G20 CLIMATE RISK ATLAS

Impacts, policy, economics

ITALY

With the scientific
contribution of
Enel Foundation

How to read the Atlas: graphs, colours and scenarios.

The maps used in this Atlas are taken from **The World Bank Official Boundaries** - ***https://datacatalog.worldbank.org/search/dataset/0038272*** (accessed on May 28, 2021). For the section Energy, the maps are based on Panoply Data Viewer ***https://www.giss.nasa.gov/tools/panoply/credits.html***

Each sector of this Atlas contains data and information on various climate scenarios.

When reported in graphs, the **colour black** indicates data and information referring to the current state, the past or the baseline.

When the authors refer to **RCP (Representative Concentration Pathways)**, the 3 colours used across the factsheet refer to 3 scenarios, which are 3 different development options with different levels of greenhouse gas emissions, **respectively low emissions (green), medium emissions (orange), and high emissions (red)**. The same colour code is used when RCPs are associated with Shared Socioeconomic Pathways (SSP).

In some cases, the authors refer to global warming scenarios. In these cases, the 3 colours used refer to a temperature rise of **1.5°C (green), 2°C (dark green), and 4°C (red)**.

When the authors refer exclusively to **Shared Socioeconomic Pathways - SSPs** (Population affected by river floods in the section: "Water"), data related to **SSP3** - that encompasses, among other things, slow economic growth, material-intensive consumption, and persisting or worsening inequalities – **are reported in a lighter shade**; **SSP5** – which refers to social and economic development that is coupled with an energy-intensive lifestyle and the abundant exploitation of fossil fuel resources – is shown using a **middle shade of the colour**, whereas data related to **the present** conditions **are represented in a dark shade**.

Further details on scenarios, methodologies, and the full list of references are available at: **www.g20climaterisks.org**

Concept and graphic design by element6.eu

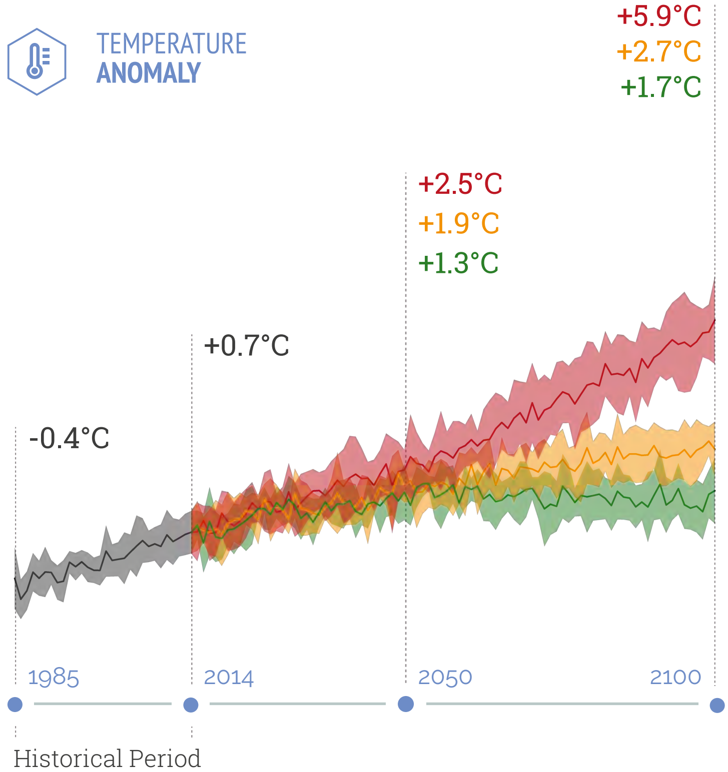
ITALY
CLIMATE

OVERVIEW

Italy is characterized by an extremely variable climate, which is mainly due to the long extension of the country and its geographical position. The northern part exhibits a climate that is similar to the European continent whereas in the South is typically Mediterranean. Finally, the Alps are relativity cold with very peculiar climate features.

TEMPERATURE PROJECTIONS

Under a low emissions scenario projected temperature variations will remain contained at around +1.5°C, both by 2050 and 2100.
Under a high emissions scenario, with no reduction in GHG emissions, much greater temperature anomalies are expected by both 2050 and 2100.



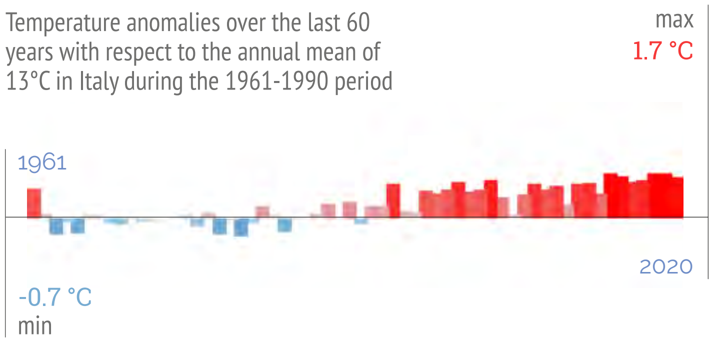
TEMPERATURE

Temperatures in Italy are regulated by the complex orography, ranging from high mountain chains (Alps and Apennines) to a very diverse coastline. Overall, temperatures are lower in Northern Italy and higher in Southern Italy.

MEAN TEMPERATURE

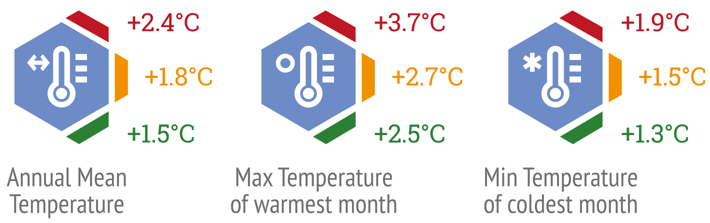
TEMPERATURE TREND

Temperature anomalies over the last 60 years with respect to the annual mean of 13°C in Italy during the 1961-1990 period



EXPECTED VARIATION FOR TEMPERATURE AT 2050

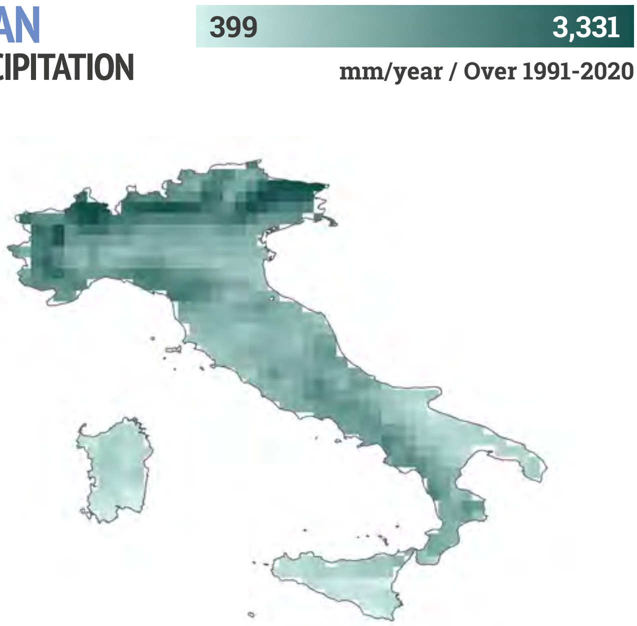
The indicators show variations in selected temperature characteristics for a thirty-year period centred on 2050 (2036-2065) with respect to the reference period 1985-2014.



PRECIPITATION

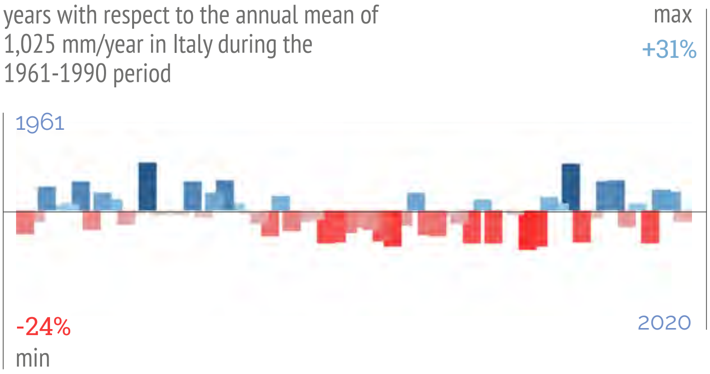
The precipitation regime changes a lot due to the complex orography and occurrence of different precipitation dynamics.
The Alps have the highest annual precipitation values, followed by the Apennine mountains, which run down the entire peninsula.
Precipitation patterns show neither pronounced nor constant trends on the Italian territory, due to the complexity of the precipitation regime and to possible compensation between opposite patterns reported at a local level.

MEAN PRECIPITATION



PRECIPITATION TREND

Precipiation anomalies over the last 60 years with respect to the annual mean of 1,025 mm/year in Italy during the 1961-1990 period

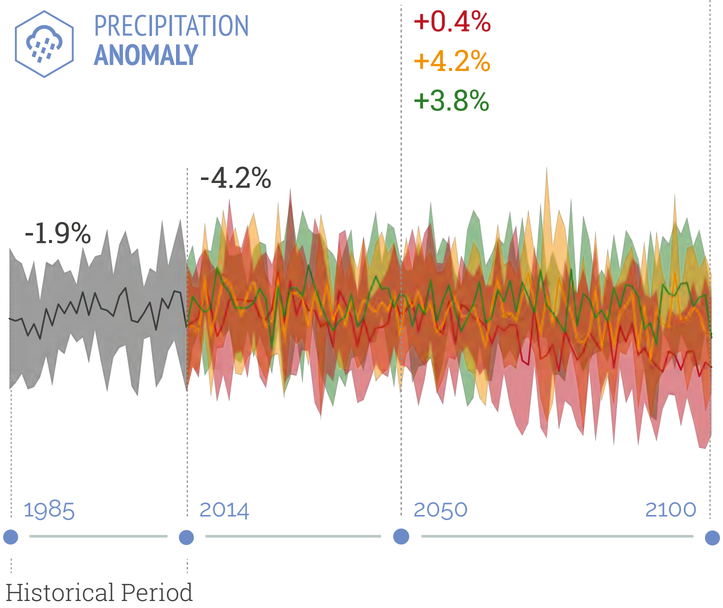


PRECIPITATION PROJECTIONS

Precipitation trends show a very complex signal, under all emissions scenarios, with a very large variability among climate models. This can be explained considering the complexity of the precipitation regime and dynamics requiring more detailed spatial and temporal analysis.

-14.8%
-5.8%
-7.0%

PRECIPITATION ANOMALY



EXPECTED VARIATION FOR PRECIPITATION AT 2050

The indicators show variations in selected precipitation characteristics for a thirty-year period centred on 2050 (2036-2065) with respect to the reference period 1985-2014.

Annual total precipitation	-2.1%	+0.4%	+1.5%
Precipitation of wettest month	+0.8%	+2.4%	+4.8%
Precipitation of warmest quarter	-7.2%	-4.4%	-5.4%

VARIATION OF SPECIFIC CLIMATE INDICATORS

Climate indicators variation showing impacts of climate change on sectors such as agriculture, health and water. Analysis considers 3 threshold average temperature increase: **+1.5°C**, **+2°C**, **+4°C**.

Agricultural drought proportion of time	% of time	+35%	+19%	+14%
Hydrological drought proportion of time	% of time	+31%	+15%	+12%
Heatwave duration	% of time	+1,461%	+261%	+100%
Runoff increase	% of area	+59%	+29%	+10%
Agricultural drought frequency	% of change	+74%	+50%	+35%
Hydrological drought frequency	% of change	+17%	+12%	+14%
Heatwave frequency	% of change	+80%	+35%	+21%
Runoff decrease	% of area	+10%	+6%	+4%

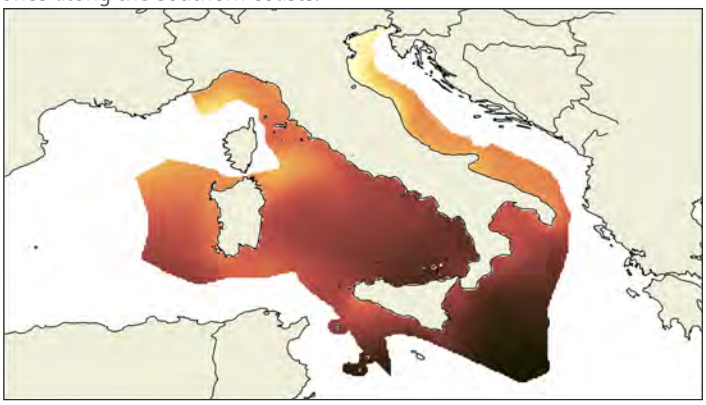
ITALY OCEAN

OCEAN IN ITALY

Italy's marine exclusive economic zone (EEZ) is mainly characterized by a Mediterranean climate and hosts a large variety of ecosystems such as seagrass meadows, rocky reefs, and lagoons. The wide ensemble of coastal systems can be divided into three main subbasins: the Adriatic, Ionian, and Tyrrhenian seas.

CURRENT CLIMATE CONDITIONS

Mean sea surface temperature reflects the Mediterranean climate regime, with cold waters located in the northern areas and warmer ones along the southern coasts.

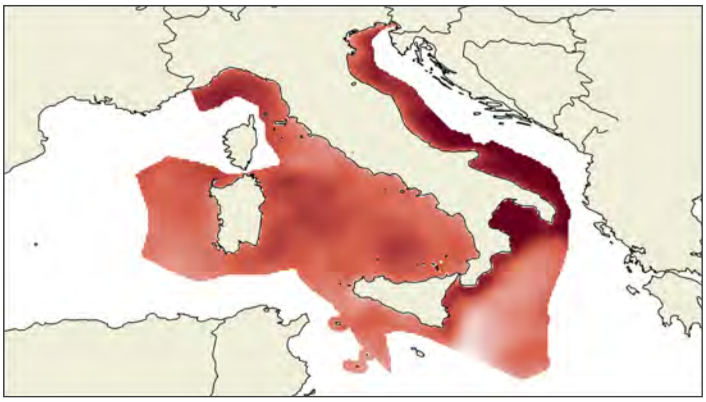


17 21 **MEAN**

SEA SURFACE TEMPERATURE

Celsius degrees / Over 1991-2020

0.1 0.5 **TREND**



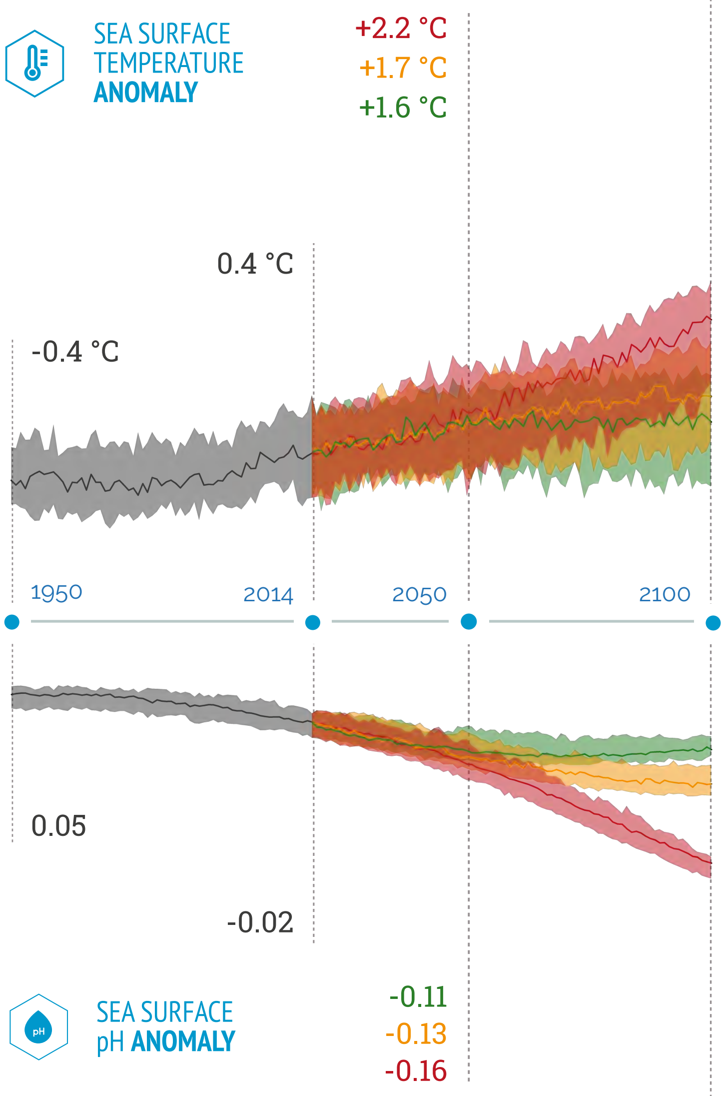
Surface temperature trends indicate a general warming of 0.5°C per decade in all marine areas.

FUTURE PROJECTIONS

Projected annual changes within the marine EEZ for the two most significant marine indicators of climate change: sea surface water temperatures and pH.

Seawater temperature changes are in line with the definitions of each scenario, with maximum values in 2100 close to +5°C under a high emissions scenario.

+4.9 °C
+2.6 °C
+1.7 °C



-0.1
-0.19
-0.38

Seawater surface pH becomes more acidic in all scenarios, closely reflecting rising atmospheric CO_2 concentrations, and only a low emissions scenario leads to a stable condition by 2100.

ECOSYSTEM INDICATORS AT 2050

Regional changes in key marine ecosystem indicators under projected future scenarios by mid-century (2036-2065) with respect to present climate conditions (1985-2014).

Adriatic

Ionian

Tyrrhenian

Temperature regulates the metabolism of marine organisms determining which habitats remain suitable. Excessive warming will likely push ecosystems beyond tolerance thresholds.

pH represents the acid/base status of marine waters, where a decreasing pH reflects the acidification of the ocean due to increased absorption of atmospheric CO_2.

Oxygen is fundamental to sustain marine life and its reduction can have a large impact on coastal ecosystem services including fisheries and aquaculture.

Chlorophyll is an indicator of the biomass available at the base of the marine food web supporting all ecosystem productivity.

	Adriatic	Ionian	Tyrrhenian
Temperature	17.94°C	19.44°C	18.78°C
	+2.12 °C	+2.62 °C	+2.16 °C
	+1.72 °C	+1.83 °C	+1.56 °C
	+1.71 °C	+1.67 °C	+1.68 °C
pH	8.11	8.1	8.11
	-0.16	-0.16	-0.16
	-0.13	-0.13	-0.13
	-0.1	-0.11	-0.11
Oxygen	242.17 $mmol/m^3$	233.36 $mmol/m^3$	236.54 $mmol/m^3$
	-4.96 %	-4.46 %	-3.04 %
	-3.48 %	-3.03 %	-2.1 %
	-3.03 %	-2.5 %	-1.54 %
Chlorophyll	0.17 mg/m^3	0.13 mg/m^3	0.1 mg/m^3
	-0.59 %	0 %	+13 %
	+22.35 %	-27.48 %	-7 %
	+4.12 %	-14.5 %	-4 %

FISH CATCH POTENTIAL

Fish catch potential is an estimate of the maximum fish catch achievable given the marine resources available over a sustained period. It is linked to the concept of maximum sustainable yield, meaning the maximum amount of fish that can be extracted from a system without causing a collapse in fish populations.

It is a characteristic of the natural system, which is substantially different from realized catch, and a direct result of the fishery policy in place.

While no specific data is available for the Italian EEZ, a decrease between 0 and 5% in potential catch for the Mediterranean Sea at mid century has been projected under a high emissions scenario.

ANALYSIS DETAILS

All datasets were analysed using only data from within the marine EEZ and therefore excluding overseas territories, detached islands and any disputed or joint territories with other nations. In the assessment of current climate conditions, seawater surface tempereture data was obtained using satellite observations distributed in the framework of ESA Climate Change Initiative.

Future projections of marine indicators are represented by the combined analysis of results from 15 different Earth System models participating in the Coupled Model Intercomparison Project Phase 6 (CMIP6). These models include new and better representations of physical and biogeochemical processes, compared to previous IPCC assessment reports.

Fish catch potential data was obtained using the FAO's technical report and refers to the best and worst case climate scenarios from the Fifth IPCC Assessment Report. These mean estimates are subject to substantial uncertainties as discussed in the original work.

ITALY COASTS

OVERVIEW

Surrounded by the Mediterranean and Adriatic seas, and with a total length of over 9,000 kilometres, Italy's coastline is exceptionally geographically diverse as well as both historically and economically valuable for the country. Among the coastlines most notable features is the variety of natural features such as rocky and sandy beaches, cliffs, river deltas, wetlands and lagoons. It is also home to a significant proportion of the population.

Shoreline Length: 9,226 km

Sandy Coast Retreat at 2050: -17.4 m

CLIMATE CHANGE HAZARDS

Coastal hazards such as erosion, storm tide inundation and permanent flooding, can have strong adverse impacts on coastal regions, with loss of sandy shores, damage to settlements, infrastructure and ecosystems. Climate change can exacerbate these impacts due to rising sea levels and increasing impacts of waves and storms. Coastal erosion and temporary inundation due to storms are quite common along the Italian coast, in particular in areas with low lying beaches. The country has already begun to feel the impacts of sea level rise, with numerous areas being exposed to the impact of inundation and storms, such as the North Adriatic Sea and the Venetian lagoon.

SEA LEVEL RISE

Based on observational data, the average sea level rise for Italy has been estimated at 1.64 millimetres per year since 1903, with the Northern Adriatic area identified as one of the most susceptible to sea level rise. The latest IPCC projections indicate that, by 2050, global sea levels may rise between 0.18 metres, under a low emissions scenario, and 0.23 metres, under a high emissions scenario.

Observed and projected sea level rise at 2050: 1.64 mm/year; 0.23 m; 0.18 m

EXTREME SEA LEVEL

On average, one in 100 extreme sea level events are expected to rise from 1.12 metres at present day to 1.31 metres by 2050 under a medium emissions scenario.

Current and projected extreme sea level at 2050: 1.12 m; 1.39 m; 1.31 m

OBSERVED STORMS

Several regions of the Italian coast, such as the low-lying and subsiding Po Delta, are vulnerable to the effects of storm surges and extreme waves. Although the Mediterranean Sea sees relatively small tides and low energy storms an increasing number of extreme events are being observed, causing alarm due to fears of erosion and other damages, particularly given a rising coastal population.

FUTURE STORMS

A projected increase in the frequency and intensity of extreme waves and storms could worsen the coastal impacts of climate change significantly, especially when considered in combination with sea level rise, which will increase the probability of such events as well as compounding their severity. Although it is possible that storms may not increase in severity in a significant way, expected sea level rise is likely to lead to more severe impacts.

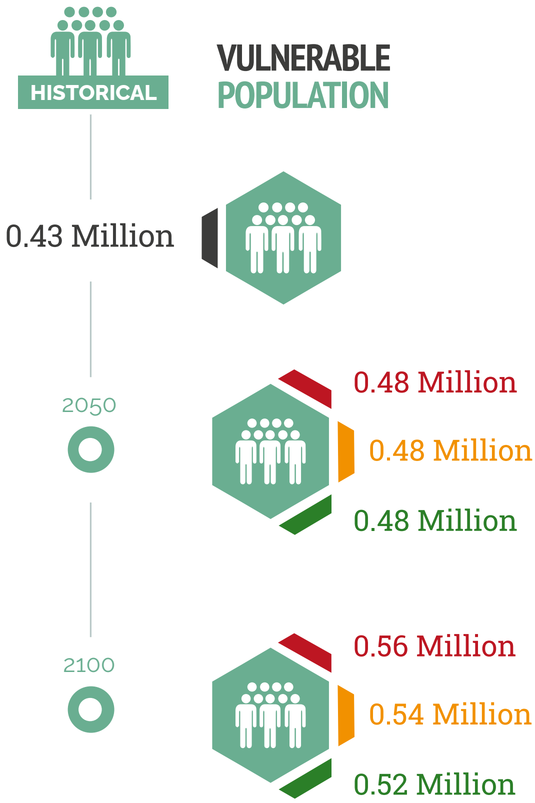
VULNERABILITY AND RISK

Several important sectors are particularly vulnerable to climatic risks, including coastal tourism, which is hugely important to the Italian economy, as well as industrial activities and important infrastructure and assets.

Of particular note is the historic city of Venice, which is already facing significant impacts from sea level rise and storm surges, threatening many points of cultural heritage.

Numerous Italian localities suffer from chronic beach erosion and coastal risks have been increasing in the past few years, going hand in hand with increasing costs of shoreline protection and management.

Furthermore, the fragile ecosystems that can be found in coastal areas, and the wildlife that inhabits them, will be threatened by degradation, saltwater intrusion, and loss of habitat. Under a medium emissions scenario, the population exposed to the annual coastal flood level is expected to increase from 430,000 to 480,0000 people by 2050.



INFLUENCE OF SEA LEVEL RISE ON EXTREME SEA LEVEL

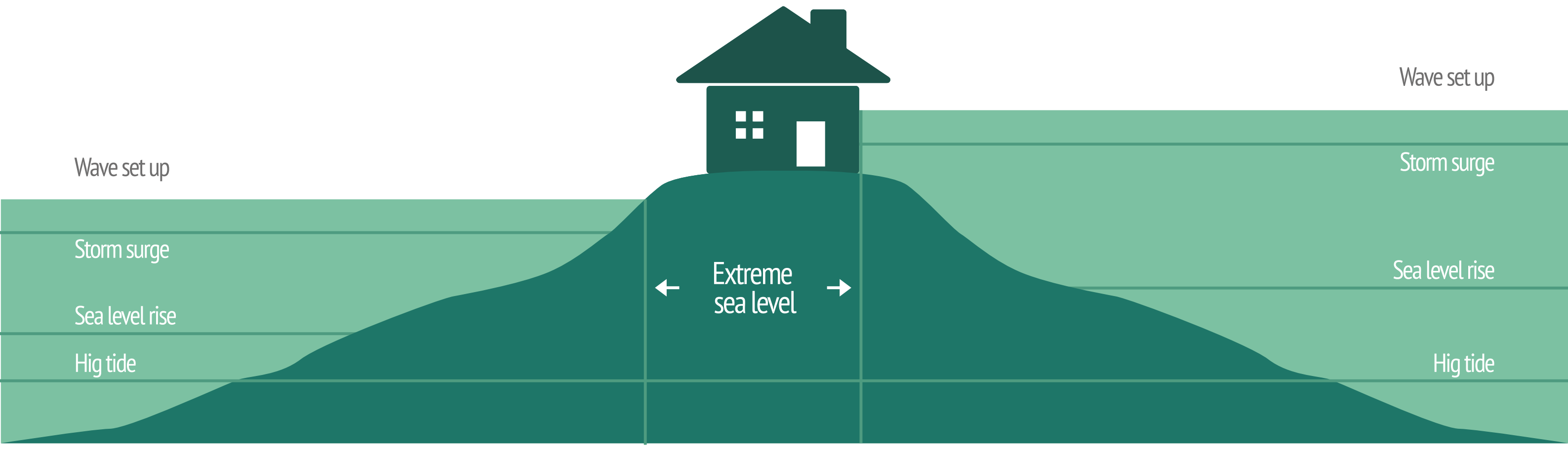
Present and future sea level rise are a consequence of carbon induced global warming causing melting ice and ocean expansion due to heat accumulation.

The extreme sea levels reported here are based on the 100-year storm surge + wave set up + sea level rise + high tide indicators. The first two parameters (storm surge + wave set up) are based on the 100-year value for the event; sea level rise is its projected value at 2050; and high tide is the absolute value of the highest tide calculated for a given locality, which won't be influenced by climate change.

+ Wave set up refers to the accumulation of water near the shore due to the presence of breaking waves.

+ Storm surge is an occasional increase in sea level driven by shoreward wind-driven water circulation and atmospheric pressure.

+ High tide is usually the highest tide reached in a given location based on tide records.



Present sea levels have risen globally by approximately 20 centimetres over the past century.

Future sea level rise is a projection based on different global warming scenarios, at approximately 100 centimetres by the end of 2100, with consequent inundation during extreme sea level events.

ITALY WATER

OVERVIEW

Italy's water resource distribution is driven by a highly variable annual rainfall, both in volume and spatial distribution. The trend over time and the distribution of cumulative annual rainfall are quite diversified.

This variability affects runoff, streamflow, groundwater recharge and water availability for human activities. Due to its geographical distribution, Italy experiences great meteorological variability from one region to the other, which affects the availability of natural water resources.

The main rivers and the largest lakes are located in the northern and central parts of the country.

Renewable internal freshwater resources — 183 billion m³

Renewable internal freshwater resources per capita — 3,014 m³

Italy's water resources are distributed as follows: 60% agriculture, 25% energy and industrial sector, and 15% civil uses. Inefficiencies in distribution networks result in losses of around 40% for both drinking and irrigation waters. The most important rivers in Italy are located in the North of the country, including the Po, Adige and Brenta.

CLIMATE CHANGE HAZARDS

Climate change can affect water resources through increasing temperatures, higher rates of evapotranspiration and altered rainfall patterns. This leads to changes in the water cycle, including decrease of snow and ice coverage, alterations of surface runoff and groundwater storage, as well as drought and flood occurrence. Italy's water security has been deeply affected by climate change: the country is prone to water-related hazards and climate change is expected to increase its vulnerability in coming decades. In the north of Italy, cities that are vulnerable to extreme weather events, such as Venice and its lagoon, are particularly at risk.

KEY POINT RUNOFF

Marked variations in the fluvial seasonal streamflow may be observed due to climate change. In particular, an increase of the flow rate is expected in winter in the Alps and at high altitudes, along with a decrease in the Po river, in the Italian plains and in summer, due to the changes in the snow line and in the water/glacial reservoirs.

At a country scale, an average decrease in surface runoff by approximately -6% and -2% is expected respectively under low and medium emissions scenarios for the 2045-2055 period compared to 2015-2025.

If temperatures rise by 1.5°C, 2°C or 4°C, 4%, 6.1% or 10% of the area of the country will likely experience an increase in runoff, while 10%, 28.6% and 59% of the surface of the country will likely experience a decrease in runoff, respectively.

2050

Changes in annual runoff
% of change

-2.3%

-6.3%

2050

Runoff increase
% of area

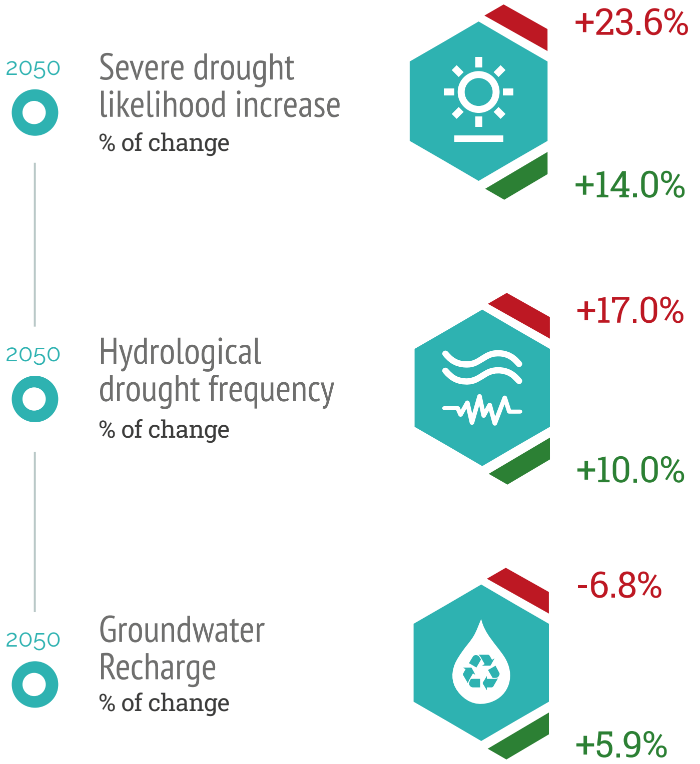
+10.0%

+4.0%

KEY POINT DROUGHTS

The central and southern regions of Italy are more likely to experience severe drought events: a common feature of Mediterranean droughts is the persistence of high pressure systems. In the Mediterranean area, drought seems to be connected to La Niña, an anomalously high cooling of the equatorial Pacific Ocean; out of 14 La Niña events, occurring between 1865 and 1990, 13 were associated with droughts in the Mediterranean area. In southern Italy, a widespread decreasing trend of annual rainfall is observed over 97% of the whole area from 1921 to 2001.

The likelihood of severe droughts in Italy is expected to increase by 6%, 19.6% and 23.6% (2040-2059) under low, medium and high emissions scenarios. Similarly, If temperatures rise by 1.5°C, 2°C or 4°C, there is an expected increase of hydrological drought frequency by 11%, 12.2% and 13%, respectively.



KEY POINT GROUNDWATER

Italy is one of the European countries where problems of groundwater overexploitation and subsequent salinization are felt most severely. Groundwater recharge in Italy shows a declining trend, with consequent shrinking of fresh groundwater resources, especially in coastal areas.

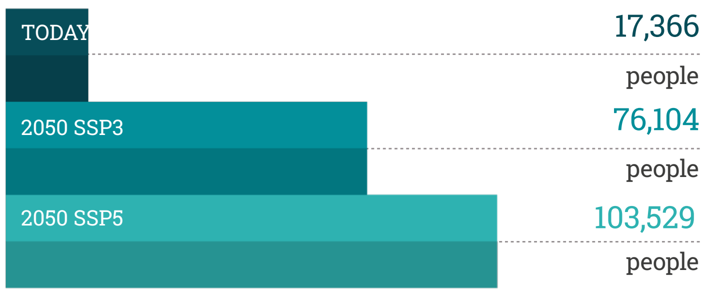
Due to the general decreasing precipitation trend in Italy (especially in the center and south of the peninsula), groundwater recharge is threatened, in particular in the least rainy regions. In addition, coastal groundwater may be susceptible to changes in salinity because of saltwater intrusion, associated with sea level rise. At the country level, a +5.9%, -1.7% and -6.8% change of the annual groundwater recharge for the period 2040-2060 compared to the timeframe 2010-2030 is expected respectively under under low, medium and high emissions scenarios.

KEY POINT FLOODS

Italy is prone to floods, with 28 large events affecting Italy between 1939 and 2004, causing 694 victims, leaving 1.5 million people homeless, 2.85 million people affected and vast economic damage. Many Italian cities have experienced severe flooding events in recent years: for instance, in Rome, between 2010 and 2019, 18 flash flood events occurred; in Milan 23 analogous events, 17 of them related to flooding of the Seveso and Lambro rivers.

Changes in the population exposed to floods are expected, with an increase from about 17,000 in the present day to 76,000 under SSP3 and 103,000 under SSP5 by 2050. As such, potential impacts related to river floods might increase.

POPULATION AFFECTED BY RIVER FLOODS

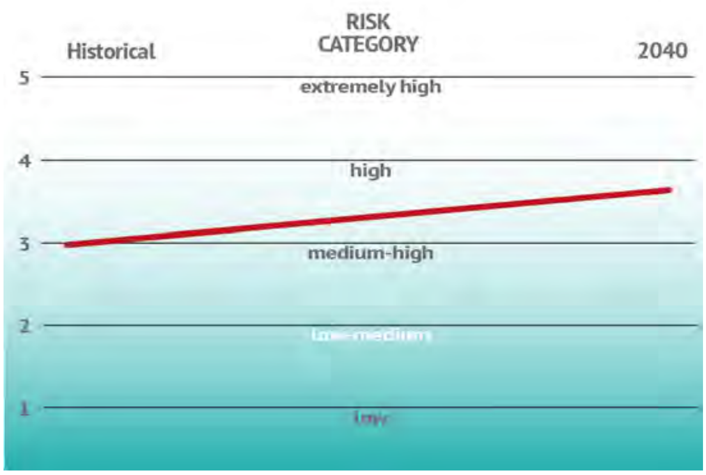


RISK INDICATORS

The water stress index summarises current and future water related vulnerabilities and risks at the global level. Scores are based on the ratio of total water withdrawals, including agriculture, industrial and human consumption, to available renewable surface and groundwater supplies.

WATER STRESS

Italy's water stress level is considered high for the recent past (1960-2014 average), and it is expected to increase in the near future (2030-2050) based on climate change projections.



ITALY AGRICULTURE

OVERVIEW

Italy is a major agricultural producer and exporter, with agriculture still a relevant sector in terms of GDP and employment.

The Italian landscape and its agriculture are highly diversified, ranging from highly intensive farming in northern Italy to extremely marginal and fragmented farms in mountain zones and southern Italy. More than half of the total agricultural area is cultivated with arable crops (54.5%), whereas the rest features grasslands and pastures (26.7%) and agricultural woody crops (18.5%). Maize and wheat account for about 80% of total cereal production. Among tree crops, the cultivation of olive and grapes stand out.

Irrigation adsorbs about 50% of total water withdrawal, and is mostly used for maize, vegetables, fodder crops and several tree crops (olives, grapes, citrus, etc.).

8.5 Mt
Grapes

7.1 Mt
Wheat

6.2 Mt
Maize

5.7 Mt
Tomato

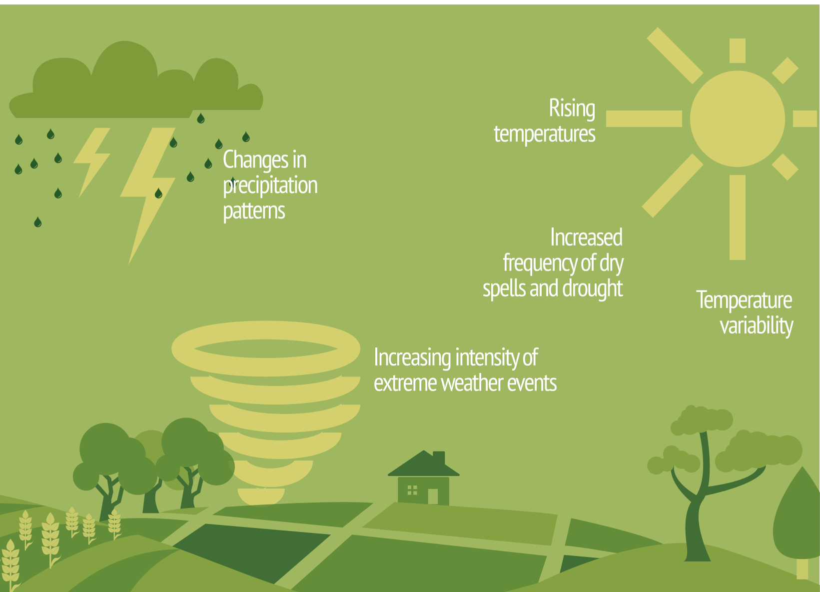
2.5 Mt
Citrus

1.9 Mt
Olives

	Added Value of Agriculture, Forestry and Fishing	Share of Agriculture Value added in Total GDP	Agricultural land	Area Equipped for Irrigation
2000	38,294 USD Million	2.1 %	11,284 Thousand HA	3,856 Thousand HA
2018	36,655 USD Million	1.9 %	9,160 Thousand HA	4,124 Thousand HA

EXPECTED IMPACTS ON AGRICULTURE PRODUCTIVITY

Rising temperatures, reduction in average annual precipitation, and intensification of extreme events such as heat waves and drought, affect production variability with a tendency towards yield reduction for many cultivated species, accompanied by a probable decrease in food quality. Crops respond to increases in temperatures with changes in duration of the growing season, early appearance of phenological phases and potential shifts of cultivation areas toward higher latitudes and altitudes for better growing conditions. However, impacts vary significantly depending on the geographical area and specific crops in question.

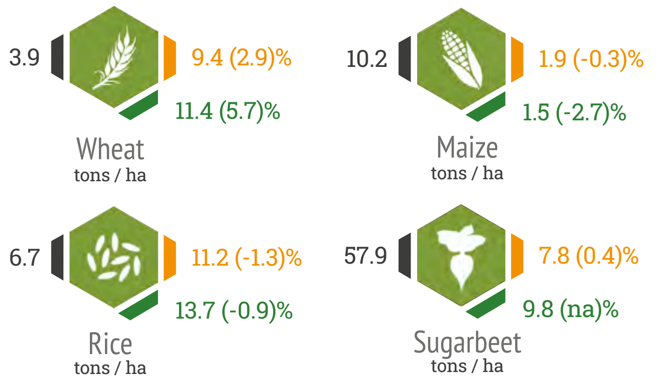


CROP PRODUCTIVITY

Crop productivity refers to the harvested yield of a crop per unit of land area. It is strongly influenced by climate and other environmental and management factors.

Climate change is expected to have an impact on the productivity of several major crops, although this may in part be offset by the fertilizing effect of higher CO_2.

Impacts are estimated using a range of model projections based on low to high emission scenarios and reported as percentage changes between the 30-year average around the historical period and the 30-year average around 2050.

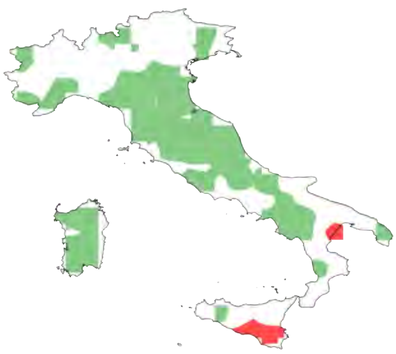


2050

Productivity change with (without) the CO_2 fertilization effect. Estimates assume sufficient water and nutrient supplies, and do not include impacts of pests, diseases, or extreme events.

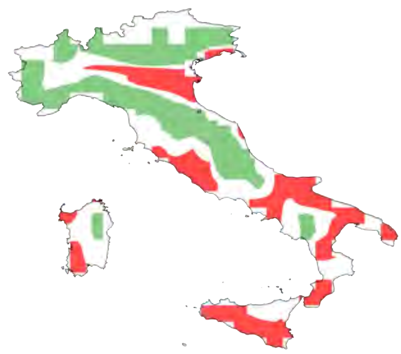
CHANGE IN WHEAT

− = +



CHANGE IN MAIZE

− = +



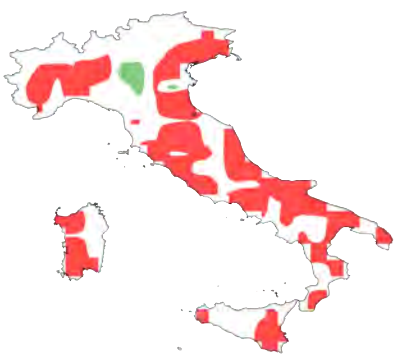
Although wheat productivity is expected to decrease in southern Italy and the major islands, it is expected to see a general increase over central and northern Italy. Maize is the main affected crop with significant losses in yield and some increases at higher elevation. Large yield reductions are also expected for spring-summer crops (sunflower, soy), especially if not irrigated. Rice may see a general yield increase until mid-century, followed by a decrease. However, rice productivity may suffer from extreme temperatures during flowering and ripening. Increasing frequency of extreme weather events during crucial crop development stages (e.g. heat stress during flowering, rainy days during sowing) may reduce yields, particularly of summer crops.
Tree crop productivity is expected to decrease in Mediterranean areas due to drought and high temperatures, which can also deteriorate fruit quality, pushing cultivation of olive and grapes towards colder regions.

ADAPTATION IN AGRICULTURE AND WATER RESOURCES

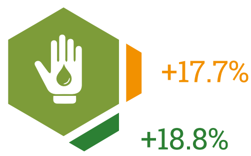
Climate change may have some positive effects on some of the most widely used crops. However, higher temperatures will generally require an increase in irrigation demand due to higher plant evapotranspiration. Agriculture may therefore become more dependent on more intensive irrigation, especially in the southern regions. Climate change may affect water resources, pointing to a severe reduction in the quantity of renewable water resources, both superficial and underground, in almost all semi-arid areas. Water deficit will worsen in the hot season when resources are scarce and demand for irrigation increases.

CHANGE IN WATER DEMAND

− = +



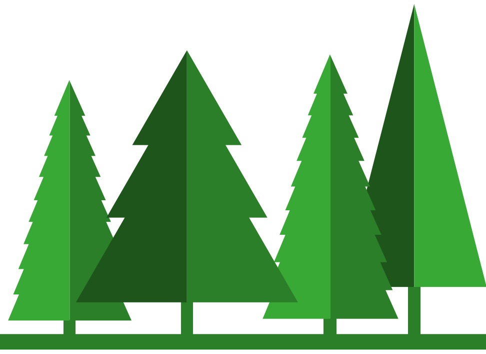
Agriculture Water Demand
% of change



2050

A consistent increase in water demand (17 to 20% on average) will be required to sustain current levels of agricultural production, and it will require adaptation practices and crop varieties that enhance water-use efficiency and limit stress on water resources.

ITALY FORESTS



FORESTS IN ITALY

Forested areas in Italy, albeit largely fragmented, are considered the most important nature-based solution with which to face the unfolding climate emergency.

Due to its complex topography, Italian forests include a wide variety of types such as deciduous broadleaved woods, mediterranean sclerophyllous and boreal coniferous forests in the Alps.

1990

8 Mln ha
Million hectares
Forested area

140 Tons/ha
Tons of Carbon per hectare
Carbon stock

2020

10 Mln ha
Million hectares
Forested area

157 Tons/ha
Tons of Carbon per hectare
Carbon stock

FORESTED AREA AND CARBON STORAGE

With a constant increase in recent decades, Italian forests have come to cover nearly 40% of the territory. Italian forests remove approximately 46.2 million tons of carbon dioxide from the atmosphere each year, which amounts to 12.6 million tons of accumulated carbon.

FOREST PRODUCTIVITY

Forest productivity or Net Primary Production is the net carbon captured by plants. It is the difference between the carbon gained by Gross Primary Production - net photosynthesis measured at the ecosystem scale - and carbon released by plants' respiration. It is expressed per unit land area.

2050

Productivity anomaly
Tons of Carbon per hectare per year

+1.03

+0.77

Generalized increase expected throughout the country except for the western and eastern mountainous areas. Very marked increase under a medium emissions scenario

+ Fertilizing effect of increasing atmospheric CO_2, nitrogen deposition, rising temperature and increasing length of growing season promotes productivity

No areas with an expected decrease in forest primary production

+ Prolonged periods of drought stress reduce productivity

KEY SPECIES UNDER CLIMATE CHANGE

VULNERABILITY
SPRUCE
Forests dominated by spruce will have a very high vulnerability

SPREAD
THERMOPHILOUS
Progressive natural spread of lower altitude thermophilus species strips both in the Alps and Apennines

EXPANSION
MED OAKS
Considerable expansion of mediterranean oaks such as the holm oak, downy oak and Turkey oak

VULNERABILITY
BEECH
Negative variation in suitability values is expected for European beech, especially in the central and southern Apennines

FIRES IN ITALY

Fire is a structural ecological process that provides several types of ecosystem services and impacts on socio-ecological systems, including human health, carbon budgets, and climate change. Changes in global fire activity are influenced by multiple factors such as land-cover change, policies, and climatic conditions. Fire also releases large quantities of greenhouse gases into the atmosphere, contributing to a vicious cycle.

During the last three decades, the total area affected by fire was approximately 2.6 million hectares with 238 thousand fires occurring.

BURNING
2.6 MILLION HECTARES

EMITTING
0.83 TERAGRAMMES OF CARBON PER YEAR

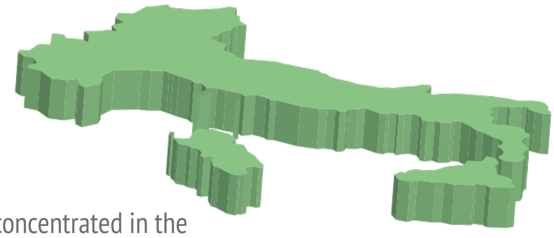
FOREST FIRE EMISSIONS
12% OF TOTAL FIRE RELATED CARBON EMISSIONS

COSTING
580 MILLION USD IN FIRE SUPPRESSION AND FIRE DAMAGES IN 2005 ALONE

WHERE DO FIRES OCCUR?

Between 2000 and 2017, agricultural lands and pastures were most affected contributing to 58% of the total burned area. Heartland and shrubland fires contributed to approximately 17.2% of the total burned area.

Social factors such as unplanned urbanization, land use changes, as well as population dynamics including rural exodus and population ageing, have had a significant effect on fire event frequency, particularly in the south.



Fires are concentrated in the southern regions of Sicily, Sardinia, Calabria, and Campania during the summer months, representing 14% of total burned area in Europe over the last two decades.

The 2017 fire season was one of the worst in recent decades in terms of burned areas, with 160 thousand hectares burned, exceeding the 2008-2016 average by approximately 300%.

FUTURE BURNED AREA

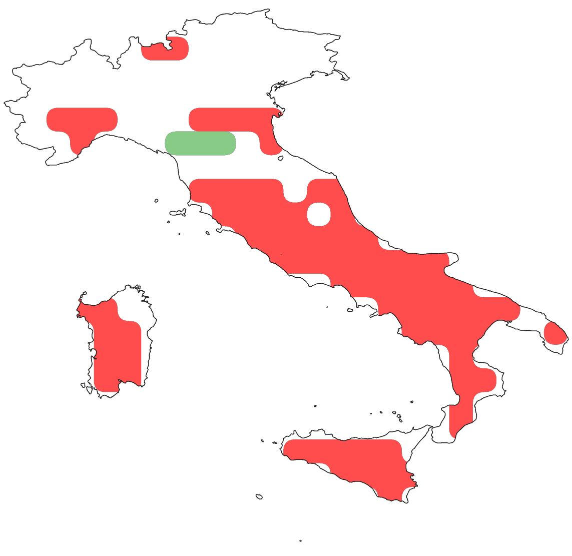
Under a low emissions scenario, models project that the burned area will mainly increase in Sardinia, Sicily, central and southern Italy. This might predominantly affect sclerophyllous and semi-deciduous forests. Burned area under a medium emissions scenario is expected to follow a similar spatial pattern.

Burned Area
km² per year

2050

+131

+120

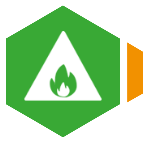


 Decrease in burned areas for a low emissions scenario

 Increase in burned areas for a low emissions scenario
+ Prolonged and more intense fire seasons and an increase in future fire weather risk due to warming and drought conditions

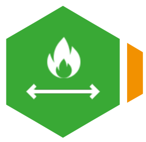
VARIATION OF SPECIFIC FIRE INDICATORS

% of change
High fire-risk days
2041-2070



+46%

% of change
Fire season lenght
2041-2070



+11%

% of change
PM2.5 emissions
2010-2050

+46%

+41%

FUTURE FIRE EMISSIONS

Fire emissions might follow the same spatial pattern as burned area with the added variable of a large increase in the alpine areas. Under a medium emissions scenario, this pattern is expected to be more pronounced.

Fire Carbon emission
Teragrams of Carbon per year

2050

+1.3

+1.0

ITALY
URBAN

OVERVIEW

In 2020, 71% of the population lived in urban areas. This rate is expected to increase slightly by 2050, reaching 82%.

The Italian urban landscape is dominated by small towns, whereby almost half the population live in cities with less than 300,000 inhabitants and more than one third live in the four main Italian cities with more than 1 million inhabitants.

This situation, with a high rate of sub-urbanization, will not change substantially in the near future considering the slightly declining demographic trend.

Built up areas cover 6.77% of Italy (20,387.38 square kilometers).

Population in Urban Areas

2020: 42,006,701

2050: 44,670,873

Graphs refer to data provided by United Nations, Department of Economic and Social Affairs, Population Division (2018). World Urbanization

Urbanization Rate

2020: 71.0%

2050: 81.1%

OVERVIEW OF KEY CLIMATE IMPACTS IN URBAN AREAS

Italian cities are most vulnerable to impacts from heatwaves and flooding following intense precipitation events

HEATWAVES AND HEAT STRESS

Heatwaves are increasingly frequent and, in particular night-time temperatures, contribute to health effects. During the 2003 European heatwave, Italy was one of the most affected countries where mortality was up to two times higher than the European average.

During the 2003 heatwave particularly high numbers of heat related deaths were observed in Turin, +23%, and Milan, +23%, a large amount of which among the elderly, as well as people with low incomes and low levels of education.

During a subsequent heatwave in 2008, mortality rates increased by 22 and 30% in Rome and Milan, respectivley. From an analysis of future climate scenarios, increasing mean and summer temperatures and duration of heatwaves are expected for the whole country.

Frequency, intensity and duration of heatwaves will be significantly higher for urban areas.

2050 — Cooling Degree Days (% of change): +236.9% / +78.3% / +47.1%

2050 — Heatwave frequency (% of change): +80.1% / +35.1% / +21.4%

2050 — Heatwave duration (% of time): +1,461% / +261% / +100%

HEAT AND AIR POLLUTION

Heat related health impacts from rising temperatures in urban areas are accentuated by air pollution. While air quality has improved in most EU countries during the past decade, the situation in Italy is improving at a slower pace. Safe levels of air pollution indicators such as PM10 and PM2.5 were often exceeded in more than 30% of major urban areas in Italy in 2017.

The Po plain experiences particularly high concentrations of air pollution due to its geography, which causes frequent situations of air stagnation. Urban population, and in particular the elderly and children, suffer from the combined impacts of air pollution and high temperatures.

2017

Population exposed to air pollution

94.8%

COASTAL FLOODING

In Italy, approximately 4,500 square kilometers of coastal areas are at risk of flooding due to sea level rise over the next 100 years; the areas most at risk are situated in the northern Adriatic Sea, the Po delta and the Venice lagoon, where there are highly urbanized areas, cultural heritage sites and industrial establishments situated below sea level.

Projected sea level rise

2050

0.23 m

0.18 m

2100

0.77 m

0.38 m

FLOODING

Flooding from short but intense precipitation events affects Italian cities frequently, due to an increasing rate of artificial surfaces both in cities and throughout the country. This prevents water from infiltrating into the ground and causes increasing run-off and accumulation of water in the lower parts of cities. Italy is exposed to a high risk of flooding and landslides due to both its geography and rapid urbanization. 91% of Italian municipalities are exposed to medium risks of landslides and inundations and more than 6 million Italians live or work in areas of elevated risk. One of the main drivers is urban and sub-urban expansion into high risk areas despite decreasing demographic trends. Flooding causes important economic damages and frequently leads to loss of human lives. Despite decreasing overall precipitation trends, short and more intense events are expected to occur more frequently in the future, putting in particular urbanized areas with high shares of sealed surfaces under threat.

2050

Runoff increase
% of area

+10%

+6%

+4%

SURFACE SEALING AND FLOODS

Heavy precipitation in cities is problematic due to the high level of sealed surfaces. Soil sealing increases run off and reduces the amount of water absorbed by soil. Where there are large amounts of impervious ground cover, short duration extreme rainfall events can lead to increased flooding, even resulting in flash floods.

ENERGY POVERTY AND HEAT-WAVES

Energy poverty rates in Italy are higher than the EU average, whereby low income households don't always have the means to keep their homes cool in summer and warm in winter. Under future climate scenarios this problem may be exacerbated.

2010

% of urban population
Population living in slums

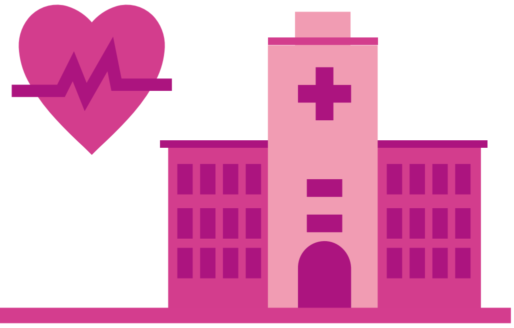
0%

2018

% of total population
Urban population living in areas where elevation is below 5 meters

4.2%

ITALY
HEALTH



OVERVIEW

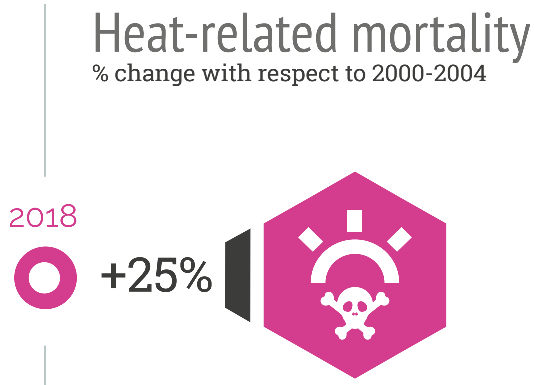
Italy has the highest heat-related effects on daily mortality in the international context (and therefore among the G20), considering both hot temperatures and overall summer temperatures. 30.6% of heat-related mortality in Italy from 1991 to 2015 can be attributed to human-induced climate change. Furthermore, there is a concrete risk of a re-emergence of previously endemic agents (such as tick-borne encephalitis, Lyme disease, Mediterranean spotted fever, and West Nile fever), or the arrival of tropical communicable diseases, such as dengue, chikungunya, Zika, Crimean-Congo fever, or Rift Valley fever and diseases occurring in animals, including, Bluetongue disease and lumpy skin disease.

HEAT RELATED MORTALITY

The Italian population has increasingly been affected by heat waves, especially with over 23% of the Italian population currently over 65. The increase in frequency and intensity of heat waves and population ageing will significantly impact health in the future.

Guo et al. (2018) use historical daily time series of mean temperature and all-cause mortality January 1984 and December 2015 and estimate the change in heatwave-related excess mortality in the period 2031–2080 compared to 1971–2020 (present day).

In 2018, there was a 25% increase in heat-related deaths in Italy from a 2000 to 2004 baseline. 30.6% of heat-related mortality in Italy during 1991 to 2015 can be attributed to human-induced climate change.

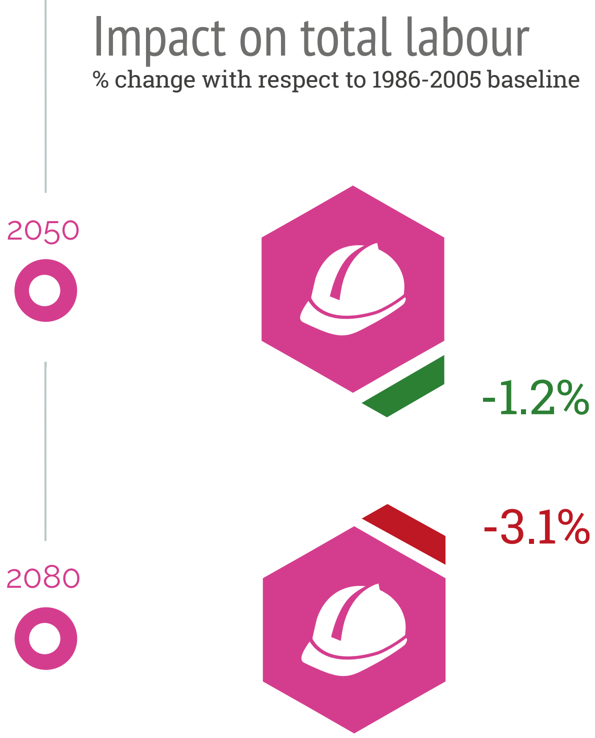


IMPACTS ON LABOUR

Labour is directly affected by changes in environmental conditions. Warming affects both the number of hours worked (labour supply) and on the productivity of workers during their working hours (labour productivity). Both labour supply and productivity are projected to decrease under future climate change in most parts of the world, and particularly in tropical regions.

Parts of sub-Saharan Africa, south Asia, and southeast Asia are at highest risk under future warming scenarios. Future climate change will reduce global total labour in the low-exposure sectors by 18 percentage points and by24.8 percentage points in the high-exposure sectors under a 3.0°C warming scenario

Labour is directly affected by changes in environmental conditions and especially heat stress. In the agriculture, construction, service, and industrial sectors in Italy, there was a 79.9% decline in potential hours of labour lost in 2019 compared to a 1990-94 baseline. Total labour in Italy is expected to decline by 1.2% under a low emissions scenario, and by 3.1% under a medium emissions scenario.



CLIMATE CHANGE AND DENGUE

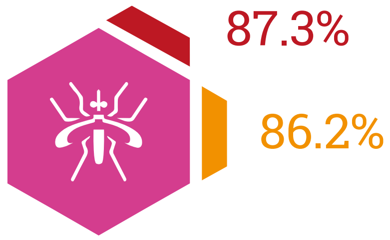
Dengue has spread throughout the tropical world over the past 60 years and now affects over half the world's population. Globally, vectorial capacity for both dengue vectors (A. aegypti and A. albopictus) has been rising steadily since the 1980s, with nine of the ten highest years occurring since 2000.

Climatic stressors are one important driver of the current distribution and incidence of dengue. Climate change is likely to expand the geographical distribution and suitability of several vector-borne human infectious diseases including dengue. The risk of dengue transmission is increased by warming climates, as the growth and development of mosquitoes are significantly influenced by temperature, precipitation, and humidity.

Dengue suitability

% of population at risk

2050



CLIMATE CHANGE AND ZIKA

Zika virus has spread to at least 49 countries and territories since 2013. Climate change impacts on transmission suitability risk have increased over the years and future warming over 1.3 billion additional people could face suitable transmission temperatures for Zika by 2050.

DENGUE AND ZIKA: POPULATION AT RISK

Italy is currently at low risk of dengue and Zika transmissions. However, these risks will increase due to future climate change.

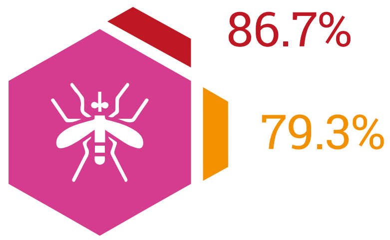
Under a medium emissions scenario, 86.2% of the population will be at risk of transmission suitable mean temperature for dengue by 2050, whereas 87.3% will be at risk under a high emissions scenario.

In the case of Zika, 79.3% of the population will be at risk by 2050 with medium emissions, whereas 86.7% will be at risk under high emissions.

Zika suitability

% of population at risk

2050



CLIMATE CHANGE AND MALARIA

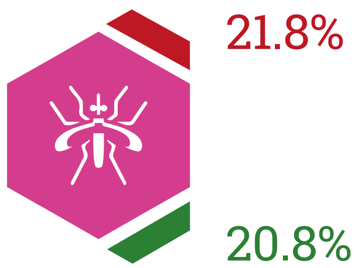
Although Italy has essentially been free of malaria transmission since the 1970s, malaria transmission stability has been rising due to climatic changes favouring vectors.

More than one-fifth of the Italian population will be at risk of malaria due to future warming. 20.8% of the Italian population will be at risk of malaria in a low emissions scenario in 2050, whereas 21.8% will be at risk under a high emissions scenario.

Malaria suitability

% of population at risk

2050



POLLUTION AND PREMATURE MORTALITY

Short and long term exposure to air pollution can have direct and sometimes severe consequences on health. Although regulations have helped improve outdoor air quality significantly, premature deaths due to exposure to near-surface ozone and heat are likely to increase. Under the medium emissions scenario, annual premature deaths due to long-term exposure to near-surface ozone and heat will increase from 8,349 (2010) baseline to 10,282 in 2050.

ITALY ENERGY

ENERGY SYSTEM IN A NUTSHELL

Italy has seen a substantial downsizing of its energy-intensive industries over the past 40 years, vis-a-vis an increasing relevance of the service sector.

Italy has a long-standing tradition of energy efficiency policies, which has brought it to have one of the lowest energy intensities of GDP in the world.

0.06
ktoe/US$
Energy intensity

7.9%
AC Share in electricity consumption

85%
Import dependence ratio

ENERGY SUPPLY

Italy's energy mix of total primary energy supply shows a prevalence of oil and gas (respectively, 34% and 42% in 2018), the virtual disappearance of coal (4%), and a still minor, but fast-growing share of renewables (17%, including hydro and biofuels). There is no nuclear energy in the country. Fossil fuels are imported from a diversified portfolio of sources, as national production is negligible.

CLIMATE CHANGE TODAY

ENERGY

The Italian energy sector has so far shown a high level of resilience to climate related threats due to the international diversification of its supply sources and the reliability of its electricity transmission and distribution grid and international interconnectors.

AIR CONDITIONING

In more recent years, increasing summer peak demand for air conditioning has caused stress to the energy system at the local level, resulting in short, localized blackouts.

HYDROPOWER

Spring and summer droughts have already resulted in repeatedly low levels of water in hydropower dams, raising concerns about the ability of the system to satisfy demand. The issue was tackled by increasing imports, but also resulted in higher electricity prices.

ENERGY DEMAND

Energy in Italy is mainly used for transport (31% in 2018, mostly on road), residential (27%) and tertiary (14)% sectors. Industry claims a 26.5% share (including 6% of total demand for non-energy uses), while agriculture and fishing combined only amount to a 2.6% share. Air conditioning contributes 7.9% of residential electricity demand.

FUTURE ENERGY DEMAND

Italy has a very varied climate, ranging from cold Alpine valleys to hot southern regions. Overall, the decrease in heating demand is going to be more than compensated by the increase in cooling needs by 60 PJ (16,7 billion Kwh) under a medium emissions scenario.

Net change in energy demand due to changes in DD/CDD
Billion KWh

2050

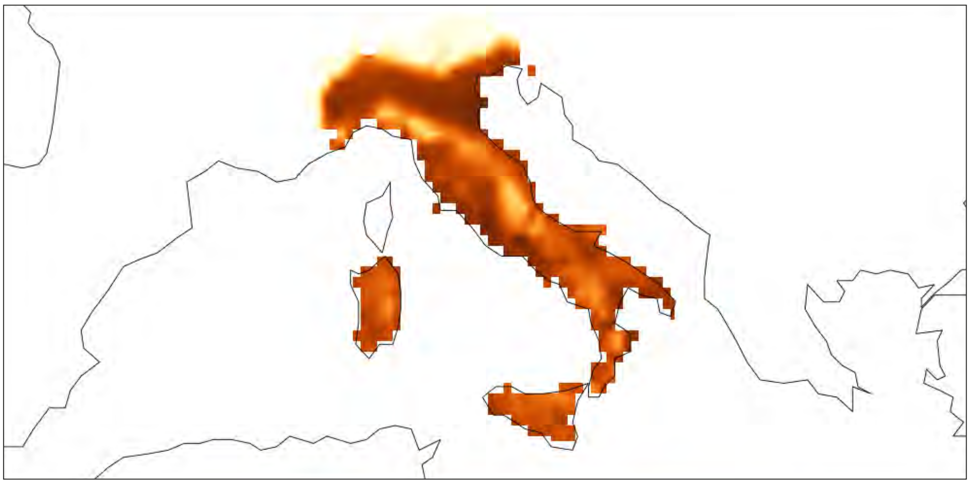
+ 16.69

COOLING NEEDS

Marked increases in cooling degree days all over Italy, bar at the highest elevations in the Alps, whereas the Apennines are less likely to escape from the increase in cooling needs. Stronger increases are expected in the densely populated Po valley, Tuscany, Lazio, Campania (hence in Florence, Rome and Naples) and in general along the coasts.

COOLING DEGREE DAYS

0 400

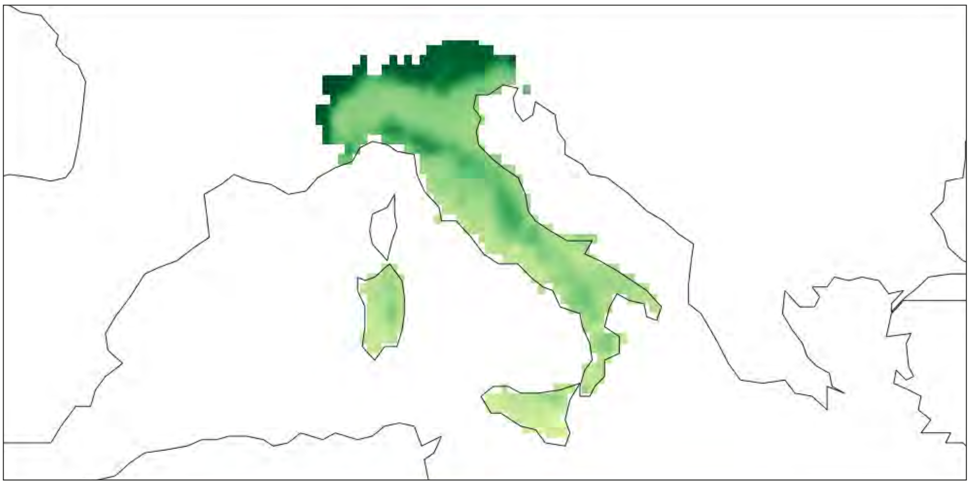


HEATING NEEDS

Heating needs are expected to decrease all over Italy, particularly in traditionally colder regions, where the territory is partially mountainous, such as all northern regions and to a lesser extent, central Italy. Moderate decreases expected in southern Italy.

HEATING DEGREE DAYS

-831 0



FUTURE ENERGY SUPPLY

The future configuration of the Italian energy mix is likely to be determined by the evolution of climate mitigation policies and hence is outside the scope of this report. The EU net-zero carbon target by 2050 is likely to result in a marginal relevance of fossil fuels and their vulnerabilities to climate change, while carbon free sources (renewables and imported electricity) and their vulnerabilities will prevail.

Change in Hydropower generation
% of change

2050

-3.30%

-3.73%

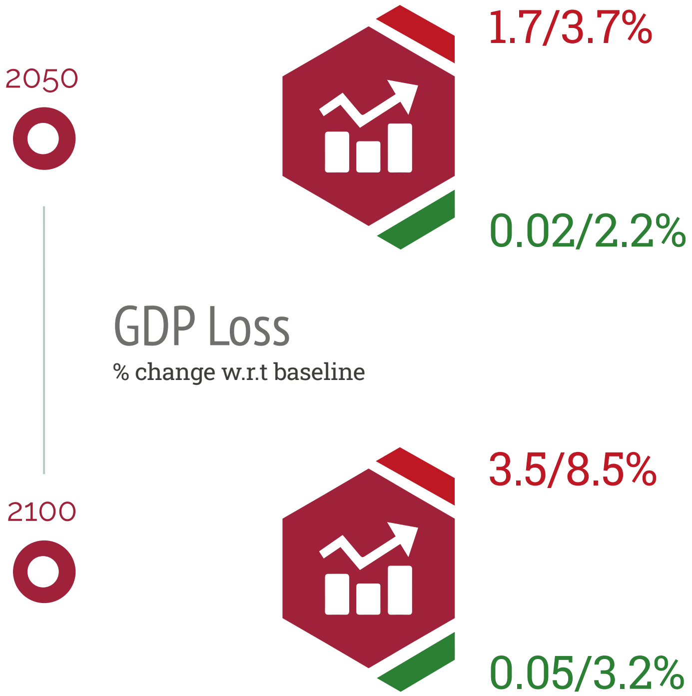
EXPECTED IMPACTS OF CLIMATE CHANGE

The current trend of rising summer temperatures, with rising chances of heatwaves and droughts, is expected to intensify, leading to peak electricity demand coinciding with low water availability for power generation and heat stress on the grid, particularly in central and southern Italy, and in northern cities, due to the heat island effect. Hydropower generation is expected to decrease moderately on average.

ITALY ECONOMY

OVERVIEW

Italy ranks 8th in GDP among G20 economies. It has been one of the EU economies most severely hit by the COVID crisis, experiencing a decline larger than 9% of GDP in 2020.



IMPACTS ON GDP

Italy, located in the Mediterranean hot spot for temperature, is particularly vulnerable to changing climate conditions. GDP losses related to climate change impacts can be significant already by mid century under a low emissions scenario, peaking at 2.2% of GDP or 36 billion EUR.

Losses could reach 116 billion EUR (more than 8% of GDP) by the end of century in a high emissions scenario.

SECTORAL ECONOMIC IMPACTS

IMPACTS ON INDUSTRY AND INFRASTRUCTURE

Italy features the 5th longest coastline in the EU and the 14th in the world. Damage to coastal area infrastructure from sea-level rise can be particularly severe.

In part due to the country particular oro-geography, today 91% of Italian municipalities are prone to hydro-geological risk; hence the projected increase in frequency and intensity of riverine floods under climate change is particularly worrisome.

IMPACTS ON AGRICULTURE

As is typical of developed economies, the overall contribution of the Italian agricultural sector to national GDP is rather limited: 1.9% in 2019.

Nonetheless the high quality of Italian production offers a fundamental direct and indirect contribution to national exports. For instance, in 2020 the agri-food sector export volume totaled 46,1 billion EUR. Wine product exports alone reached a value of 6,2 billion EUR.

The direct costs of climate change for Italian agriculture may be relevant. Yield losses, affecting among others high value-added cultivars, can determine a production contraction quantifiable in an aggregate cost of 12.5 billion EUR (0.7% of GDP) for a temperature increase of 2°C, to 30 billion EUR (1.9% of GDP) for a temperature increase of 4°C.

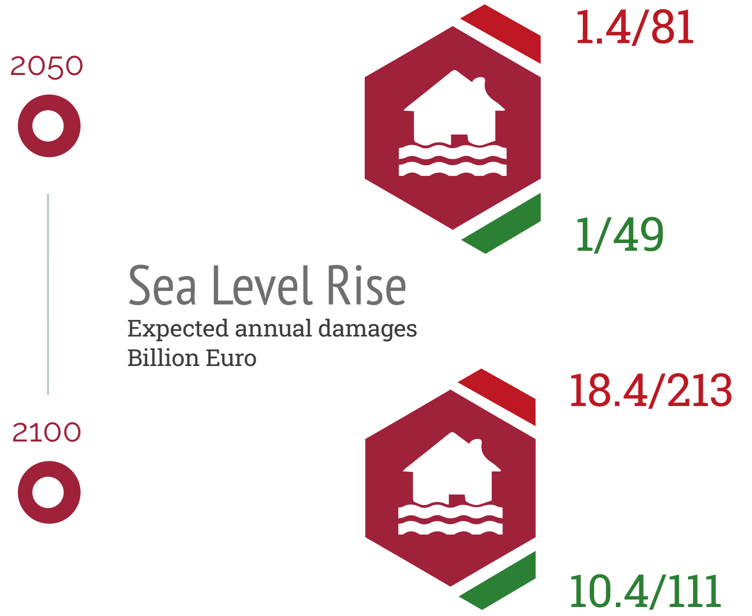
Due to its high-quality cultivars, Italy is also characterized by one of the highest average farmland values in the EU. Climate-change however can reduce the suitability of soils to grow high quality varieties leading to a dramatic decline in farmland values.

Estimates range from a loss of 1–11% of aggregate farmland values under a medium emissions scenario, and a loss of 4-16% under a high emissions scenario by the end of century. Other studies report more pessimistic estimates of a 10% loss in farmland value per degree of temperature increase.

SEA LEVEL RISE DAMAGES

Assuming that no new investments in coastal protection are undertaken, the expected annual damages on assets under a high emissions scenario may peak at 81 billion EUR already in 2050.

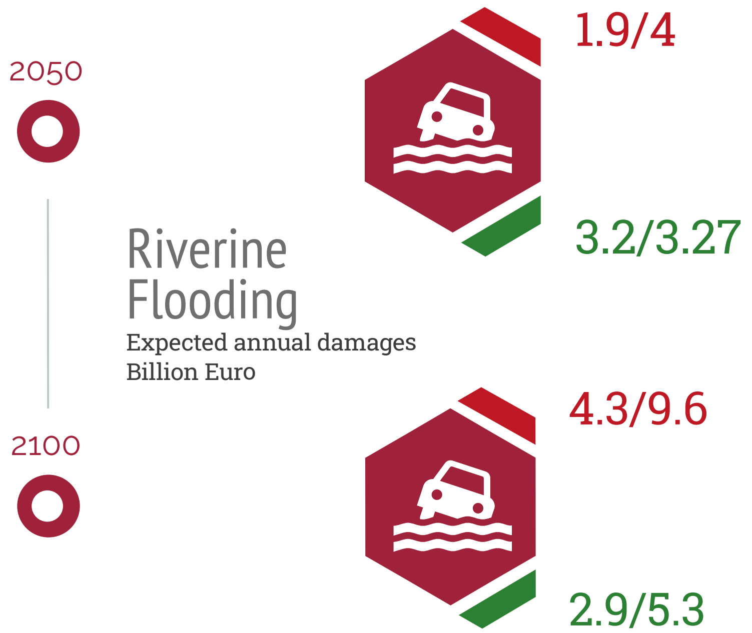
By 2100 annual damage can range between 18.4 and 213 billion EUR depending on different assumptions on adaptation.



RIVER FLOODING DAMAGES

Increase in frequency and intensity of extreme weather events can generate relevant economic losses associated with riverine floods.

9.6 billion EUR in expected annual damage to infrastructure assets could be experienced under a high emissions scenario in the second half of this century.



IMPACTS ON ENERGY

Economic impacts of shifts in household and firm energy demand (see the "Energy" chapter) are difficult to predict and will mostly lead to redistribution effects.

Being a temperate to warm country, Italy will see a decline in energy consumption for warming and an increase for cooling. Residential electricity demand is for instance expected to increase between 5 and 10% in 2070 under a high emissions scenario. The net effect on household bills is however difficult to estimate.

IMPACTS ON FORESTRY AND FISHERY

The fishing sector may experience a reduction in catches with a direct production loss in 2070 ranging between 191 and 323 million EUR under low emissions and high emissions scenarios, respectively.

IMPACTS ON TOURISM

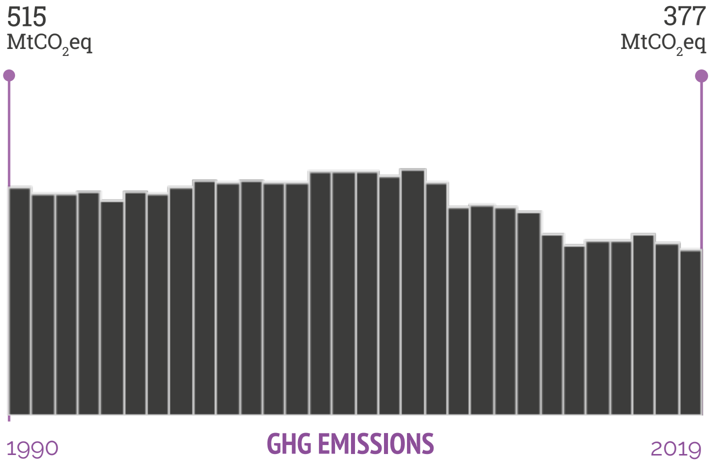
Tourism in Italy is one of the most important tertiary sectors. In 2019, it contributed the 10.4% of national GDP. It can be also one of the sectors most severely impacted by climate change.

The loss of climatic attractiveness and amenity of Italian destinations, becoming too hot, or loosing snow during the winter season, can induce a loss of up to 17 and 52 billion EUR due to touristic demand reduction under a low and high emissions scenario, respectively.

ITALY
POLICY

OVERVIEW

Italy is responsible for 0.87% of global GHG emissions and has a 20% higher than world average rate of CO_2 emissions per capita. Emissions have been declining since 2007, and a net zero emissions by 2050 target has been set.



INTERNATIONAL COMMITMENTS

Italy has the same target as the EU. In its 2020 NDC update, it strengthened its emissions target to a 55% reduction below 1990 levels by 2030.

CLIMATE POLICY COMMITMENTS CHRONOLOGY

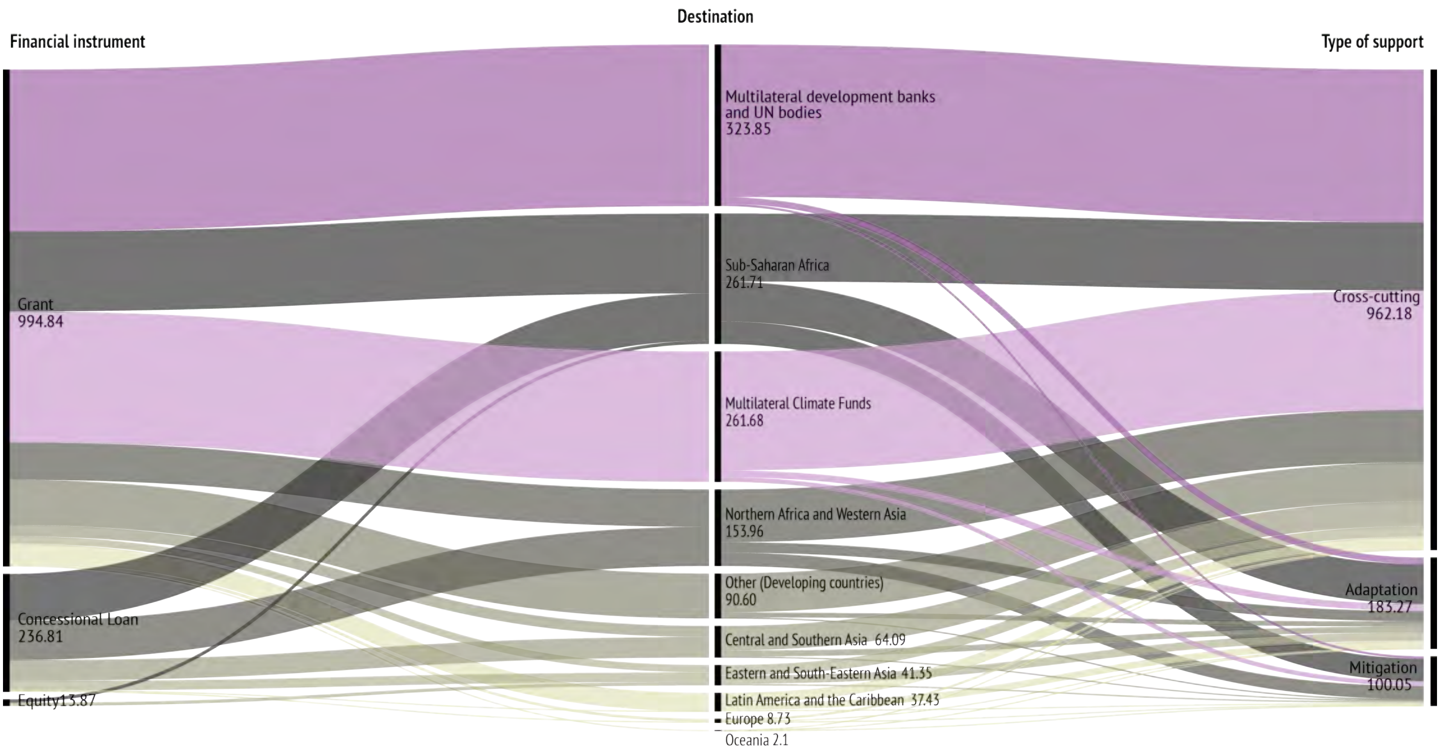
2002 — **Kyoto Protocol - 1st period**
6.5 % yearly average reduction in GHG over the four year period 2008-2012, with respect to 1990 levels

2016 — **Paris Agreement - 1st NDC**
40% in GHG reduction by 2030, with respect to 1990 levels

2020 — **Paris Agreement - NDC update**
55% GHG reduction by 2030, with respect to 1990 levels

INTERNATIONAL CLIMATE FINANCE ASSISTANCE

Italy's 4th Biennial Report shows a total commitment of 1.2 billion USD for climate action in 2017-2018. This is mainly provided in the form of grants. The majority is directed to multilateral institutions, while bilateral support mainly addresses sub-Saharan Africa.



SUSTAINABLE RECOVERY POLICY

According to the Global Recovery Observatory, in 2020 the proportion of green spending out of total recovery spending was 7%.

Total Spending	Recovery Spending	Green Spending
693.39 billion $	12.09 billion $	0.81 billion $

DOMESTIC ADAPTATION POLICY

In 2015 the Ministry for the Ecological Transition adopted the National Adaptation Strategy to climate change, and in 2016 it started the elaboration of the National Adaptation Plan. Some regions (Emilia Romagna, Lombardy and Sardinia) approved their adaptation strategy. Other regions have started procedures aiming to define planning documents on adaptation.

- ○ Domestic Adaptation Policy
  - ○ Inclusion of Adaptation in NDCs
  - ○ Integrated Adaptation & Mitigation Policy
  - ● Dedicated Adaptation Strategy
  - ○ Dedicated Adaptation Plan
- ○ Subordinate Adaptation Policies
  - ○ Sectoral Adaptation Plans
  - ● Subnational Adaptation Plans

○ Policy not in place ● Active policy

ADAPTATION POLICY HIGHLIGHTS

TRANSNATIONAL INITIATIVES

Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas

The aim of the Framework is to set a cross-border approach to increase the resilience of the Mediterranean marine and coastal systems, assisting decision-makers in the implementation of policies

Alpine Climate Action Plan 2.0

The plan is part of the Alpine Climate Target System 2050 strategy that supports progress towards reaching climate-neutral and climate-resilience in the Alps by 2050

NATIONAL INITIATIVES

Creiamo PA

The Ministry of Ecological Transition set up a technical assistance programme to support Italian local administrations in developing their own climate mitigation and adaptation plans

Experimental programme of actions for adaptation to climate change in urban areas

The program aims at increasing the resilience in municipalities with a population of 60,000 inhabitants or more which are subject to climate change risks (heat waves, extreme rainfall and drought)

SUBNATIONAL INITIATIVES

Un filo Naturale

The City of Brescia is developing a "Climate Transition Plan" that will abate greenhouse gases emissions and mitigate the impacts of urban flash floods and urban heat islands

Sardinian Regional Adaptation Strategy

The SRACC aims to assess the climate vulnerability and risk on the island of Sardinia, to identify adaptation options, and to define a governance system for the inclusion of adaption in all regional programs

ENERGY TRANSITION

Italy has undertaken a significant process of transformation of its energy sector and is among the best performers in Efficiency, driven by the low level of energy intensity of the economy and by the advanced digitalization of the electric grid, which had a positive benefit in terms of transmission and distribution losses. During the last decade, many investments have been made in Renewables increasing their fundamental role and also allowing Italy to substitute fossil fuels which are mostly imported. The good performance in terms of the overall Energy Transition indicator is also driven by significant improvements in Emissions. In order to further speed up the transition, Electrification opportunities, especially in buildings and in transport sectors, must be seized.

	G20 AVERAGE	COUNTRY
Energy Transition	58.7	64.6
Fossil Fuels	45.3	52.3
Renewables	19.7	26.2
Efficiency	84.9	93.2
Electrification	70.8	71.3
Emissions	72.9	79.8

Only actively pursuing an energy transition based on decarbonization and electrification – from policy and regulation, to health and education – will enable countries to benefit the most from future opportunities and fight climate change whilst ensuring an equitable distribution of wealth.

The Energy Transition indicators were developed by Enel Foundation in cooperation with SACE, and provide a retrospective analysis based on historical data.