WHITE PAPER

CLIMATE CHANGE IMPACTS ON THE GREEK JOB MARKET

GREEN JOBS AND RELATED SKILLS

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The current report has been produced as part of the program "From California to Mt. Olympus" coordinated by Ecogenia and funded by U.S. Embassy

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Climate Change – An overview

The importance of sustainability and climate change education in fostering environmental awareness, protection and conservation is undeniable. Highlighting the need for public education on sustainability and climate as well as the challenges of climate change are steps towards a more sustainable future.

The latest findings on climate change according to the 6th Assessment Report of the IPCC (2023) indicate an increase in the global surface temperature reaching 1.1°C above the pre-industrial reference year of 1850. According to Copernicus the Global Average Temperature has increased over 1.2°C in relation to the mean value of the period 1850 – 1900 (*Figure 1*). Global greenhouse gas emissions have continued to increase, in unequal manners due to unsustainable energy use, land use and land-use change, lifestyles and patterns of consumption and production. The measured atmospheric CO_2 concentrations in 2019 were 410 parts per million, higher than at any time in at least 2 million years. Similarly, the concentrations of methane (1866 parts per billion) and nitrous oxide (332 parts per billion) were higher than at any time in at least 800,000 years.

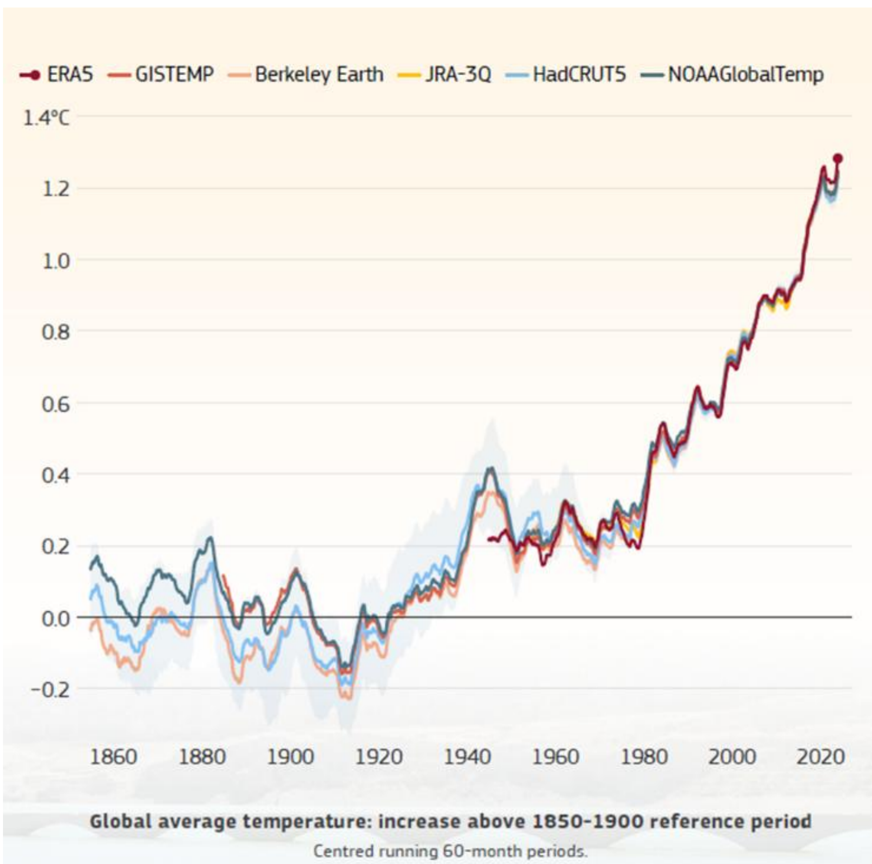

Figure 1 Six temperature datasets covering all or part of 1850-2023 (source European State of the Climate Summary 2023)

The human-induced climate change has caused widespread adverse and rapid impacts on the atmosphere, ocean, cryosphere, nature, biodiversity and people in an unequal distributed manner across systems, regions and sectors (*Figure 2*) [1]. Approximately 3.3 to 3.6 billion people live in contexts of high vulnerability to climate change. Millions of people are exposed to acute food insecurity and reduced water security due to climate change, with the largest vulnerability been located in less developed regions of Africa, Asia, Central and South America, Small Islands and the Arctic. In addition, human mortality or risk for life from climate related extreme events, such as floods, droughts and storms were 15 times higher in highly vulnerable regions for the period 2010 - 2020, compared to regions with very low vulnerability.

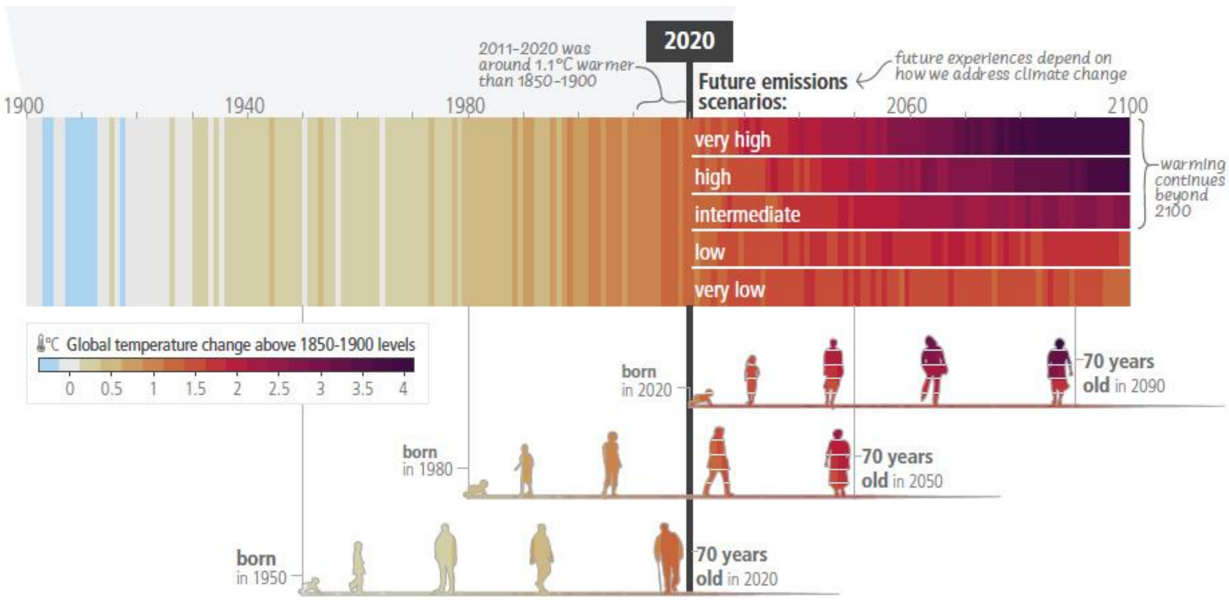

Figure 2 Observed (1900–2020) and projected (2021–2100) changes in global surface temperature (Source: IPCC (2023) Summary for Policymakers. In: Climate Change 2023)

Furthermore, the climate change has affected the livelihoods of individuals through the destruction of homes and infrastructure, loss of property and income, human health and food security, with adverse effects on gender and social equity. Severe economic damages from climate change are observed in several sectors, such as agriculture, forestry, fisheries, energy, and tourism, while there are security concerns for low lying coastal systems, terrestrial and marine ecosystems, human health, critical infrastructure, networks and services, living standards, water and food security, peace and mobility.

[1]), which are linked to changes in climate conditions and impacts, illustrate how the climate has already changed and will change along the lifespan of three representative generations (born in 1950, 1980 and 2020). Future projections (2021–2100) of changes in global surface temperature are shown for very low (SSP1-1.9), low (SSP1-2.6), Observed (1900–2020) and projected (2021–2100) changes in global surface temperature (relative to 1850-1900) intermediate (SSP2-4.5), high (SSP3-7.0) and very high (SSP5-8.5) GHG emissions scenarios. Changes in annual global surface temperatures are presented as 'climate stripes', with future projections showing the human-caused long-term trends and continuing modulation by natural variability (represented here using observed levels of past natural variability). Colours on the generational icons correspond to the global surface temperature stripes for each year, with segments on future icons differentiating possible future experiences.

The observed increase in temperature and humidity levels introduce risks to human health, which are expected to become more severe in the tropical regions and the Mediterranean by the end of the century (*Figure 3*)[2], while the well-being of cities and societies will be affected (*Figure 4*) [3]

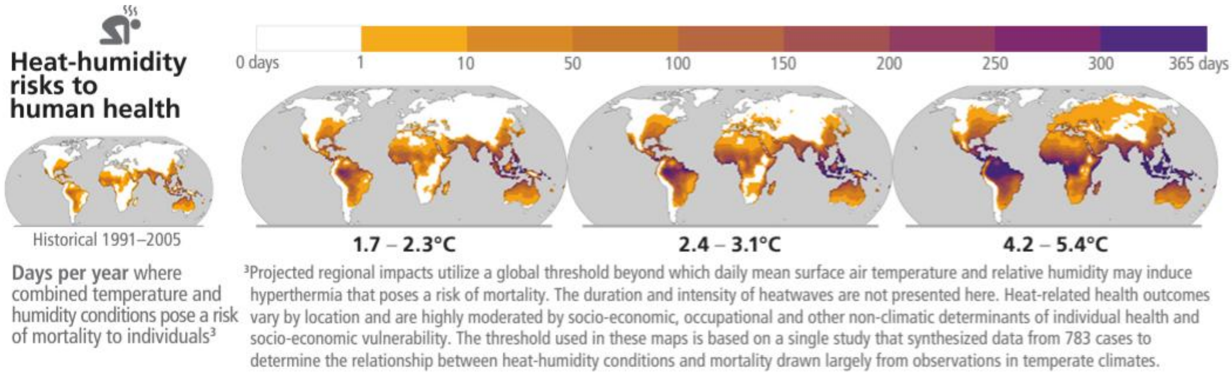

Figure 3 Risks to human health [Source: IPCC (2023) Summary for Policymakers. In: Climate Change 2023]

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[2] Risks to human health as indicated by the days per year of population exposure to hyperthermic conditions that pose a risk of mortality from surface air temperature and humidity conditions for historical period (1991–2005) and at GWLs of 1.7°C–2.3°C (mean = 1.9°C; 13 climate models), 2.4°C–3.1°C (2.7°C; 16 climate models) and 4.2°C–5.4°C (4.7°C; 15 climate models). Interquartile ranges of GWLs by 2081–2100 under RCP2.6, RCP4.5 and RCP8.5. The presented index is consistent with common features found in many indices included within WGI and WGII assessments.

[3] The left-hand side of panel a shows climate responses and adaptation options assessed for their multidimensional feasibility at global scale, in the near term and up to 1.5°C global warming. The term response is used here in addition to adaptation because some responses, such as migration, relocation and resettlement may or may not be considered to be adaptation. WASH refers to water, sanitation and hygiene. Six feasibility dimensions (economic, technological, institutional, social, environmental and geophysical) were used to calculate the potential feasibility of climate responses and adaptation options, along with their synergies with mitigation. For potential feasibility and feasibility dimensions, the figure shows high, medium, or low feasibility. Synergies with mitigation are identified as high, medium, and low. The right-hand side of Panel a provides an overview of selected mitigation options and their estimated costs and potentials in 2030. Costs are net lifetime discounted monetary costs of avoided GHG emissions calculated relative to a reference technology. Relative potentials and costs will vary by place, context and time and in the longer term compared to 2030. The potential (horizontal axis) is the net GHG emission reduction (sum of reduced emissions and/or enhanced sinks) broken down into cost categories (coloured bar segments) relative to an emission baseline consisting of current policy (around 2019) reference scenarios from the AR6 scenarios database. The potentials are assessed independently for each option and are not additive. Health system mitigation options are included mostly in settlement and infrastructure (e.g., efficient healthcare buildings) and cannot be identified separately. Fuel switching in industry refers to switching to electricity, hydrogen, bioenergy and natural gas. Gradual colour transitions indicate uncertain breakdown into cost categories due to uncertainty or heavy context dependency. The uncertainty in the total potential is typically 25–50%.

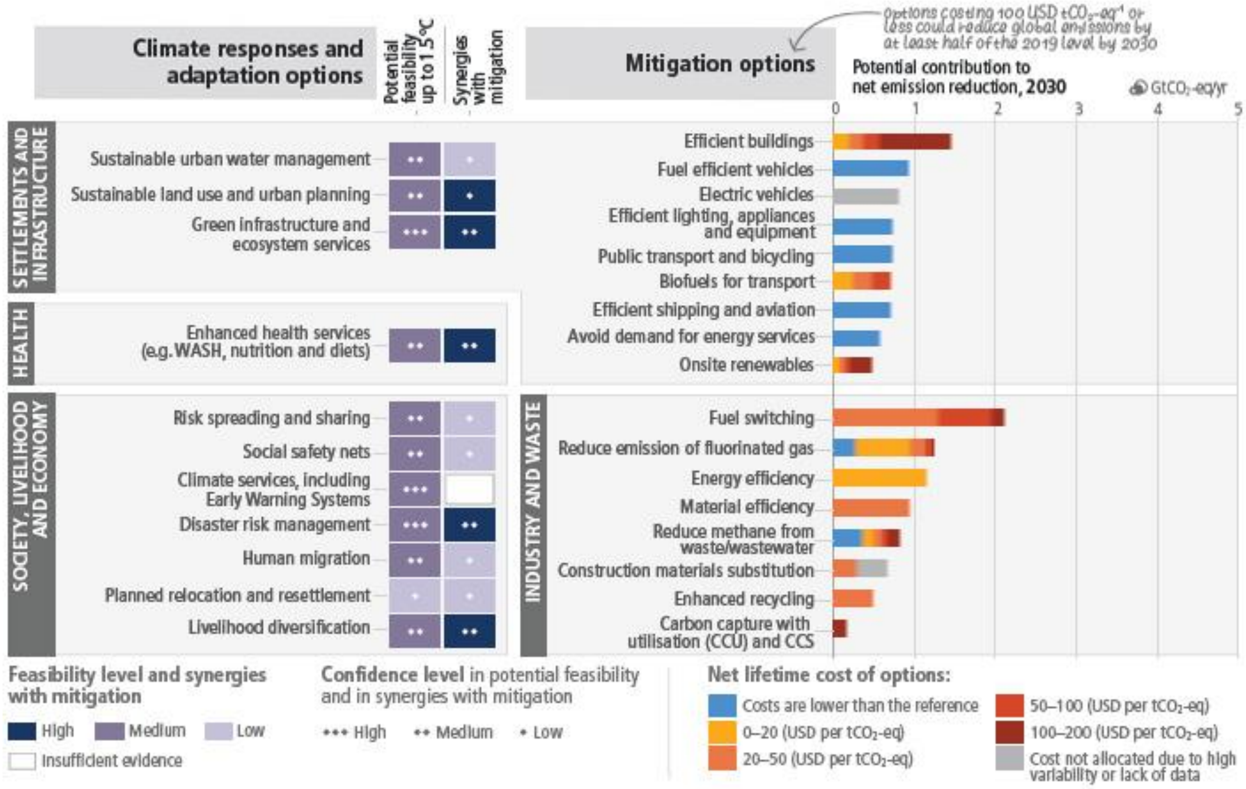

Figure 4 Selected mitigation and adaptation options across different systems. [Source: IPCC (2023) Summary for Policymakers. In: Climate Change 2023, modified]

Climate Change Impacts on the job market in Greece

The Mediterranean basin and Greece are considered hot spots of climate change with an average increase of temperature exceeding the global average. The Copernicus Service of the European Commission (2023) identifies year 2023 as the warmest calendar year on record for the region (*Figure 5*). 2023 reached a record number of days with 'extreme heat stress', of more than 46°C. Summer also saw the largest area of Europe affected by at least 'strong heat stress' of any day on record, with 13% of the continent, and 41% of southern Europe, experiencing 'strong', 'very strong' or 'extreme heat stress' on July. Furthermore, the eastern Mediterranean has experienced a record number of ocean water temperature increase of up to 5°C (*Figure 6*).

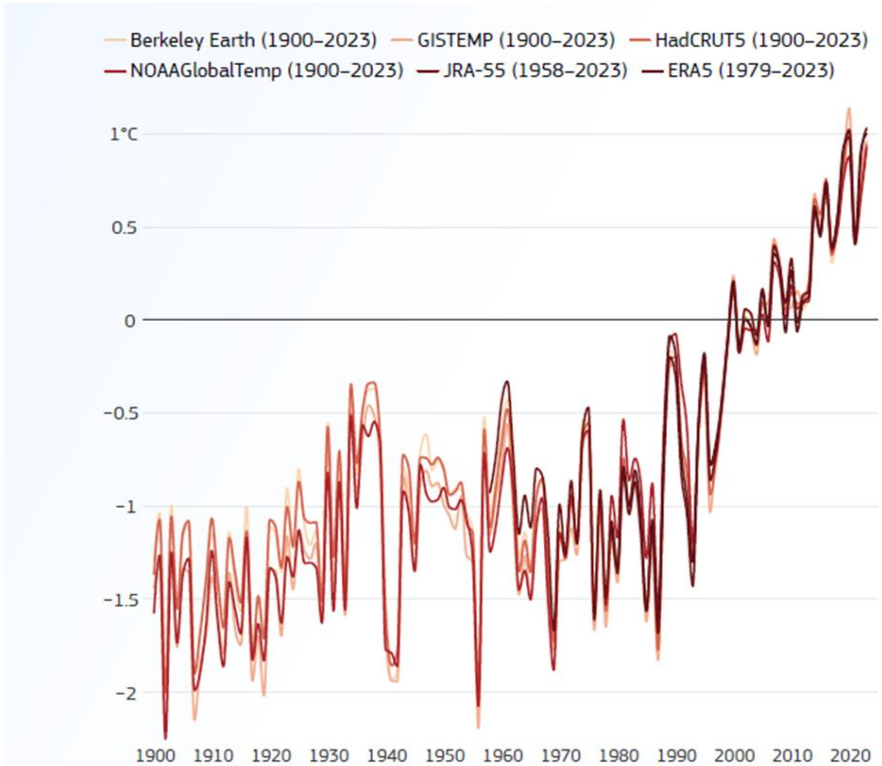

Figure 5 Anomalies in annual surface air temperature (°C) for European land (WMO RA VI Europe domain). (Source European State of the Climate Summary 2023; doi.org/10.24381/bs9v-8c66)

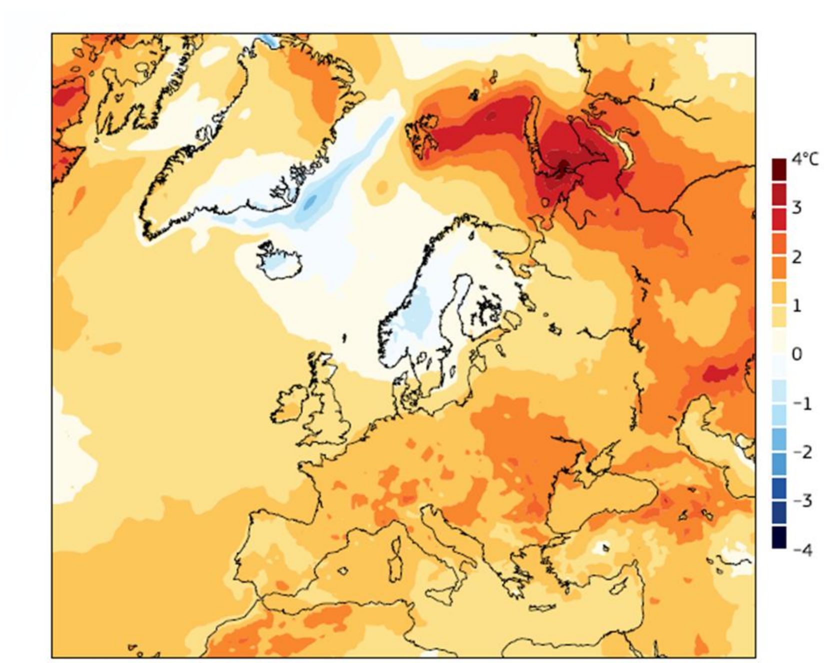

Figure 6 Average surface air temperature anomalies (°C) in 2023. (Source European State of the Climate Summary 2023; doi.org/10.24381/bs9v-8c66)

In this section projections[4] of five climatological indexes in Greece are used and are linked to their impacts on the job market in the country:

- Change in the Number of Days with Extreme Risk of a Forest Fire per year
- Change in Maximum Annual Drought Duration per year
- Change in in total annual precipitation
- Change in mean annual wind speed per year)
- Change in the number of tropical nights per year

The horizontal spatial resolution of the simulations presented in the following figures is 0.11°. Resolution of the maps is 500m after applying spatial interpolation methods to the original data. These climate projections have been produced using an online open-source tool produced within the framework of the EU LIFE-IP AdaptInGR project *'Boosting the implementation of adaptation policy across Greece'* (https://mapsportal.ypen.gr/thema_climatechange).

The indexes are interrelated with many production processes mainly of the primary sector (agriculture, animal husbandry, forestry and others) securing jobs for many thousands of people in the country and affecting the prices of basic goods, thus having significant impacts on livelihood and well-being.

Health sector

Facts

Based on the global projections of Figure 3 the World Health Organisation (*Figure 7*) has predicted spread of diseases, including infectious diseases, heat-related and water-related diseases, zoonoses but also mental health diseases.

[4] Climate projections are synchronous tools which presents estimations about how different climatological indexes are expected to change in the near or far future.

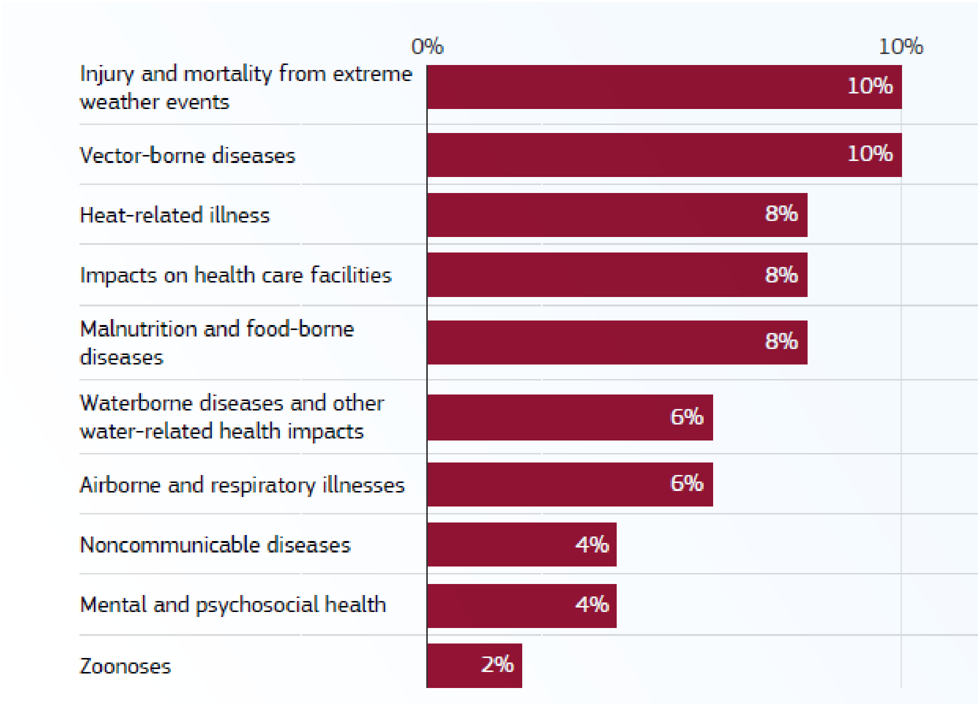

Figure 7. Expected spread of diseases

Lack in the health sector have been identified globally (Figure 8) affecting the job market.

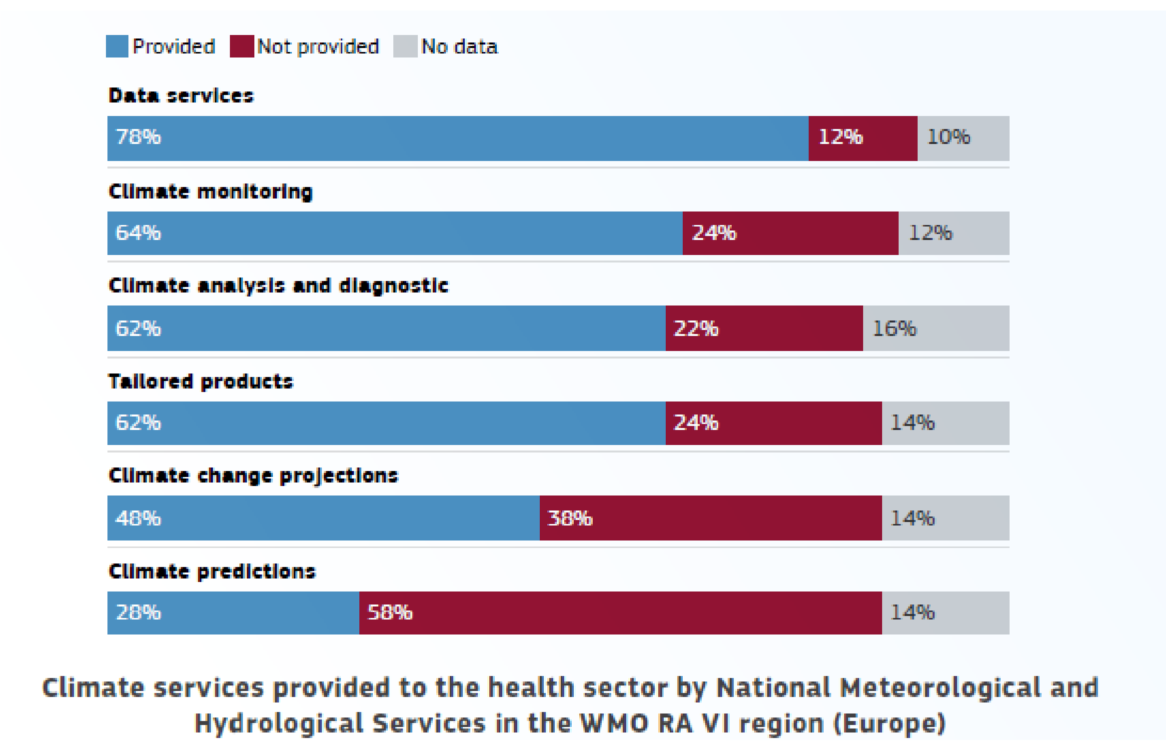

Figure 8. WHO Climate Services Dashboard (2023)

Jobs

In Greece it is expected that practitioners will be needed on the health-related sectors of:

- Policy programs on climate impacts to health
- Health scientists and practitioners
- Health system infrastructures
- Early warning and response systems

At the same time, to ensure the well-being of societies and in particular in the urban areas, expertise on several sectors related to infrastructure, nature-based interventions and relevant initiatives, will be required:

- Flood defense
- Flood management
- Engineers and scientists with expertise on Nature-based solutions
- Green urban planning
- Landscape architecture
- Eco-buildings

Water availability and food security - Primary productive sector: agriculture, animal breeding, aquaculture and fishing

The facts

Figure 9 shows the spatial distribution of the maximum drought duration per year during the reference period (1971-2000). The map highlights southeastern regions, such as Crete and Rhodes, as suffering from the longest drought periods. Figure 10 provides projections of this parameter for the near future (2031-2060), based on different RCP scenarios. According to these projections, the maximum drought duration per year is expected to increase primarily in southern mainland Greece, including the Peloponnese and the southern Aegean islands. In other parts of the country, a decrease of approximately three days is expected under the RCP 2.6 scenario, while an increase of around three days is projected for RCP 8.5.

Figure 11 shows similar results for the far future (2071-2100). These projections indicate that southern areas will be the most affected compared to the rest of the country. Under the RCP 8.5 scenario, the maximum drought duration per year is expected to increase across the entire country, with the largest increases (up to 15 days) occurring in southern regions by the end of the century. Conversely, under RCP 2.6, drought duration in the northern mainland is expected to remain stable or decrease slightly, while southern regions may experience a modest increase.

The increase in drought duration at certain locations highlights the significant risks to jobs related to water use, particularly in agriculture, which depends heavily on large water supplies.

Figure 12 depicts the spatial distribution of total annual precipitation during the reference period (1971-2000). Western Greece receives the highest levels of precipitation, while other regions, such as central

Greece and some islands, experience much lower levels. Figure 13 projects changes in total annual precipitation for the near future (2031-2060), based on different RCP scenarios. The projections suggest a general decrease in precipitation across nearly the entire country, with the most arid regions expected to see the greatest reductions. Depending on the scenario, the decrease in total precipitation could range from 0% (under RCP 2.6 in certain areas) to as much as 30% (under RCP 8.5).

Figure 14 provides similar projections for the far future (2071-2100). With the exception of RCP 2.6 in certain central regions, most of the country is expected to experience a reduction in total annual precipitation.

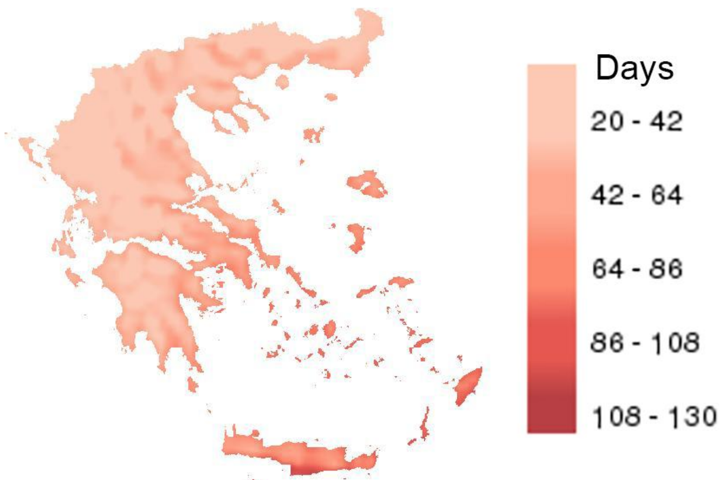

Figure 9 Maximum drought duration per year (consecutive days with precipitation<1mm) during the reference period (1971-2000).

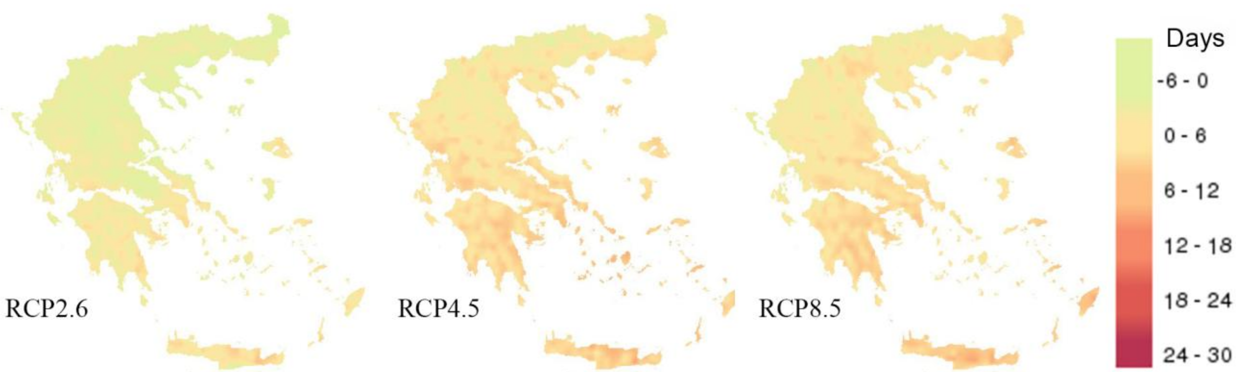

Figure 10 Change in maximum drought duration per year (consecutive days with precipitation <1mm) in the near future (2031-2060).

Figure 11 Change in maximum drought duration per year (consecutive days with precipitation <1mm) in the far future (2071-2100).

Decreased water availability is likely to have a significant impact on agriculture and industrial production, as well as job availability in these sectors. A reduction in water resources will also affect the energy sector, as it will reduce hydropower production and limit the efficiency of pumped-storage hydroelectricity systems. Similar impacts have been projected by IPCC in the AR6 (*Figure 15)*[5]*, Figure 16*).

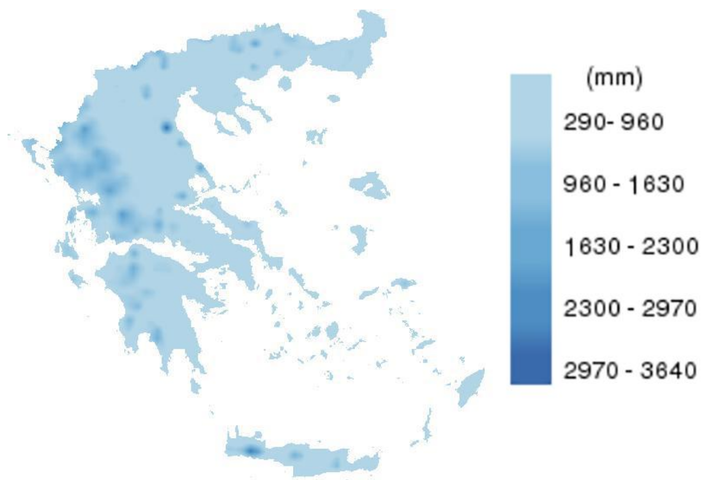

Figure 12 Total annual precipitation during the reference period (1971-2000).

[5] (c1) Changes in maize yield by 2080–2099 relative to 1986–2005 at projected GWLs of 1.6°C–2.4°C (2.0°C), 3.3°C–4.8°C (4.1°C) and 3.9°C–6.0°C (4.9°C). Median yield changes from an ensemble of 12 crop models, each driven by bias-adjusted outputs from 5 Earth system models, from the Agricultural Model Intercomparison and Improvement Project (AgMIP) and the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP). Maps depict 2080–2099 compared to 1986–2005 for current growing regions (>10 ha), with the corresponding range of future global warming levels shown under SSP1-2.6, SSP3-7.0 and SSP5-8.5, respectively. Hatching indicates areas where <70% of the climate-crop model combinations agree on the sign of impact. (c2) Change in maximum fisheries catch potential by 2081–2099 relative to 1986–2005 at projected GWLs of 0.9°C–2.0°C (1.5°C) and 3.4°C–5.2°C (4.3°C). GWLs by 2081–2100 under RCP2.6 and RCP8.5. Hatching indicates where the two climate-fisheries models disagree in the direction of change. Large relative changes in low yielding regions may correspond to small absolute changes. Biodiversity and fisheries in Antarctica were not analysed due to data limitations. Food security is also affected by crop and fishery failures not presented here

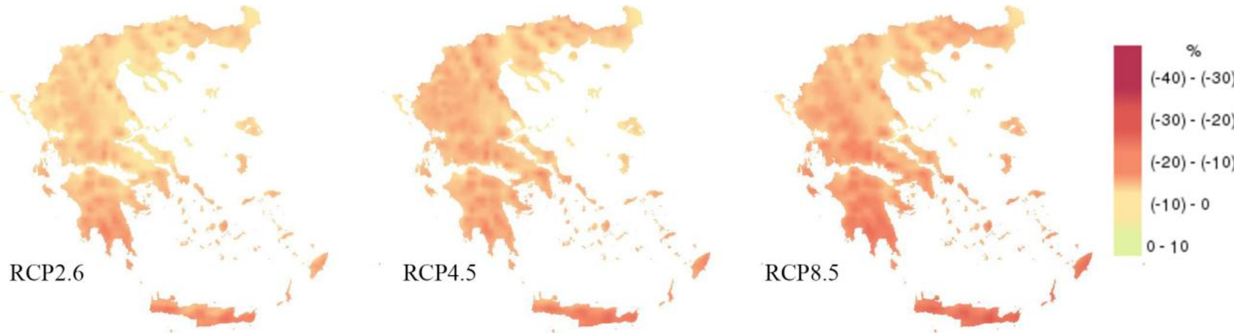

Figure 13 Percentage change in total annual precipitation in the near future (2031-2060).

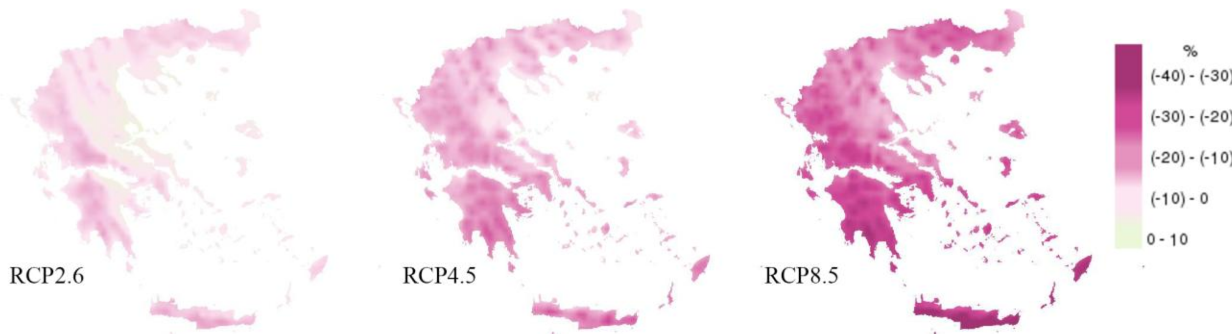

Figure 14 Percent change in total annual precipitation in the far future (2071-2100).

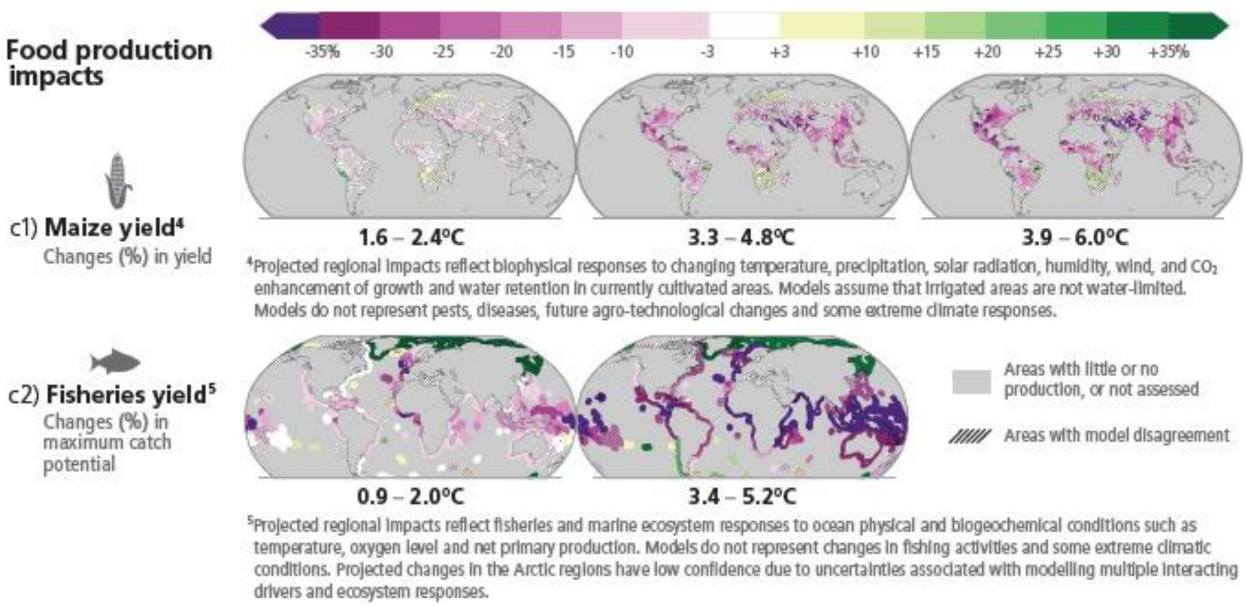

Figure 15 Impacts on food production. (Source: IPCC (2023) Summary for Policymakers. In: Climate Change 2023)

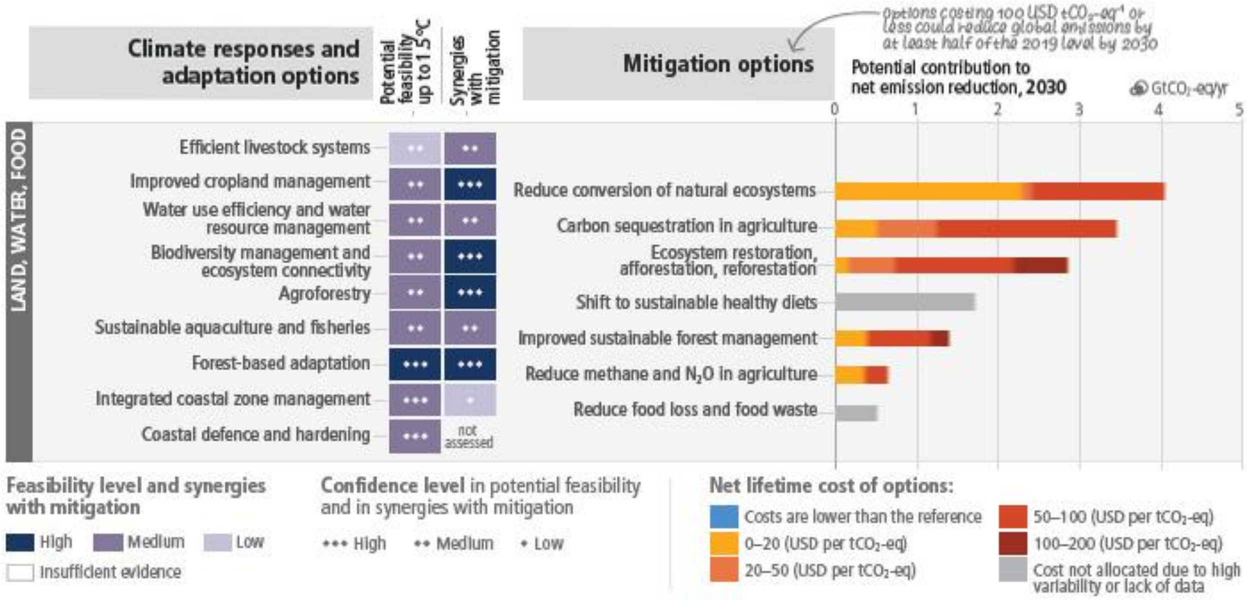

Figure 16 See caption of figure 5. (source: IPCC (2023) Summary for Policymakers. In: Climate Change 2023)

Jobs

- Knowledge on new, often digitized practices and techniques
- New farming techniques
    - precision & smart agriculture;
    - organic production;
    - xeriscaping and native crops
- Sustainable animal breeding expertise
- Sustainable Aquaculture-related expertise

Drought, Fires, Extreme Events

Facts

Figure 17 shows the spatial distribution of days per year with an extreme risk of forest fires during the reference period (1971-2000). According to this map, areas such as southern mainland Greece (Viotia, Attica), the southern Peloponnese, Crete, and islands in the eastern Aegean exhibit the highest risk of extreme forest fires (Fire Weather Index, FWI > 50). Northeast Greece (Thrace) also experiences elevated FWI values during this period.

Figure 18 illustrates projected changes in this parameter for the entire country in the near future (2031-2060) under different Representative Concentration Pathway (RCP) scenarios. From left to right, the maps correspond to RCP 2.6, RCP 4.5, and RCP 8.5, respectively. These projections indicate an expected increase in the number of days with an extreme risk of forest fire in vulnerable areas by approximately 10, 20, and 25 days for each scenario, respectively. For the rest of the country, the projected increase varies from 0 to about 10 additional days under the RCP 8.5 scenario.

Figure 19 presents similar projections for the far future (2071-2100). According to these results, the most vulnerable areas are expected to be disproportionately affected. Under the RCP 8.5 scenario, the number of days per year with an extreme risk of forest fire is projected to increase by more than 35 days by the end of the century.

Higher values of this index in specific areas suggest that jobs directly or indirectly linked to forests could be significantly impacted in both the near and far future. The agricultural sector is also likely to be severely affected, as forest fires often destroy not only forested areas but agricultural lands as well.

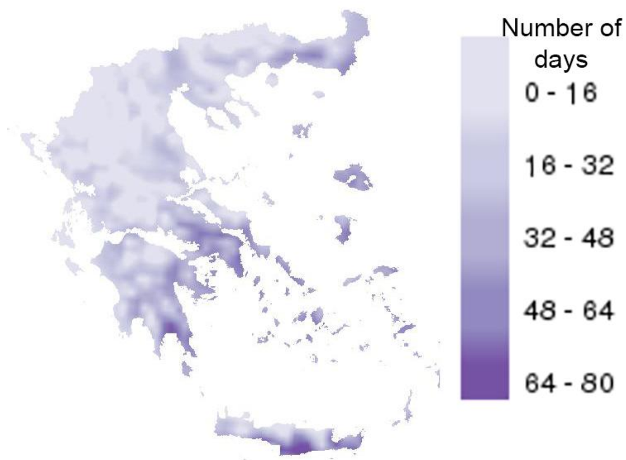

Figure 17 Number of days per year with extreme risk of forest fire event (FWI>50) during the reference period (1971-2000).

Figure 18 Change in the Number of Days per year with extreme risk of forest fire event (FWI>50) in the near future (2031-2060).

Figure 19 Change in the Number of Days per year with extreme risk of forest fire event (FWI>50) in the far future (2071-2100).

Figure 20 shows the spatial distribution of mean annual wind speed during the reference period (1971-2000). Regions such as the Cyclades, southern Peloponnese, and eastern Crete experience the highest wind speeds, while areas like Thessaly and central Macedonia experience much lower average speeds.

Figure 21 projects wind speed changes for the near future (2031-2060) under different RCP scenarios. The projections indicate that mean annual wind speed will remain relatively constant or decrease slightly across most of the country. Western Greece is expected to experience the largest reductions in wind speed, with decreases of up to 0.15 m/s, and reductions exceeding 0.2 m/s in some regions under RCP 8.5.

Figure 22 provides projections for the far future (2071-2100), showing that most Aegean islands and eastern coastal regions of mainland Greece could see wind speeds increase by 0.1 to over 0.2 m/s, depending on the scenario.

Figure 23 summarizes key events Europe experienced during 2023.

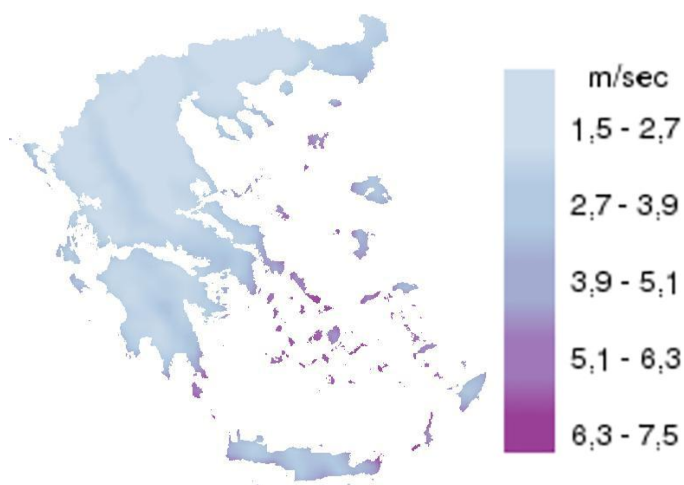

Figure 20 Mean annual wind speed (m/sec) during the reference period (1971-2000).

Figure 21 Change in mean annual wind speed (m/sec) in the near future (2031-2060).

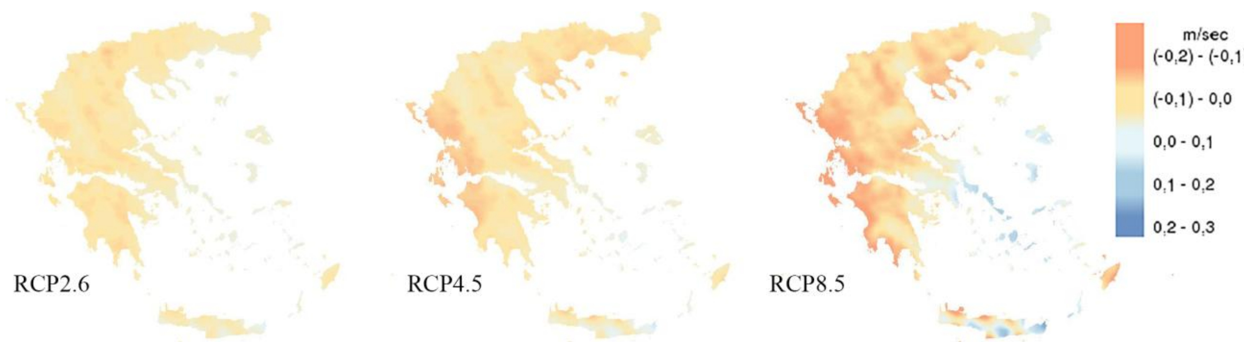

Figure 22 Change in mean annual wind speed (m/sec) in the far future (2071-2100).

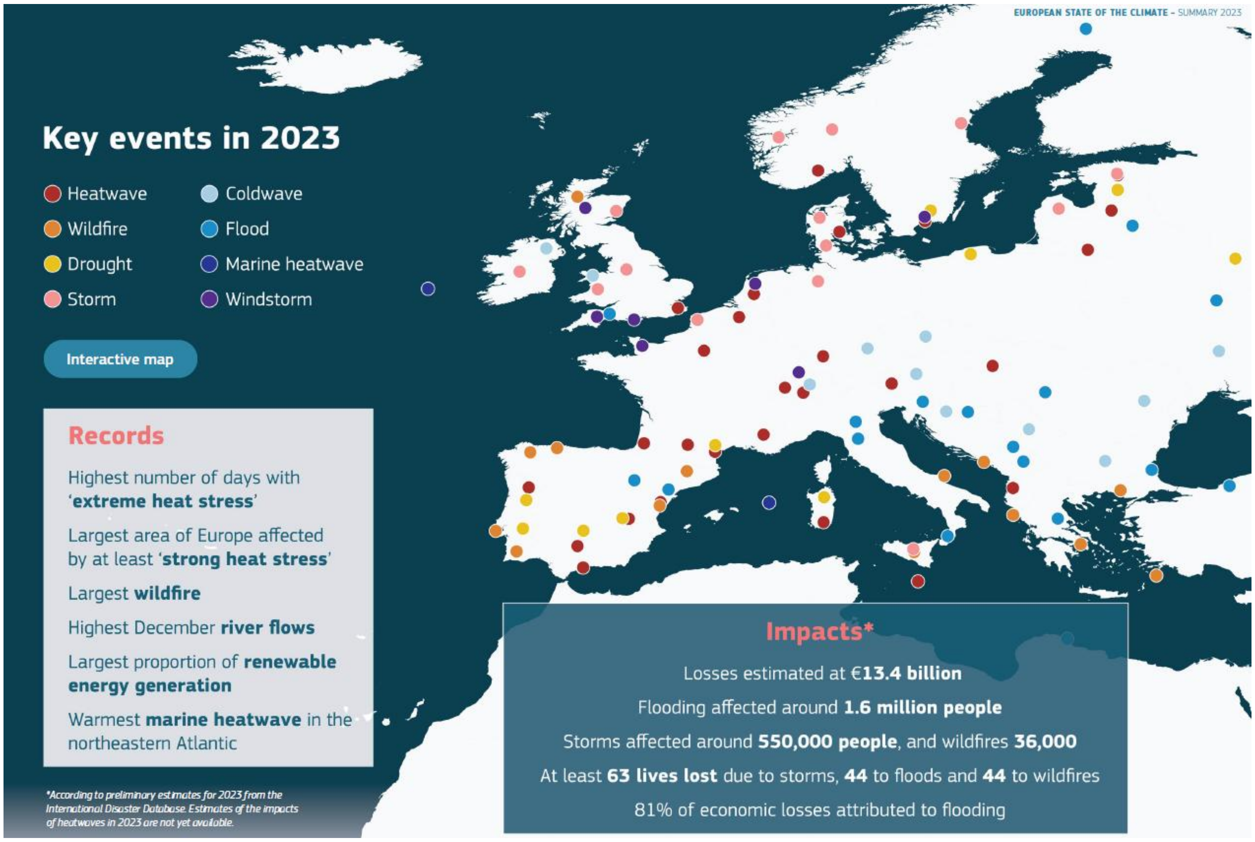

Figure 23 Copernicus Climate Change Service European State of the Climate 2023

Jobs

- Prognosis
- Early warning systems – IT expertise
- Civil protection
- Forest management for protection from fires
- Fire fighting
- Post-fire management

Nature - conservation of ecosystems and biodiversity

Facts

Natural ecosystems and biodiversity are affected by any changes in climate indicators and other environmental parameters. Some additional global projections can be used to identify current and future needs (*Figure 24* & *Figure 25*) [6] & [7].

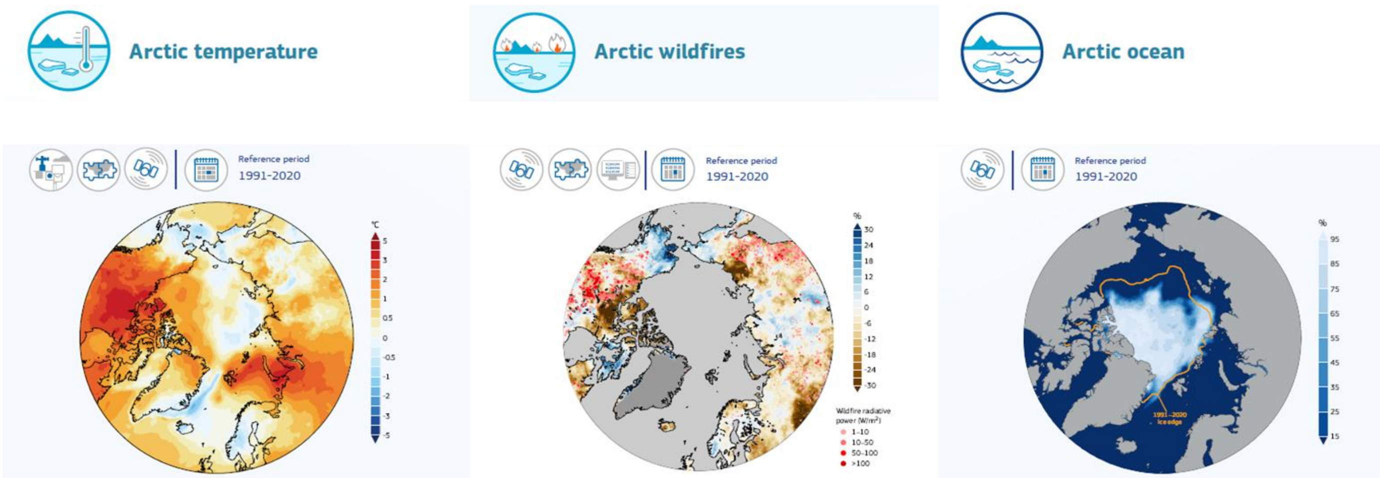

Figure 24: Anomalies in surface air temperature in 2023 (Source European State of the Climate Summary 2023; doi.org/10.24381/bs9v-8c66)

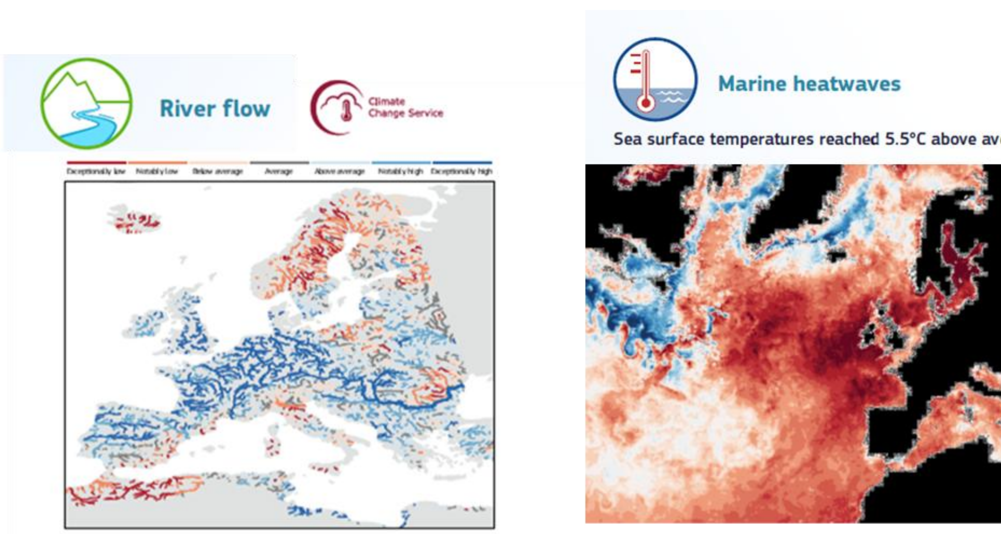

Figure 25 Anomalies in monthly average river flow & Daily sea surface temperature anomalies (°C) on 21 June 2023 (Source European State of the Climate Summary 2023; doi.org/10.24381/bs9v-8c66)

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[6] Anomalies in surface air temperature in 2023, Middle: Wildfires and anomalies (%) in soil moisture in June to August 2023, Right: Monthly average sea ice concentration (%) in September 2023. (Source European State of the Climate Summary 2023; doi.org/10.24381/bs9v-8c66)

[7] Left: Anomalies in monthly average river flow in December 2023., Right: Daily sea surface temperature anomalies (°C) on 21 June 2023.

Jobs

- Ecosystem management
- Protection of natural resources;
- Circular economy
- Pollution control
- Environmental Scientists
- Climate experts
- Earth Science experts
- Ecosystem and biodiversity conservation experts
- Ecosystem management systems
- Pollution control (monitoring, antipollution practices, integrated management practices)

Energy sector

Facts

Changes in the wind speed (Figure 20, Figure 21 &Figure 22) are likely to affect wind energy production, influencing electricity prices and the cost of industrial production. These changes will also impact the planning and productivity of wind turbine parks.

Furthermore, Figure 26 displays the number of tropical nights per year during the reference period (1971-2000). The highest number of tropical nights occurs along the eastern coastal regions of southern Attica, the Peloponnese, and the southern Aegean islands. Figure 27 projects the number of tropical nights for the near future (2031-2060), based on different RCP scenarios. The projections indicate that, across all RCP scenarios, the number of tropical nights will remain relatively constant in most inland regions. However, coastal areas are expected to experience an increase of 5 to 15 tropical nights.

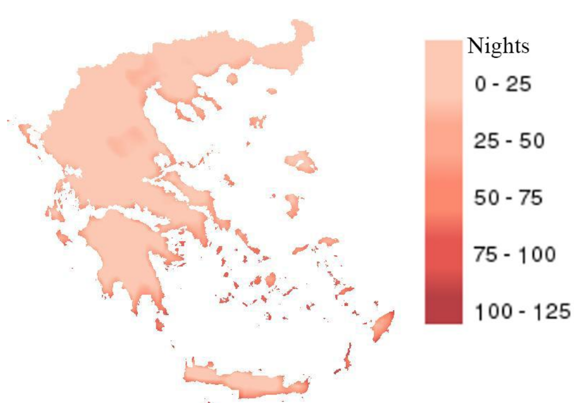

Figure 26 Number of tropical nights per year (days with TN > 20 °C) during the reference period (1971-2000).

Figure 28 provides projections for the far future (2071-2100). Under the RCP 2.6 scenario, significant changes are not expected across the country. However, under RCP 8.5, tropical nights are projected to increase by over 50 to 70 nights in many areas by the end of the century.

Figure 27 Change in the number of tropical nights per year (days with TN > 20 °C) in the near future (2031-2060).

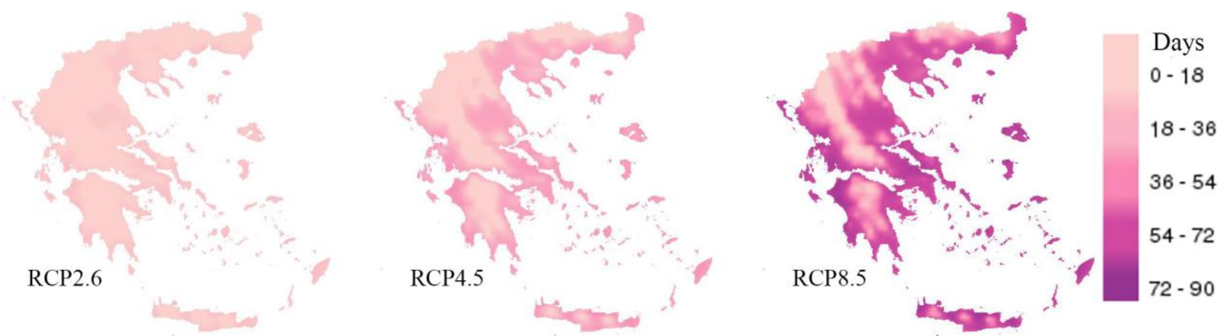

Figure 28 Change in the number of tropical nights per year (days with TN > 20 °C) in the far future (2071-2100).

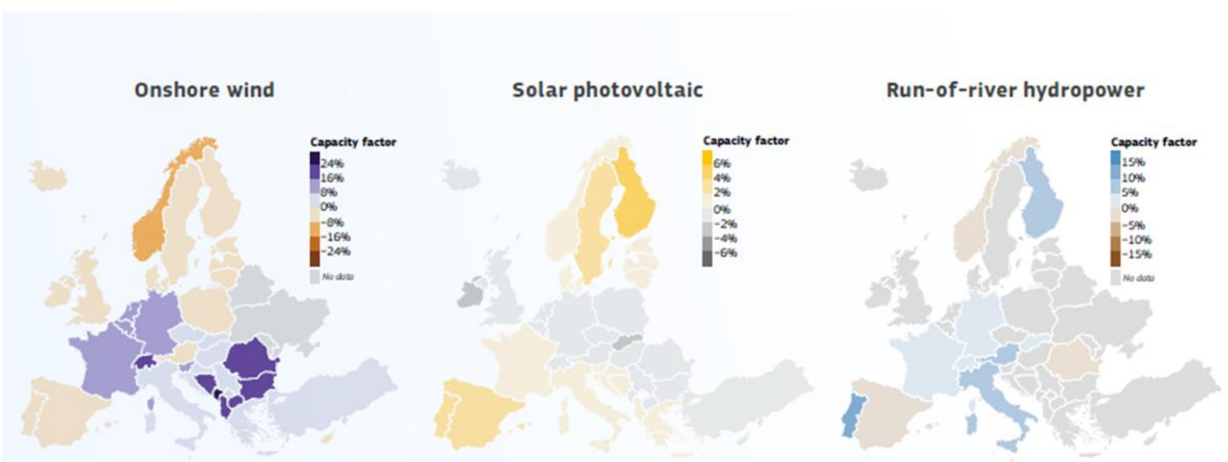

Figure 29 Anomalies (%) in potential electricity generation (capacity factor) in 2023 (Source: IPCC (2023) Summary for Policymakers. In: Climate Change 2023)

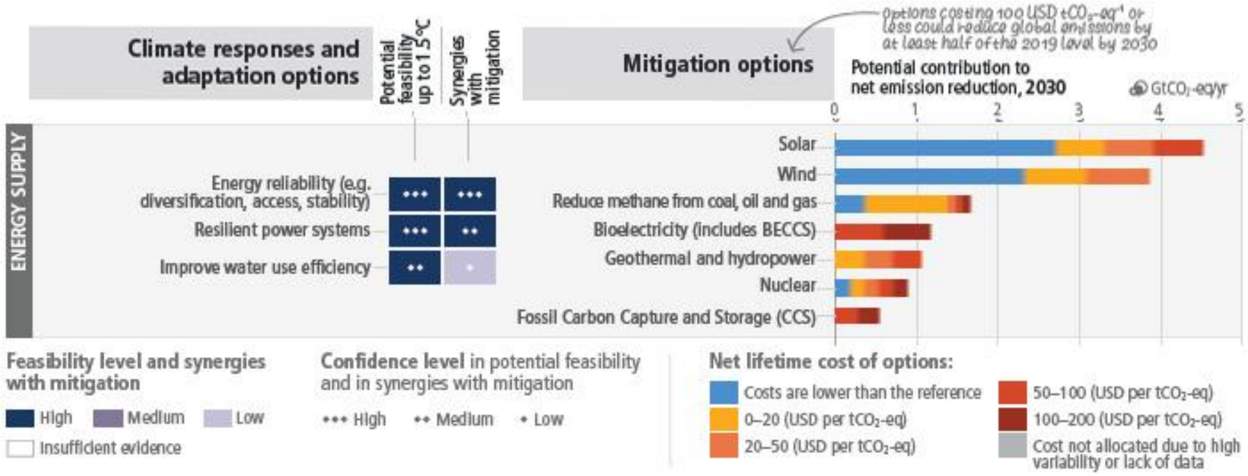

Figure 30 See caption of figure 5. (source: IPCC (2023) Summary for Policymakers. In: Climate Change 2023)

Jobs

- Jobs ensuring energy security
- Production of green, affordable, renewable energy → Energy experts
- Skills important in the production energy from renewable and/or alternative sources;
- Digital skills in the production of energy
- Knowledge of environmental and climate economics

Green entrepreneurship and services

Facts

Currently there is a global shift towards a greener economy and a more equitable world. As a result, there is growing interest and need for greening of the world of entrepreneurship, as well as for green and social oriented businesses. Moreover, the Environmental, Social, and Governance (ESG) framework is gaining ground in the business world while ESG reporting is a requirement for medium to large enterprises in most economic sectors.

The environmental component of ESG is related to a big extent to the ecological and carbon footprint of the company. It evaluates how a company interacts with the natural environment and its surrounding ecosystems and it examines parameters such as the company's energy consumption, waste management and disposal practices, pollution and emissions reduction efforts, natural resource conservation efforts, policies on biodiversity conservation and protection of animal (if applicable through the business processes).

The social element of ESG relate to the stakeholder engagement processes and to the welfare of its employees and affected communities and it addresses factors such as provisions for the wellbeing of employees, promotion of diversity and inclusion within its workforce, consumer protection in its products or services, respect of human rights.

The Governance factors include protocols and structures defining the leadership, financial auditing, shareholder rights, non-corruption policies, setting ethical standards as well as compliance with laws and regulations.

Jobs

- Sustainability reporting (ESG framework, due diligence etc.).
- Green marketing
- Policy making
- Regulations
- Sustainability reporting
- ESG - Due diligence reporting
- SDG reporting
- Green manufacturing
- Green Logistic Chain
- Green marketing
- Participatory and Decision making processes

The way forward

In this new challenging world, education and Universities play a fundamental pivotal dual role: on one hand education is necessary to acquire the green skills to address contemporary challenges, on the other hand jobs on climate education at all levels (from pre-K to graduate level) are on the rise. Consequently, this new era introduces new challenges but also opportunities for the Universities. New challenges in this case comprise the new curricula of studies and degrees as well as reforming the existing degrees so as to offer education on green skills. Formal education on obtaining relevant expertise on related sciences is essential. In more detail, Universities should:

- Incorporate climate education in all disciplines – Formal Educators
- Invest on field research – monitoring – Scientists and technicians
- Implement climate related solutions and plans – Scientists, engineers, technicians, planners, policy makers
- Raise public awareness – Scientists, educators, NGOs, informed community groups
- Communicate with the public – Scientists, environmental journalists
- Research outcomes,
- Monitoring results,
- Mitigation-adaptation-resilience options

On the other hand, the civic society is called not just to be informed but to actively participate in related activities through volunteerism, supporting awareness raising, youth involvement, citizen sciences and civic engagement approaches.

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