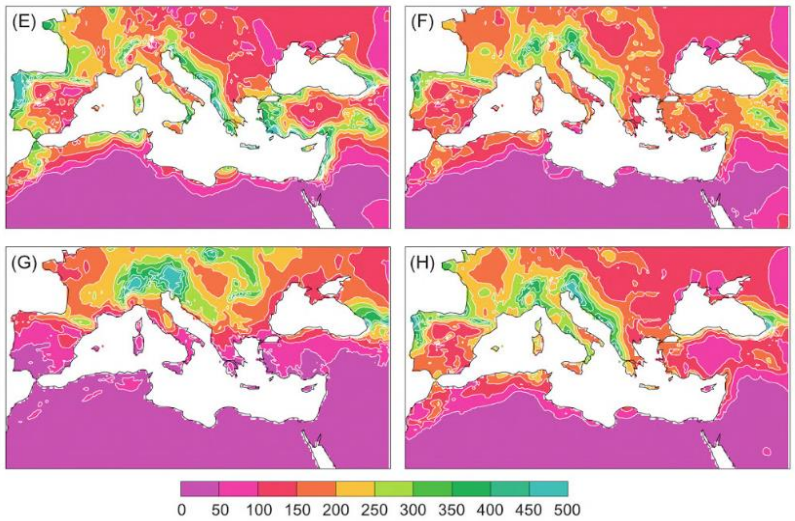


Figure 1: Seasonal (winter: December – January – February; sping: March – April – May; summer: June – July – August; autumn: September – October – November) mean temperature (°C, panels A-D) and total precipitation (mm per season, panels E-H) maps for the period 1961 -1990 based on CRU data

Source: Lionello, 2012

The increase of the projected temperatures in the Mediterranean region in the period 2071 - 2100 compared to 1961-1990 is at least 3 degrees in the South countries and could be even higher, depending the season, as presented in the figure below (Giorgi et al., 2008).

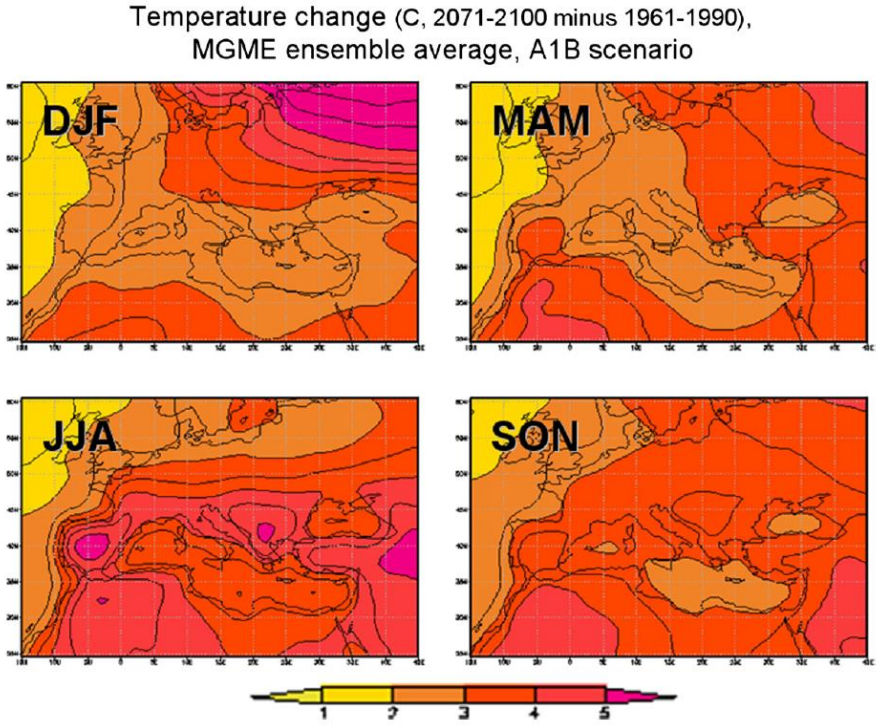


Figure 2: Multi Global Model Ensemble (MGME) average change in surface air temperature for the four seasons, 2071–2100 minus 1961–1990. Units are °C. DJF is December–January–February, MAM is March–April–May, JJA is June–July–August, SON is September–October–November

Source: Giorgi et al., 2008

According to an EIB report of 2008, for the Mediterranean region, climate experts anticipate during the 21st century:

- An increase in air temperature in the range of 2.2 C° to 5.1 C° for the countries of Southern Europe and the Mediterranean region over the period 2080 – 2099 with respect to the period 1980 – 1999;
- A significant decrease in rainfall, ranging between -4 and -27 % for the countries of Southern Europe and the Mediterranean region (while the countries of Northern Europe will report a rise between 0 and 16 %);
- Increase in drought periods manifested by a high frequency of days during which the temperature would exceed 30 °C. Extreme events, such as heat waves, droughts or floods, are likely to be more frequent and violent.
- An increase of the sea level which, according to some specific studies, could be around 35 cm up to the end of the century.

Giannakopoulos et al. (2005) underlines that in line with the results of the projection scenarios, the most significant temperature increases in the 21st century are expected in Eastern Egypt and especially the Nile Delta, Lebanon, Israel and the Maghreb. It is therefore evident that the more vulnerable Mediterranean areas will be those of North Africa adjacent to desert areas, the major deltas (such the Nile one), the coastal areas (Northern rim and Southern rim of the Mediterranean basin), as well as the high-demographic growth and socially vulnerable areas (Southern and Eastern rim, densely populated cities and suburbs).

In the Mediterranean region, 50% of the urban population lives in an altitude of less than 10 meters from the sea level, in areas which are vulnerable to sea level rise. In addition to the above, tourist destinations in these areas are vulnerable not only due to the sea level rise, but also due to the temperature increase encountered (Plan Bleu, 2009).

The impacts of climate change on the Mediterranean environment will relate particularly to (EIB, 2008):

- Water, via a change of its cycle due to a rise in evaporation and a decrease in rainfall. This water problem will be of crucial importance with regard to the issue of sustainable development in the region;
- Soil, via the acceleration of already existing desertification phenomena;
- Land and marine biological diversity (animal and plant), via a displacement northwards and in altitude of certain species, extinction of less mobile or more climate sensitive species, and emergence of new species;
- Forests, via a rise in fire hazards and parasite risks.

These impacts will exacerbate already existing pressures on the natural environment connected with anthropogenic activities, such as agriculture and fishery (reduction of yields), tourism attractiveness (heat waves, water scarcity), coastal areas and infrastructures (significant exposure to the action of waves, coastal storms and other extreme weather events, rise in sea level), human health (heat waves), the energy sector (water needs for power plants, hydropower and increased consumption).

In line to the above, the Southern and Eastern Mediterranean Countries (SEMCs) appear to be more vulnerable to climate change than the Northern Mediterranean Countries (NMCs).

Indeed, they are, on the one hand, more exposed to accelerated desertification, soil aridity and water scarcity and, on the other hand, presenting economic structures that are more strongly dependent on natural resources, as well as technical and financial capacities that are too limited to help implement large-scale adaptation options (EIB, 2008).

The Mediterranean, and more especially the Southern and Eastern rim, is and will be more affected by climate change than most other regions of the world in the course of the 21st century. The impacts of the rise in temperatures, the decrease in rainfall, the multiplication of the number and intensity of extreme events and the possible rise in sea level overlap and amplify the already existing pressures of anthropogenic origin on the natural environment.

Through the crucial issue of scarcity of water resources, their impacts are fraught with consequences in the 21st century for human activities, in particular agriculture, fishery, tourism, infrastructures, urbanised coastal areas and hydropower production. In order to minimize as much as possible the economic losses and damages, several adaptation options must be thought out and implemented.

Energy lies at the heart of the climate change issue. On the one hand, it is the main GHG emitting sector, and CO2 emissions in the future are likely to increase much more rapidly than the global average. On the other hand, hydropower production—relatively significant in certain countries (13% of power production in the SEMCs)—is affected by the climate as well as by the plant cooling constraints. Lastly, the energy demand (in particular, electricity) which is growing at a very high pace in the region, is likely to be further accelerated by the additional demand necessary to lessen the impacts of climate change (water desalination, air-conditioning of buildings, etc).

3.2 National and Regional Strategy on Climate Change Adaptation

This section focuses on the national and regional strategy on climate change adaptation if applicable. It is advised to describe

- The commitments in place at the national level within the international environment (UNFCCC etc) and the agreements that have been signed in the past for Climate Change.
- The national strategy, its goals and commitments, sectors affected etc.
- The regional strategy, if applicable, based on the national one, and the specificities the region faces.

3.3 Climate data and Clima projections

Climate data covering at least mean temperature and precipitation levels should be added regarding:

- The current situation, including time-series with the available data.
- Climate projections, based on official studies.

3.4 Adaptation Scoreboard

The adaptation scoreboard is part of the SECAP template developed by the JRC. The municipality is intended to realize a self-assessment of its adaptation status, putting a grade from A to D, in line with its progress.

More specifically:

- "A", corresponds to completion level of 75 - 100%.
- "B", corresponds to completion level of 50-75%.
- "C", corresponds to completion level of 25-50%. Finally,
- "D", corresponds to completion level of 0-25%.

The municipality will put one of these four grades to each one of the adaptation cycle specific steps, as presented in the following table.

Table 1: Municipality's score in the Adaptation Cycle Specific Steps (SECAP template and JRC guidelines)

Adaptation Cycle Steps	Actions
Step 1: Preparing the ground for Adaptation	Adaptation commitments defined/integrated into the local climate policy
	Human, technical and financial resources identified
	Adaptation team (officer) appointed within the municipal administration and clear responsibilities assigned
	Horizontal (e.g. across departments) coordination mechanisms in place
	Vertical (e.g. across governance levels) coordination mechanisms in place
	Consultative and participatory mechanisms set up, fostering the multi stakeholder engagement in the adaptation process
	Continuous communication process in place
Step 2: Assessing risks and vulnerabilities to climate change	Mapping of the possible methods and data sources for carrying out a Risk &Vulnerability Assessment conducted
	Assessment of climate risks and vulnerabilities undertaken
	Possible sectors of actions identified and prioritized
	Available knowledge periodically reviewed and new finding integrated
Steps 3 and 4 – Identifying, assessing and selecting adaptation options	Full portfolio of adaptation actions compiled, documented and assessed
	Possibilities of mainstreaming adaptation in existing policies and plans assessed, possible synergies and conflicts identified
	Adaptation actions developed and adopted
Step 5: Implementing	Implementation framework set with clear milestones
	Adaptation actions implemented and mainstreamed as defined in the SECAP document
	Coordinated action between adaptation and mitigation set
Step 6: Monitoring and evaluation	Monitoring framework in place for adaptation actions
	Appropriate monitoring and evaluation indicators identified
	Regular monitoring of the progress and reporting to the relevant decision makers
	Adaptation strategy and/or Action Plan updated, revised and readjusted according to the findings of the monitoring and evaluation procedure

4. Section B - Risk Assessment and Vulnerability Analysis

In order to conduct a risk assessment and vulnerability analysis, as a first step, the climate hazard types should be identified.

These hazard types in general and for the Maghreb and Mashreq countries in particular, are presented in Table 2 below.

Table 2: Climate Hazard Types

General Climate Hazard Types	Applicable for Maghreb and Mashreq regions
Extreme heat	√
Extreme cold	
Landslides	
Storms	√
Droughts	√
Sea level rise	√
Floods	√
Extreme precipitation	
Forest fires	
Ice and snow	

The municipalities are called in to assess the impact that each climate hazard type has on a series of Vulnerable/ Impacted sectors, such as:

- Health
- Infrastructure (Energy, Water, Transport, Social)
- Built environment
- Economy (Tourism, Agriculture and Forestry)
- Biodiversity (Coastal areas, Green zones/ forests)

These sectors have been identified as the most relevant for the Maghreb / Mashreq region, utilizing info from Future Cities Adaptation Compass Tool, Mayors' Adapt, as well as the European Climate Adaptation Platform website.

It is suggested that the municipality formulates and fills in a table, as the one presented below (Table 3), in order to conduct the vulnerability analysis, based on sources such as the Future Cities Adaptation Compass Tool and UNFCCC.

Having conducted the vulnerability analysis, the next step is to elaborate a risk assessment, in line with the above. To this end, the development of a table in line with the one suggested in Table 4 should be realized. Although the probability of each risk cannot be estimated without specific climate data for each region, the impact of each risk is identified in the scale of High – Medium – Low.

In case specific climate projections are available, a risk analysis combining probability and impact should be realized, by formulating the Table 4 and the respective figure (Figure 1).

Figure 1: Risk assessment figure in case of climate data availability

Table 3: Suggested template for the Vulnerability analysis (based on the Future Cities Adaptation Compass tool)

	Receptors	Extreme weather event	Potential effects	Who/What is affected
Population	Public Health	Extreme heat	- Deaths due to cardiovascular diseases - Spread of vector born and infectious diseases - Altered allergic pattern - Heat stress	Everyone, but especially elderly people, babies, children, workers in outdoor environments and sensitive groups of people
		Droughts	- Asthma and cardiovascular diseases - Accumulation of trace elements	All people living or working in the area
		Sea level rise	- Asthma and respiratory allergies - Water-borne diseases - Forced migration and mental health impacts	All people living or working mainly in the coastal area
		Storms	- Casualties and deaths	All people living or working in the area
		Floods	- Injuries and deaths - Water-borne diseases - Asthma and respiratory allergies	All people living or working in the area
Infrastructure	Transport	Extreme heat	- Rail and road network damages - Change in behavior patterns - Air quality problems - Higher maintenance costs	Roads, rail roads, public transport, people mobility
		Droughts	- Difficult transport of bulk material	Waterways, water management
		Sea level rise	- Damages - Mobility difficulties in afflicted areas	Roads, rail roads, public transport, people mobility
		Storms	- Damages - Mobility difficulties in afflicted areas	Roads, rail roads, public transport, people mobility
		Floods	- Damages - Mobility difficulties in afflicted areas	Roads, rail roads, public transport, people mobility
	Energy	Extreme heat	- Altered electricity peaks/demand - Damages - Cooling problems	Conventional power plants, electricity providers and consumers

Receptors	Extreme weather event	Potential effects	Who/What is affected
		- Reduction of efficiency yield from conventional power plants and distribution grid - Higher maintenance costs	
	Droughts	- No/lower production from hydro power plants - Energy supply and demand patterns' shift - Higher maintenance costs - Cooling problems	Conventional and renewable energy facilities (hydro, PVs, etc)
	Sea level rise	- Damages - Operational difficulties - Higher maintenance cost	All facilities in coastal areas (usually conventional plants that are nearby water resources)
	Storms	- Damages	All facilities in the electricity production and especially the wind turbines, as well as the distribution grid
	Floods	- Damages - Operational difficulties	All facilities in the electricity generation and distribution grid in the affected areas
Water	Extreme heat	- Higher water demand - Water quality issues - Higher maintenance costs	Public health, water infrastructures
	Droughts	- Water scarcity - Water quality issues - Higher maintenance costs	Public health, water infrastructures
	Sea level rise	- Increased salinity of underground water - Water management issues - Damages - Water quality issues - Higher maintenance costs	Public health, water infrastructures
	Storms	- Water management issues - Water quality issues	Public health, water infrastructures
	Floods	- Water quality issues - Water management issues - Damages	Public health, water infrastructures

	Receptors	Extreme weather event	Potential effects	Who/What is affected
			- Higher maintenance costs	
	Social	Extreme heat	- Higher electricity demand to cover cooling needs - Changes in behavior patterns, e.g. living outdoors - Burdening of the health care facilities due to the increased number of patients in hospitals	Hospitals, schools, public places, municipal facilities/infrastructure, athletic facilities
		Droughts	- Difficulties in meeting water demand for athletic facilities (e.g. swimming pools) and green public spaces	Hospitals, schools, public places, municipal facilities/infrastructure, athletic facilities
		Sea level rise	- Impacts on public spaces (e.g. loss of beaches) - Damages on coastal facilities	Hospitals, schools, public places, municipal facilities, athletic facilities
		Storms	- Damages in social facilities in afflicted areas - Burdening of the health care facilities due to the increased number of patients in hospitals	Hospitals, schools, public places, municipal facilities, athletic facilities
		Floods	- Flooding of social facilities in afflicted areas - Burdening of the health care facilities due to the increased number of patients in hospitals	Hospitals, schools, public places, municipal facilities, athletic facilities
Built Environment	Building stock and material	Extreme heat	- Concrete's damages - Increased cooling demands - Higher maintenance costs - Urban heat island effect	All building infrastructure
		Droughts	- Higher water demand	All building infrastructure
		Sea level rise	- Sinkholes collapse - Extensive damages - Flooding at the city level of all building infrastructure	All building infrastructure, road network etc.
		Storms	- Damages - Higher maintenance costs	All building infrastructure
		Floods	- Damages - Higher maintenance costs	All building infrastructure

	Receptors	Extreme weather event	Potential effects	Who/What is affected
Economy	Tourist	Extreme heat	- Increased demand for cooling - Lower touristic flows during the impacted seasons - Higher water demand	Tourists, tourist infrastructure, tourist related economy
		Droughts	- Increased pressure on water resources, escalating water scarcity issues - Increased water supply costs	Tourists, tourist infrastructure
		Sea level rise	- Damages in touristic infrastructure, which in its majority is at coastal areas	Tourists, tourist infrastructure, tourist related economy
		Storms	- Damages in touristic infrastructure and related costs for repairs	Tourists, tourist infrastructure
		Floods	- Damages in touristic infrastructure and related costs for repairs	Tourists, tourist infrastructure
	Agriculture	Extreme heat	- Changes in growth cycle - Damages / loss of harvest - Livestock loss and impacts on health - Lower crop yields	Farmers, food industry, consumers
		Droughts	- Damages / loss of harvest - Lower crop yields - Livestock loss and impacts on health - Land degradation	Farmers, food industry, consumers
		Sea level rise	- Damages / loss of harvest in coastal areas - Increased water salinity will result in existing crops' long term destruction - Loss of fertile grounds near coastal areas and especially the deltas	Farmers, food industry, consumers
		Storms	- Damages / loss of harvest in afflicted areas / loss of livestock	Farmers, food industry, consumers
		Floods	- Damages / loss of harvest in afflicted areas / loss of livestock	Farmers, food industry, consumers

	Receptors	Extreme weather event	Potential effects	Who/What is affected
Biodiversity	Coastal zone ecosystems	Extreme heat	- Increased coral bleaching - Migration of coastal species towards higher altitudes - Reduction of vulnerable fishing stock - Altered flora and fauna, new and invasive species	Ecosystem, fish industry, consumers
		Droughts	- Increase of coastal water salinity - Loss of species - Altered flora and fauna, new and invasive species	Ecosystem
		Sea level rise	- Displacement of coastal lowland and wetlands and reduction of certain fish species - Increased coastal erosion - Salinization of surface and ground waters	Ecosystem, fish industry, consumers
		Storms	- Pollution of natural resources	Ecosystem
		Floods	- Loss of species - Altered flora and fauna, new and invasive species	Ecosystem
	Green zones/ Forests	Extreme heat	- Fires and destruction of the ecosystem, flora and fauna	Ecosystem
		Droughts	- Fires and destruction of the ecosystem, flora and fauna	Ecosystem
		Sea level rise	- Increase of underground water salinity and destruction of the ecosystem	Ecosystem
		Storms	- Damages	Ecosystem
		Floods	- Spoiling of water bodies and soil quality	Ecosystem

Table 4: Suggested template for the risk assessment

	Receptors	Weather Sensitivity	Future Risk	Impact
Population	Public Health	Extreme heat	- Increased number of deaths - Reinforcement of heat stress - Increased infectious diseases - Altered allergic patterns	High
		Droughts	- Increased allergic incidents - Decreased air quality - More respiratory problems	High
		Sea level rise	- Increased incidents of asthma and pneumonia - Increased water-borne diseases - Limitations to the healthcare access	High
		Storms	- Limitations to the healthcare access - Increased numbers of injuries and deaths	High
		Floods	- Limitations to the healthcare access - Increased numbers of injuries and deaths	High
Infrastructure	Transport	Extreme heat	- Damages on road and rail network - Modification of transport frequency and means - Air quality problems - Higher maintenance costs	Low
		Droughts	- Difficult transport of bulk material	Low
		Sea level rise	- Damages	Medium
		Storms	- Damages - Mobility problems	High
		Floods	- Damages - Mobility problems	High
	Energy	Extreme heat	- Blackouts and inability to cover demand load - Damages, especially in the thermal power plants	High
		Droughts	- Blackouts and inability to cover demand load - Higher maintenance costs - Cooling problems in power plants	High
		Sea level rise	- Damages - Shut down of power plants near rivers, etc - Operational difficulties - Higher maintenance cost	Medium

		Storms	- Damages / Failures in the production facilities and distribution grid / power cuts	High
		Floods	- Damages / power cuts	Medium
	Water	Extreme heat	- Water scarcity - Water quality issues	Medium
		Droughts	- Water scarcity - Water quality issues	High
		Sea level rise	- Increased salinity of underground water - Water management issues - Damages - Water quality issues - Higher maintenance costs	Medium
		Storms	- Increased damages and related maintenance costs - Water management issues	Medium
		Floods	- Increased damages and related maintenance costs - Water management issues - Water quality issues	High
	Social	Extreme heat	- Increased needs for air conditioned public spaces	Medium
		Droughts	- Increased numbers of people presenting respiratory problems and burdening the health care facilities - Inability to cover the water demand - Difficulties in the operation of certain facilities due to lack of water (e.g. swimming pools)	Medium
		Sea level rise	- Potential damages in the coastal area facilities - Loss of coastal public spaces (beaches etc.)	High
		Storms	- Damages - Increased maintenance costs	High
		Floods	- Damages - Increased maintenance costs - Flooding at the city level of the afflicted public building infrastructure (schools, hospitals, etc) - Difficulties in providing the envisaged services	High
Built Environment	Building stock and material	Extreme heat	- Concrete's damages - Increased cooling demands - Higher maintenance costs - Urban heat island effect	Low
		Droughts	- Higher water demand	Medium
		Sea level rise	- Sinkholes collapse - Extensive damages and loss of property - Impact on coastal zone economy	High

		Storms	- Damages - Increased maintenance costs	Medium
		Floods	- Damages - Increased maintenance costs	Medium
Economy	Tourist	Extreme heat	- Change of the tourism season – lower touristic flows - Reduction of the tourism related economy	Medium
		Droughts	- Increased water supply costs - Potential increase of indirect costs for the tourists (infrastructure related) and reduction of touristic flows	Low
		Sea level rise	- Damages and even complete destruction of touristic infrastructure, nearby coastal areas and deltas	High
		Storms	- Damages to touristic facilities	Medium
		Floods	- Damages to touristic facilities - Potential effects on the touristic flows, in areas with flooding history	High
	Agriculture	Extreme heat	- Changes in growth cycle - Damages / loss of harvest - Livestock loss and impacts on health - Lower crop yields - Increased fire risks	High
		Droughts	- Damages / loss of harvest - Lower crop yields - Livestock loss and impacts on health - Land degradation - Increased fire risks	High
		Sea level rise	- Damages / loss of harvest in areas near delta, sea etc. - Increased water salinity will result in existing crops' long term destruction.	High
		Storms	- Damages/ loss of harvest in afflicted areas - Surface soil erosion	High
		Floods	- Damages/ loss of harvest in afflicted areas - Livestock loss - Surface soil erosion	High
Biodiversity	Coastal zone ecosystems	Extreme heat	- Loss of specific species (fish, etc)	High
		Droughts	- Increase of coastal water salinity	Medium
		Sea level rise	- Loss of specific species (fish, etc) - Soil erosion - Water salinization	High
		Storms	- Soil erosion	Medium

	Floods	- Soil erosion	High
Green zones/ Forests	Extreme heat	- Fires and destruction of the ecosystem, flora and fauna	High
	Droughts	- Fires and destruction of the ecosystem, flora and fauna	High
	Sea level rise	- Increase of underground water salinity and destruction of the ecosystem	Medium
	Storms	- Destruction of trees and other damages	Medium
	Floods	- Destruction of trees and other damages	High

5. Section C - Adaptation Actions

The municipality, having compiled the vulnerability analysis and risk assessment, needs to identify a specific set of actions that will allow it to adapt to the situation it faces. A list of adaptation actions, identified from the international literature and best practices available, are presented in the following tables, for each one of the five sectors studied above. Of course, these lists are not exhaustive and the consultants can look for additional measures, depending also on the local needs and situation; however, they are considered a good starting point.

For each one of the five sectors, a further distinction of the adaptation actions in four categories is realized:

- Strategic actions. Actions regarding the formulation of action plans, or strategic policy planning documents, that set the basis for all the actions to come in the specific sector.
- Alert /Communication actions. These are focusing on alerting the citizens on a situation, such as an extreme climate event or hazard (high temperatures, floods, tsunamis etc.).
- Educational actions. The focus in this case is given on increasing the awareness raising level of the citizens on a specific threat or situation that the municipality is faced and requires the citizens' collaboration in one way or another.
- Technical actions. Activities that are directly addressing in a technical the specific climate hazard.

Table 5 below focuses on a set of suggested adaptation actions on the population and public health.

Table 5: Suggested adaptation actions for population and public health

Actions' characteristic	Adaptation Actions
Strategic	Health action plan for the extreme events that the municipality is facing e.g. heat etc. (heat health action plan)
	Provide access to air conditioned public buildings during heat waves or other extreme events, for those citizens that lack the infrastructure to protect themselves (people living in underground apartments during floods, or lacking AC during extreme temperatures etc.)
	Collaboration with the regional medical services to increase preparedness level
Alert / Communication	Developing an early warning system to alert citizens in the case of extreme weather events or natural disasters such as heat waves, forest fires, floods, tsunami etc.
Educational	Educational and awareness raising campaigns about health-related effects of heat waves, floods, vector born diseases etc., and educate residents on the ways to protect their health and prevent infection or impact.
Technical	Regular cleaning and maintenance of the sewage and drainage system
	Identification of potential hot spots for the development of vector borne diseases
	Frequent monitoring of water and air quality

Table 6: Suggested adaptation actions for infrastructure

Actions' characteristic	Adaptation Actions
Strategic	Water and waste water management plan
	New specifications for bridges, according to maximum expected flow during floods or sea level rise and highest temperatures
	Modelling predicted supply changes in the electricity from the locally available RES sources that serve the community, as a result of the climate change
	Frequent monitoring of the infrastructure in order to spot and quickly repair any damages
Alert / Communication	Issuing alerts in case a part of the infrastructure has been severely damaged and citizens should avoid it
Educational	Developing guides and awareness raising campaigns for citizens on how to save water and energy, especially during crisis
Technical	Integration of sustainable drainage systems
	Establishment of underground water reservoirs
	Building desalination plants based on the best available technologies
	New or upgrade of (coastal) flood defence systems near affected facilities. Potential re-engineering to increase the height of quaysides.
	Development of controlled flood management zones near afflicted facilities

Table 7: Suggested adaptation actions for built environment

Actions' characteristic	Adaptation Actions
Strategic	Modification of building codes to allow more energy efficient and heat tolerant structures
	Modification of building codes against seismic activity
	Provision of reductions on the municipal taxes for those proceeding in adoption of adaptation measures in their houses
	Integrated land use planning with zoning system depending on the different areas (e.g. red for areas to be heavily afflicted by floods or sea level rise)
Alert / Communication	Not applicable
Educational	Educational campaigns on informing the citizens on the benefits of adopting the suggested actions in their premises
Technical	Greening infrastructure such as buildings' roofs and walls
	Increasing the amount of shade and green areas in the city by planting trees to reduce the heat island effect
	Building exemplary districts with adapted urban forms and buildings
	White roofs (cool colors), shading and bioclimatic design

	Rainwater collection and use
	Adoption of methods to reduce water demand
	Using water resistant construction materials

Table 8: Suggested adaptation actions for economy

Actions' characteristic	Adaptation Actions
Strategic	Elaboration of drought, water and ground water management plan
	Adoption of integrated land use planning for the touristic activities
Alert / Communication	-
Educational	Educating farmers and tourist personnel on ways to conserve natural resources, especially during extreme weather events
Technical	Use of drought resistant crops
	Adoption of agroforestry systems
	Utilization of drip irrigation practices
	Adoption of energy efficient and water conservation programs at resorts
	Reducing cooling needs in resorts by installing automations and setting thermostats at given temperature
	Promotion of RES (SWH, PVs) in resorts

Table 9: Suggested adaptation actions for biodiversity

Actions' characteristic	Adaptation Actions
Strategic	Establishment of a fire management plan
	Elaboration of an integrated coastal management plan
Alert / Communication	Early warning system for flooding or fire hazards
Educational	Educating the citizens
Technical	Fragmenting the forest into section to allow better fire management
	Planning, construction and maintenance of forest roads
	Trees planting
	Establishment of controlled flooding zones
	Beach nourishment or replenishment. It is the artificial placement of sand on an eroded shore to maintain the amount of sand present in the foundation of the coast, and this way to compensate for natural erosion and to a greater or lesser extent protect the area against storm surge (nourishment may also use gravel and small pebbles, in particular for the shoreface). Beach nourishment also often aims at maintaining beaches (beach width for tourism and recreational purposes)

	Restoration and management of coastal wetlands and rivers
	Establishment and restoration of riparian buffers. A general, multi-purpose, riparian buffer design consists of a strip of grass, shrubs, and trees between the normal bank-full water level and cropland. Riparian Buffer Strips are linear bands of permanent vegetation adjacent to an aquatic ecosystem intended to maintain or improve water quality by trapping and removing various nonpoint source pollutants from both overland and shallow subsurface flow. Buffer strips also provide (additional) habitat for aquatic species and may result in increased recharge of groundwater

It should be noted that the adaptation actions to be included in the chapter should be accompanied by more information on the action itself, the respective costs, the implementation timeline etc., in line with the SECAP template.

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The **adaptation actions** have been formulated based on material from the following sources:

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