Food and Agriculture Organization of the United Nations

CLIMATE RISK TOOLBOX

Guiding material for climate risk screening

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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The Climate Risk Toolbox (CRTB) is hosted on the Hand-in-Hand Geospatial platform as a collaboration between the Risks team within OCB and the AgroInformatics team within the Digitalization and Informatics (CSI) Division.

Data from the Intergovernmental Panel on Climate Chance (IPCC) Working Group I (WGI) Interactive Atlas was obtained in collaboration with the University of Cantabria, leading institution of the IPCC WGI Interactive Atlas.

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FAO, OCB: Lev Neretin (overall guidance); Jorge Alvar-Beltrán, Arianna Gialletti, and Riccardo Soldan (technical coordination, tool conceptualization, and data curation).

FAO, CSI: Karl Morteo and John Latham (technical coordination and overall guidance); Michael Tefera and Yohannis Bedane (user interface); Mohamed Megahed, Davide Battista and Daniele Conversa (data engineering and analysis services), with support from the entire Hand-in-Hand Geospatial Platform team.

ABBREVIATIONS AND ACRONYMS

AR5	Fifth Assessment Report
AR6	Sixth Assessment Report
COP26	26th United Nations Climate Change Conference of Parties
CRTB	Climate Risk Toolbox
IPCC	Intergovernmental Panel on Climate Change
SSPs	Shared Socio-economic Pathways
SDGs	Sustainable Development Goals

1
INTRODUCTION

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The Climate Risk Toolbox

The Climate Risk Toolbox (CRTB) is an open-access resource, hosted on the Hand-in-Hand geospatial platform (FAO, 2022a).

The CRTB was developed to mainstream climate resilience within agricultural investment projects, policy plans, and decision-making processes, by allowing users worldwide (including policymakers, climate funds, project formulators, and international development organizations) to perform climate risk screenings.

The CRTB supports climate-focused decision-making, through the visualization of climate risk hotspots by identifying hazard probability, exposure and vulnerability of targeted agricultural systems and communities. During the risk screening process, tailored recommendations are given to promote agricultural transformation and adaptation to climate change (FAO, 2021a).

Context

Climate variability and change pose a significant threat to agricultural production and livelihoods through changes in temperature trends and rainfall patterns, besides increasing the frequency and intensity of extreme weather events. To address increasing risks, agricultural development policies and investments need to be designed with robust evidence both on past and future climate variability, seasonality, and extremes.

Climate-related hazards are projected to increase with differentiated levels of frequency and magnitude under low to high emission scenarios. Those most vulnerable to impacts include underrepresented social groups, marginal communities and fragile ecosystems.

To address both hazards and impacts in agriculture and to ensure sustainable and transformative development in agriculture, climate investments are urgently needed (WMO, 2020; Global Commission on Adaptation, 2019).

This was highlighted in the 26th United Nations Climate Change Conference (COP26) in 2021 (FAO, 2022b). The CRTB supports FAO's Strategy on Climate Change, by informing evidence-based interventions and decision-making using the most up-to-date climate science and data.

The Strategy on Climate Change 2022–2031 highlights the need for tailoring climate action to countries' needs and contexts and supporting them in designing, revising, and implementing their agriculture-related national commitments, including policies and plans. FAO promotes inclusive and affordable digitalization to trigger climate change adaptation action by scaling-up knowledge sharing on climate-resilient datasets, methodologies, and tools across agrifood systems. In this sense, the CRTB was developed using the latest climatic, geographical, social, and economic data for each risk component to provide users with reliable and transparent data, with references available online. This allows users to access the raw data directly. This is of particular relevance to users and project formulators, who can have access to a repository of up-to-date geospatial information at the global level.

The need to identify and manage climate risk is embedded in FAO's new Framework for Environmental and Social Management (FESM). This entails integrating observed and projected climate hazards and impacts on selected agricultural systems (crops, livestock, forestry, fisheries and aquaculture, and biodiversity) in every stage of the project cycle, from design to project development and during implementation.

Climate risk

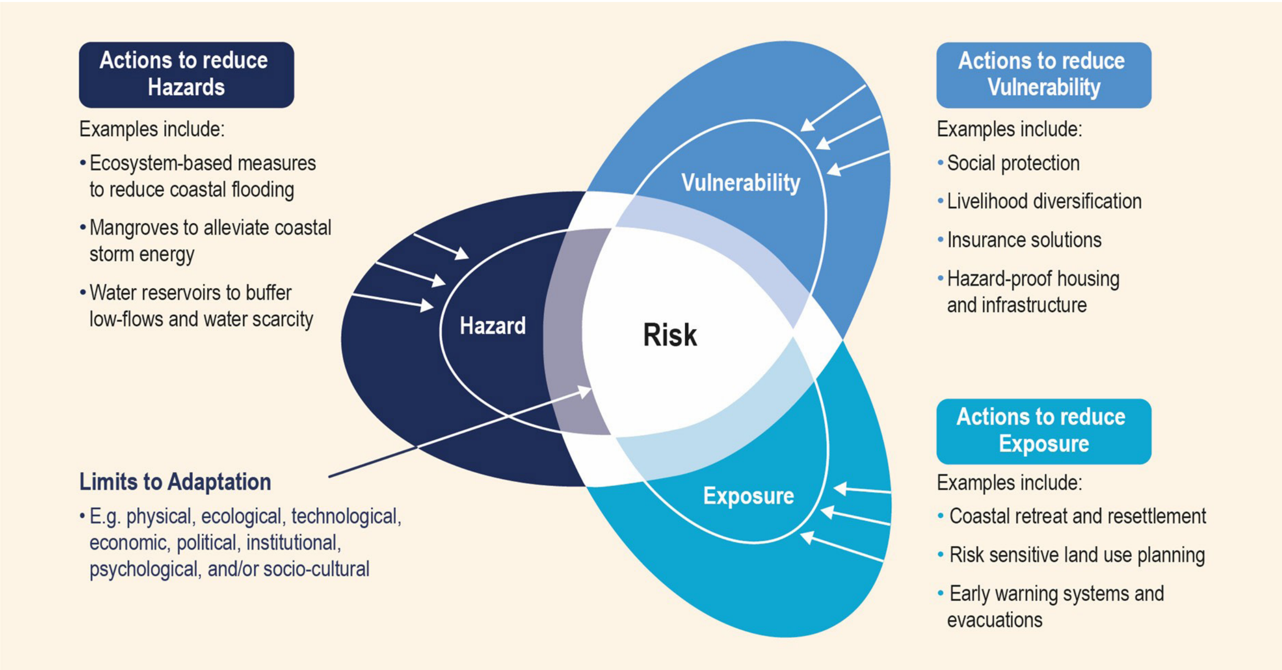
Climate risk results from the interaction of climatological, hydrological, and meteorological **hazards**, with the geographical **exposure** of human and natural systems, together with human and natural systems' **vulnerability** to climate hazards. The **adaptive capacity** component modulates the level of observed and projected risk.
The components of risk are aggregated based on the Intergovernmental Panel on Climate Change's (IPCC) most up-to-date definition of risk from the Technical Summary of the Special Report on the Ocean and Cryosphere in a Changing Climate (IPCC, 2019) (Figure 1). The understanding of risk is also based on the IPCC's risk conceptual framework used in the 5th Assessment Report (AR5) (IPCC, 2014), as well as in the 6th Assessment Report (AR6) (IPCC, 2022).

How the CRTB works

The identification and analysis of climate risk hotspots within the CRTB is performed in the most comprehensive as well as detailed way by overlaying climatic, geographic, social, and economic factors, while also allowing the user to access and assess the individual geospatial information behind each climate risk component.
Upon selecting a system of interest (crops, livestock, aquaculture and fisheries, forestry and biodiversity) in a chosen geographic area, the user is guided by questions to identify climate-related risks.

The CRTB computes the questions within the screening checklist, and classifies the level of climate risk in the project area as "Low", "Moderate", "High" or "Very High" risk. An automatic report can be generated, where climate-resilient practices are recommended.

Figure 1. Climate risk conceptual framework



Source: IPCC. 2019. *Technical Summary* [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, E. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.- O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 39-69. https://doi.org/10.1017/9781009157964.002.

CRTB for Sustainable Development Goals

The CRTB promotes adaptation to present and future climatic conditions by driving *climate action* (**SDG 13**) in the agriculture sector to achieve *zero hunger* (**SDG 2**).

During the **hazard screening,** for instance, users may find information on the observed and projected occurrence of extreme temperatures within their area of interest. This can support a farmer in planning the introduction of short-cycle crop varieties and heat-tolerant livestock breeds to improve *life on land* (**SDG 15**). The hazard screening can also be used to recommend the development of monitoring systems of ocean temperatures and ocean acidification hotspots to manage fish stocks and optimize harvesting measures. This would contribute to sustainably preserving *life below water* (**SDG 14**). Data on historical and projected extreme precipitation, drought, and flooding events, as well as the occurrence of wildfires can be used as inputs for designing more efficient water management and irrigation systems to increase access to *clean water and sanitation* (**SDG 6**) in rural areas.

The **exposure screening** reveals information on different types of land cover, including crop, grass, shrub, and forest, and their interaction with human areas. It supports the identification of resilient agroecological systems to climate impacts, such as the development of agropastoral, agroforestry, or silvopastoral systems. In addition, the identification of fisheries, mangroves, and sea level rise hotspots can support, for instance, in the restoration of mangrove and coastal ecosystems, by reducing the impacts of storm surges, coastal erosion and saltwater intrusion. Appropriate practices can contribute to preserve *life on land* (**SDG 15**) and *life below water* (**SDG 14**), while maximizing productivity potentials for *responsible consumption and production* (**SDG 12**) and *zero hunger* (**SDG 2**), as well as contributing to *decent work and economic growth* **(SDG 8**) of both land and marine communities.

The **vulnerability screening** is used to detect low levels of human development, high multidimensional poverty, high dependence on agriculture for employment, as well as severe food insecurity. This information is key to support income-generating and value-adding interventions that can enhance the resilience of agrifood systems to multiple shocks, towards achieving *no poverty* (**SDG 1**), *zero hunger* (**SDG 2**), and opportunities for *decent work* and *economic growth* (**SDG 8**). By accounting for the presence of armed conflicts and epidemics in the project location, as well as the presence of sensitive groups and gender inequalities, several SDGs are addressed. These are *good health and well-being* (**SDG 3**), *gender equality* (**SDG 5**), *reduced inequalities* (**SDG 10**), *peace, justice, and strong institutions* (**SDG 16**).

Finally, the **adaptive capacity screening** assesses the effectiveness of government, the presence or absence of disaster risk reduction policies, the availability of climate and weather information, the access to climate-proof infrastructure including markets, electricity, and internet, and the socioeconomic status of targeted communities. These assessments are made to recommend climate-resilient policy and governance measures, particularly by promoting digitalization and the use of climate information for the agriculture sector, with the aim of improving *industry, innovation, and infrastructure* (**SDG 9**), *sustainable cities and communities* (**SDG 11**), the use of *affordable and clean energy* (**SDG 7**) throughout agrifood value chains, *decent work and economic growth* (**SDG 8**), and *quality education* (**SDG 4)**.

Overall, recommendations included in the CRTB seek to integrate climate-resilient practices, multi-hazard early warning systems, climate-proof infrastructure and risk transfer systems (e.g. insurance and social protection) and promote anticipatory action, emergency preparedness and response.

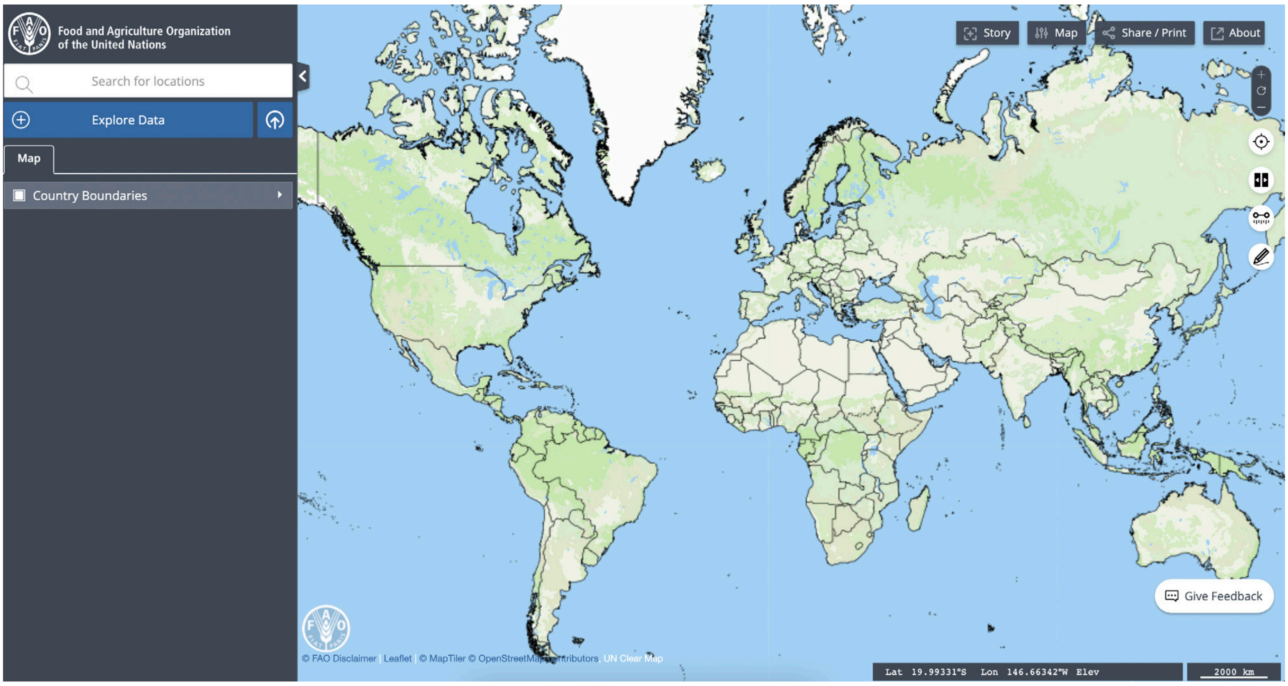
How to read this report

This document is structured as follows:

- **Chapter 2:** a step-by-step user guideline to perform climate risk screenings in the CRTB.
- **Chapter 3:** a description of the structure and key sections of the automatic report generated by the CRTB.
- **Chapter 4:** additional features to maximize all the functionalities of the CRTB.
- **Chapter 5:** technical specifications on the selection of geospatial layers for each risk component and on the climate risk calculation. All the resources behind each geospatial layer associated with the risk components can be found in the CRTB ("Metadata Link").

Maps disclaimer

All maps and screenshots included in this publication are sourced from the FAO Hand-in-Hand (HIH) Geospatial Platform which complies with United Nations Map of the World (2020).



FAO. 2022c. Climate Risk Toolbox. In: *FAO*. Rome. Cited 22 September 2022. https://data.apps.fao.org/crtb/

Notes: Final boundary between the Sudan and South Sudan has not yet been determined. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

Definitions

- **Climate finance** refers to local, national or transnational financing – drawn from public, private and alternative sources of financing – that seeks to support mitigation and adaptation actions that will address climate change. Climate finance is needed for mitigation, because large-scale investments are required to significantly reduce emissions. Climate finance is equally important for adaptation, as significant financial resources are needed to adapt to the adverse effects and reduce the impacts of a changing climate. (UNFCCC, 2022)

- **Climate-proofing** ensures that climate adaptation and mitigation actions are strongly integrated into agricultural investment projects, policies, and programmes, to provide the highest environmental, societal, and economic benefits (FAO, 2016).

- **Climate resilience** refers to the ability of an agricultural system to anticipate and prepare for, as well as adapt to, absorb, and recover stronger from the impacts of changes in climate and extreme weather. Climate resilience must go hand-in-hand with sustainability. Sustainable and climate-resilient interventions aimed at agrifood systems and value chains simultaneously reduce hunger and poverty among producers, value chain actors, and stakeholders, without compromising the intra- and intergenerational availability of natural and human resources (IPCC, 2022)

- **Climate risk management** is an integrated approach to mainstream climate-resilient decision-making, by ensuring that climate risks are identified and assessed at early stages of projects and policies, including the location, identification of climate change hotspots, the vulnerability of agricultural systems, targeted communities, and finally by integrating proposed project interventions to increase resilience (FAO, 2021a).

- **Climate risk** results from the interaction of climatological, hydrological, and meteorological hazards, with the geographical exposure of human and natural systems, together with vulnerability to climate hazards. The adaptive capacity component subtracts to the level of risk. Climate risk can be partly or totally offset both in the short- and long-term by implementing climate adaptation and mitigation strategies (IPCC, 2022).

- **Climate hazards** refer to the current and future climatological (drought, for example), meteorological (extreme temperatures, fog, storms or wind, for instance), hydrological (floods or geohazards) and environmental (land degradation and water pollution, for example) factors negatively affecting the social and ecological assets of agrifood systems (IPCC, 2022).

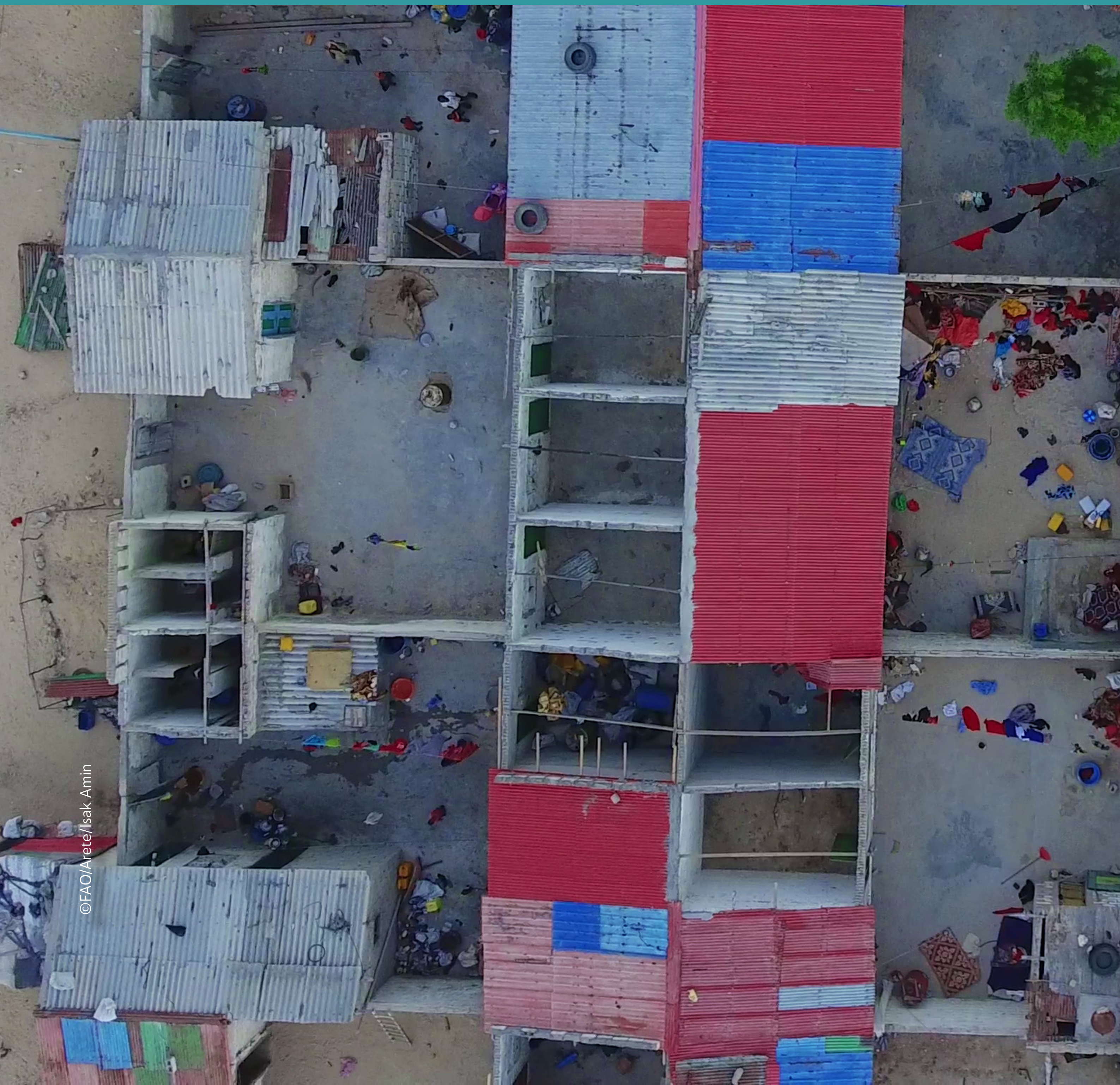
- **Human and natural exposure** to climate hazards is determined by the geographical characteristics of targeted areas, population, environmental services and the agricultural and other socioeconomic activities undertaken (IPCC, 2022)

- **Vulnerability** is determined by the social and economic conditions of the targeted population, for example, poor health, gender inequality, poverty, food insecurity and malnutrition. In the context of agrifood systems and value chains, different actors may experience different levels of vulnerability. The greater direct impacts on the most vulnerable groups may have compounded effects on earlier or later stages of the value chain, indirectly affecting the entire chain (IPCC, 2022)

- **Adaptive capacity** in the context of agrifood systems consists in farmers and value chain actors' ability to prevent or reduce climate impacts by implementing climate-proof infrastructure and technologies. This is achieved by using effective practices and being able to access social, agricultural and disaster risk insurance programmes. It depends in large part on the support provided by public and private institutions through research and investment in technological developments and access to electricity, the internet, post-harvest facilities and social protection measures (IPCC, 2022).

2

CLIMATE RISK SCREENING STEP-BY-STEP



To perform a climate risk screening analysis, users must follow the steps contained in this chapter, as shown in the screenshots taken from the CRTB:

1. Use the draw tool (Figure 2) to delineate the area of interest.

Note: The user can select Global Administrative Unit Layers to perform the climate risk screening at province or district levels by clicking "Explore Data" and subsequently "Boundaries and Backgrounds" (Figure 3).

If available, the user can drag and drop a file containing the project location data in "My Data" to view it on the map (Figure 4).

Figure 2. CRTB default page

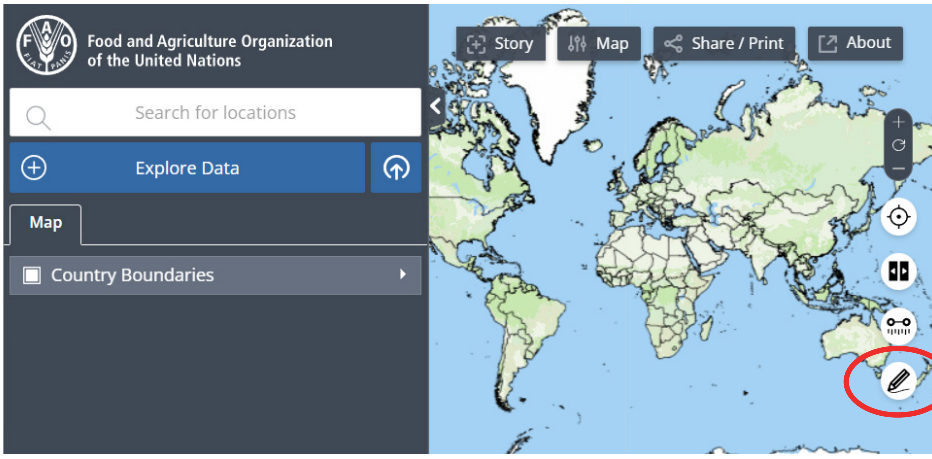


Figure 3. Defining boundaries and baseline maps

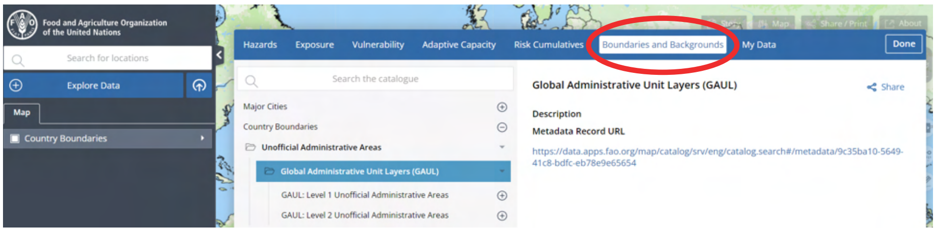
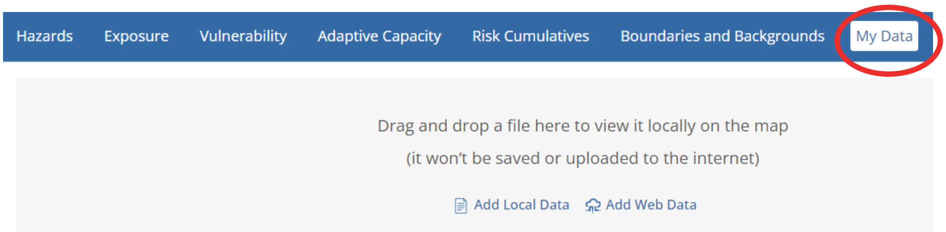
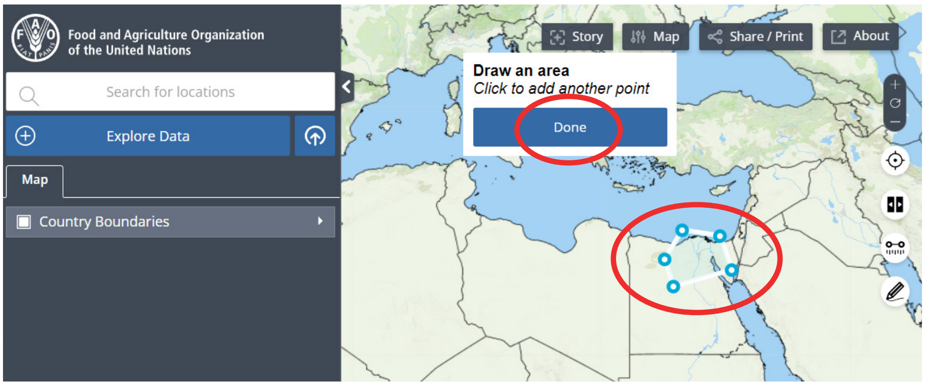


Figure 4. Uploading user data



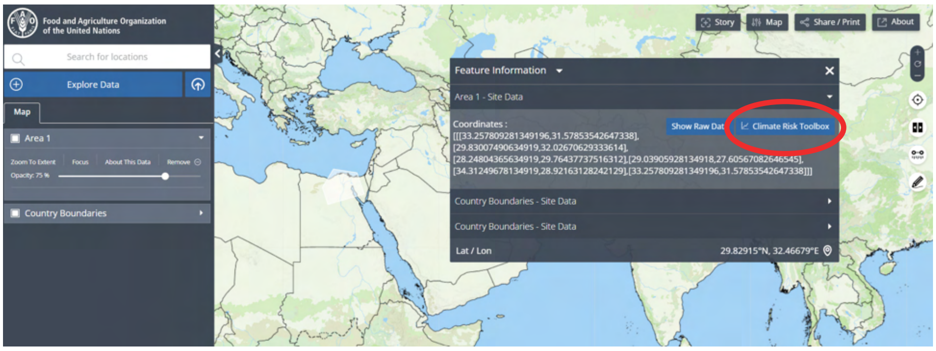
2. Click “Done” and subsequently click on the polygon (Figure 5).

Figure 5. "Draw" tool in the CRTB



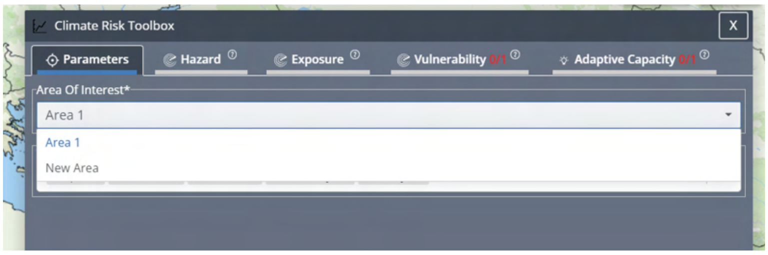
3. Click on the “Climate Risk Toolbox” button on the feature information pop-up (Figure 6).

Figure 6. Pop-up with key information on accessing the CRTB



4. Under "Parameters", the user must select the area of interest (Figure 7) as well as the agricultural systems relevant to the project in question (Figure 8).

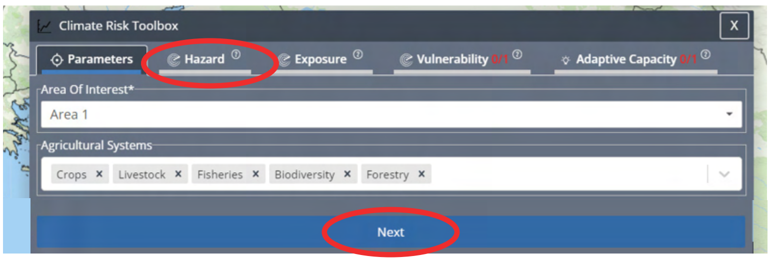
Figure 7. Drop-down box for selecting the area of interest



Note: it is possible to select more than one agricultural system.

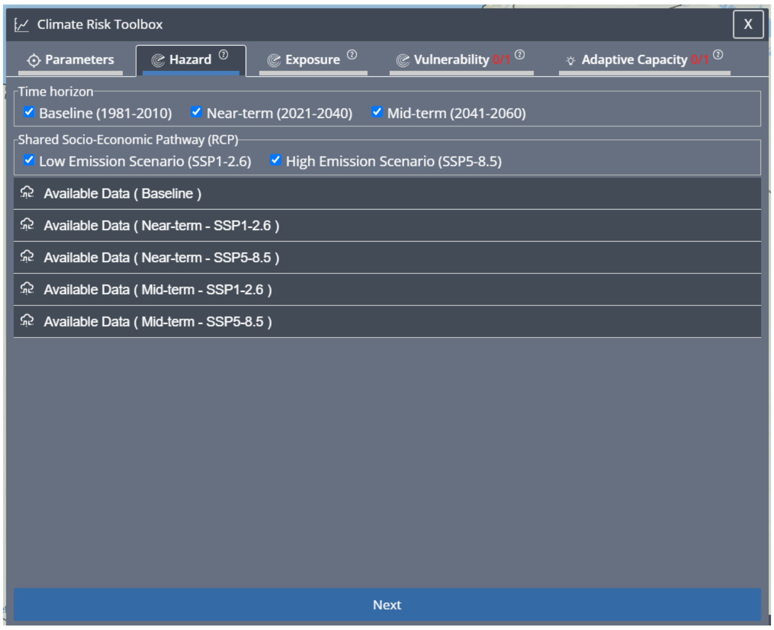
Afterwards, the user must analyze each risk component by clicking “Next” and/or directly by clicking the subsequent risk component (in the example, "Hazard").

Figure 8. Drop-down box for selecting the relevant agricultural systems



5. Under the "Hazard" component, the user can select the time horizons and Shared Socio-economic Pathways (SSPs) of interest (Figure 9).

Figure 9. Box for the completion of the "Hazard" section



6. . Under "Exposure", all the checklist questions are automatically responded (Figure 10).

Figure 10. Box for the completion of the "Exposure" section

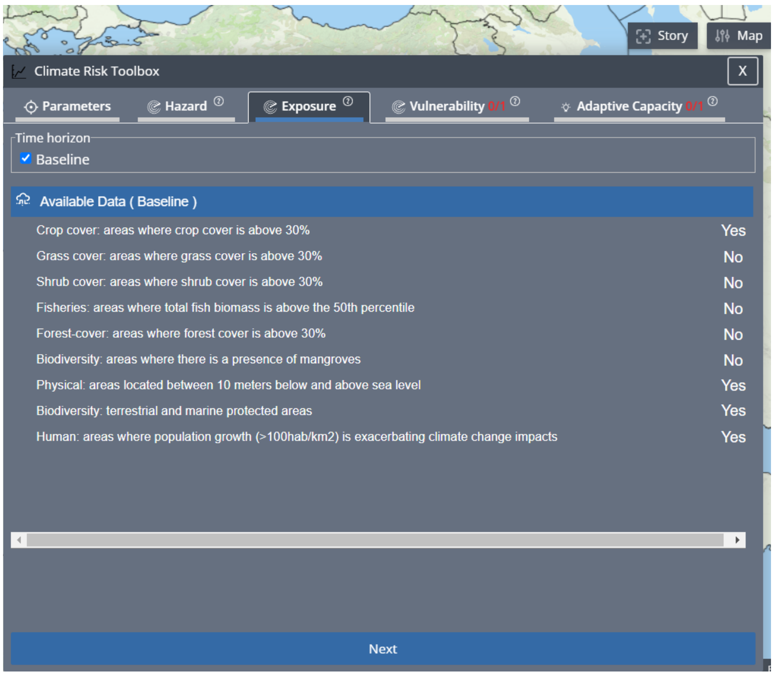
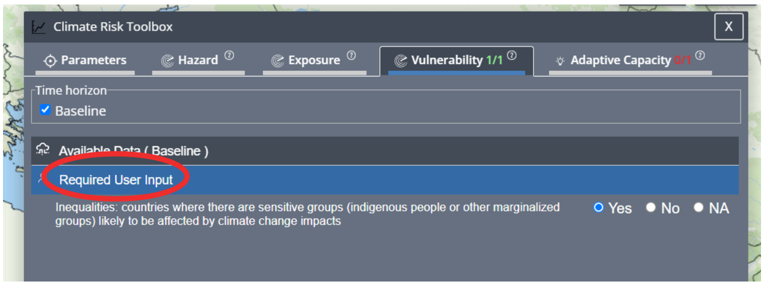


Figure 11. Box for the completion of the "Vulnerability" section



7. For both "Vulnerability" (Figure 11) and "Adaptive Capacity" (Figure 12), the user is requested to fill-out one screening question under the "Required User Input" tab.

8. After all the risk components are completed, users must run the CRTB by clicking "Run" at the bottom of the box, and subsequently "Download Report".

Note: the generation of the automatic report takes on average 5 minutes.

Figure 12. Box for the completion of the "Adaptive Capacity" section

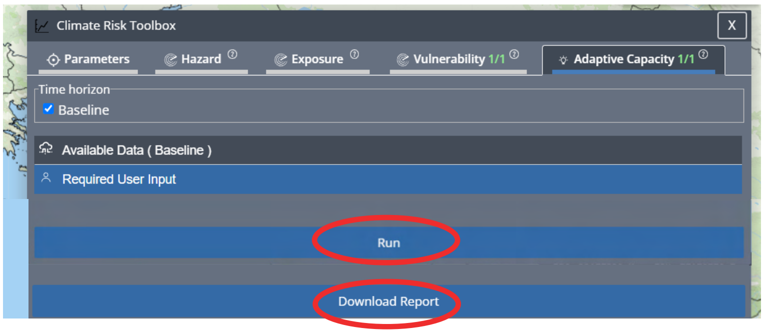
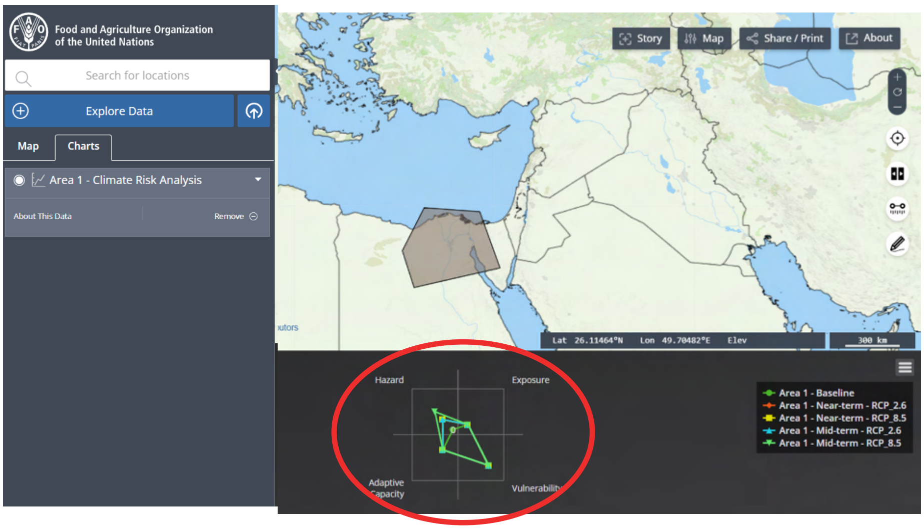


Figure 13. Completion of the climate risk screening analysis



8. A spider web diagram showing the results for each climate risk component, time horizons, as well as SSPs is automatically generated (Figure 13).

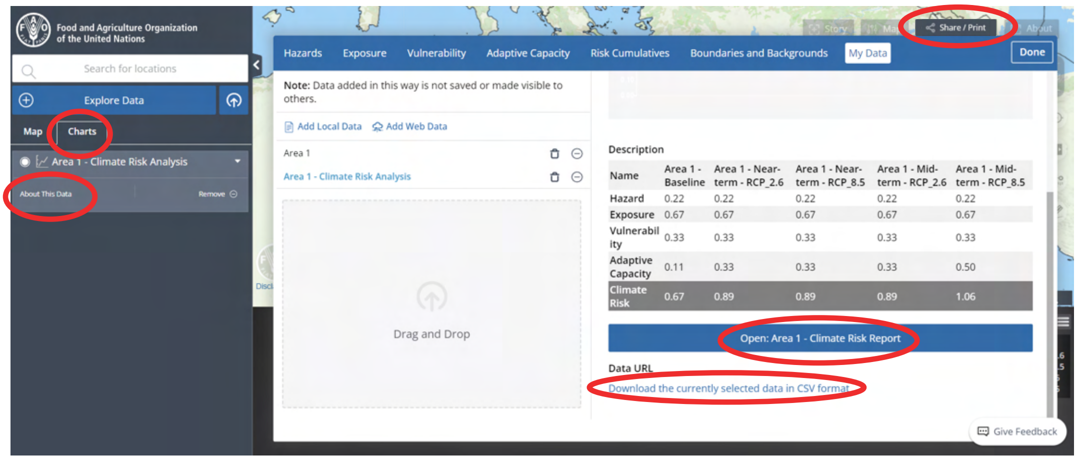
9. The automatic report summarizing the climate risk screening analysis is opened automatically in a new window in the form of a Google Document (please refer to Chapter 3 - Automatic Report for details on its structure and key sections). Note: users must enable pop-ups to be able to open the automatic report.

Results of the climate risk screening for each selected scenario and climate risk component are shown by clicking "Charts" section and "About This Data" on the left side within the drawn area layer (Figure 14). From the same "Charts" and "About This Data" section, the user can retrieve:

• The automatic report by clicking "Open: Area x - Climate Risk Report".
• A .csv file which contains the results of the different climate risk components as shown in the Spider web diagram by clicking "Download the currently selected data in CSV format".

In addition, the user can share the link of the climate risk screening results with external users by clicking "Share/Print" on the top left and copying the URL.

Figure 14. Results of the climate risk screening for different climate risk components and climate scenarios



Interpretation of the results:

The values for hazard, exposure, and vulnerability components are summed to obtain the average baseline and future climate risks within the project area. The interactions between hazards, exposure, and vulnerability are also modulated by the adaptive capacity component within the project area, which therefore reduces the overall climate risk results.

Hazard, exposure, vulnerability, and adaptive capacity values are classified on a scale of Low (values between 0.0 and 0.30), Moderate (values between 0.30 and 0.60), High (values between 0.60 and 0.80), and Very High (values between 0.80 and >1).

Once the aggregated risk for each component is computed, the overall climate risk has the following thresholds:

From -0.80 to 0.20 = Low risk
From 0.20 to 1.00 = Moderate risk
From 1.00 to 1.6 = High risk
From 1.6 to >2 = Very high risk

Additional information on the equations used for the calculation of the climate risk is provided under Chapter 5.

3

AUTOMATIC REPORT

The automatic report presents the key results as displayed in the CRTB in the form of a Google Document modifiable by the user. The report first determines the level of risk of the selected area for the specified time horizons and SSPs.

The document describes the results through context specific maps which show the different levels of climate risk within the selected area (Figure 15).

The automatic report also includes the climate risk screening checklists for each component of the risk, which answer each question linked to a geospatial layer, as previously analyzed in the CRTB (Figure 16).

In addition, the user can integrate context- and project-specific information into each section of the document.

Figure 15. Example of maps generated by the automatic report

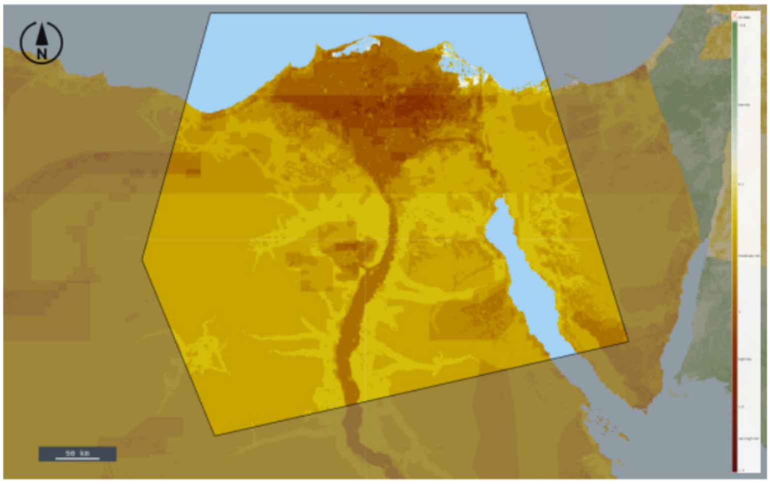


Figure 16. Example of the climate risk screening checklists generated by the automatic report

Baseline climate (1981-2010): historical climate hazards in project areas	Yes	No
Extreme high temperatures: areas where maximum temperatures are above 35°C for at least 30 days on average per year	X	
Extreme Low temperatures: areas where minimum temperatures are below 0°C for at least 15 days on average per year		X
Extreme precipitation: areas where maximum 1-day precipitation is above 50mm on average per year.		X
Extreme precipitation: Areas prone to flood events with 100-year return period.		X
Landslide: areas where median annual rainfall-triggered landslide is above 0		X
Drought: areas where the Standardized Precipitation Index is below 0%		X
Wildfires: areas where the fire frequency is above 1 on average per year		X
Ocean temperature: areas where the temperature of the sea at surface level is above 25°C		X
Ocean acidification: areas where pH at surface is below 8.085		X
Exposure of agricultural systems and population to climate hazards in project areas	**Yes**	**No**
Crop cover: areas where crop cover is above 30%	X	
Grass cover: areas where grass cover is above 30%		X
Shrub cover: areas where shrub cover is above 30%		X
Fisheries: areas where total fish biomass is above the 50th percentile		X
Forest-cover: areas where forest cover is above 30%		X
Biodiversity: areas where there is a presence of mangroves		X
Physical: areas located between 10 meters below and above sea level	X	
Biodiversity: terrestrial and marine protected areas	X	
Human: areas where population growth (>100hab/km2) is exacerbating climate change impacts	X	
Vulnerability of the population to climate hazards in project areas	**Yes**	**No**
Development: countries where the Human Development Index (HDI) is below 0.6		X
Development: countries where the Multidimensional Poverty Index (MPI) is below 0.6	X	
Food insecurity: countries where the food insecurity prevalence is above 30%	X	
Armed conflict: countries where conflict is exacerbating population's sensitivity to weather related hazards	X	
Migration: countries where weather extremes have displaced more than 50000 people in a year		X
Epidemics: countries where humanitarian crises, including health crises, are impeding the population to address the potential impacts of climate change	X	
Economic: countries where more than 30% of the population is employed in the agricultural sector		X
Inequalities: countries where gender inequalities are likely to be exacerbated by climate change	X	

The report automatically includes recommendations on climate resilient practices tailored to the previously selected agricultural systems and value chains and based on observed and projected hazards (Figure 17).

Figure 17. Example of climate resilient practices tailored to agricultural systems based on observed and projected hazards

Extreme heat	Land degradation and GHG emissions	Drought	Heavy rainfall	Cold, frost and hail	Animal diseases
- Heat tolerant breeds - Animal shelter	- Transhumance corridors - Rotational grazing - Ex-closures - Reduce herd size - Silvopastoral systems - Cut and carry fodder system - Manure management - Nutritional strategies - Rumen manipulation	- Drought tolerant breeds - Water reservoirs - Pastoral water points	- Animal shelter	- Animal shelter	- Vermin control measures - Managing livestock - Adequate animal spacing

Coastal erosion	Ocean acidification	Sea Surface temperature	Storm surges and swells
- Vegetate with trees, bushes or grasses - Mangrove restoration - Salt marshes restoration - Seaweed conservation - Plantation of marsh grasses - Submerged vegetation - Fixed concrete structures	- Shifting from harvesting to breeding - Upstream stenohaline species - Better and selective breeding	- Monitoring of autonomous adaptation - Catch limits - Transboundary agreements - Protected areas - Zonation and artificial reefs	- Disaster management - Mangrove restoration - Coastal ecosystem restoration

The user can manually complete the table on the modulation of the climate risk according to the project components and interventions (Figure 18). The user must follow the guiding questions to qualitatively identify how the project modulates the identified climate risks through each project outcome. This step should closely consider the scope, objectives and source of funding of the project. The modulation of risk by the project can be determined as "Robust", "Sufficient" or "Insufficient".

Figure 18. Modulation of climate risks by the project interventions (table to be completed by the user)

		PROJECT OUTCOMES								URGENCY LEVEL
	MODULATION OF CLIMATE RISKS	XX	XX	XX	XX	XX	XX	XX	XX	Needs more action; Current action is appropriate; Not Applicable
POLICY AND PLANNING	Does the project support the integration of climate risks into policies, planning and management frameworks?									
	Does the project explicitly support the increased use of climate data and information in policy development, planning and management?									
CAPACITY BUILDING	Does the project invest in institutional development and capacity-building for institutions involved in climate related activities?									
	Does the project invest in increased information and dissemination of climate-related information to target groups?									
	Does the project invest in strengthening resilience (e.g., through access to climate data, information and services, training etc.) of the most affected and at-risk socio-economic groups?									
	Does the project support equitable access and the capacity of target groups to utilize and apply climate and early warning services at farm level?									
DATA GATHERING	Does the project support the infrastructure and technologies necessary to collect and monitor climate variables necessary used for policy development and decision-making?									
	Does the project strengthen institutions and their networks by developing the skills required to collect, analyze, and monitor climate related data and information?									
	Does the project support development of databases and repositories of climate data and information?									
MITIGATION	Does the project invest in climate change mitigation measures along the food value chain (e.g., increasing energy efficiency, reforestation, land rehabilitation, reduction of food loss and waste, reduced methane and N_2O emissions in livestock sector) that reduces GHGs emissions?									
	Does the contribute to the government's Nationally Determined Contributions and the decarbonization of the agriculture and food systems?									
	Does the project invest in renewable energy and green technologies?									
ADAPTATION	Does the project invest in increasing adaptive capacity and resilience (e.g., climate-smart agricultural practices, soil carbon enhancement, frontier technologies, dietary change, ecosystem restoration)?									
	Does the project promote sustainable natural resources management?									
	Does the project support Nature-based Solutions for climate change adaptation and disaster risk reduction?									
	Does the project invest in agricultural insurance and on weather-forecast based financing mechanisms?									

The automatic report is finally equipped with key references and links to useful documents to complete the climate risk screening process.

Climate risk	Climate mainstreaming/Climate risk modulation		
	Robust	Sufficient	Insufficient
Low	L	L	L
Moderate	L	M	M
High	M	H	H
Very High	H	VH	VH

☐ LOW	☐ MODERATE	☐ HIGH	☐ VERY HIGH

4

ADDITIONAL FEATURES OF THE CRTB

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Additional features of the CRTB, as reported below, support the user with taking full advantage of all the functionalities of the CRTB and deepening the climate risk screening analysis.

• Users can rename the drawn area by clicking above the Area × layer on the left-side (Figure 19) and by typing the desired title (Figure 20).

Figure 19. Automatically generated title for the drawn area

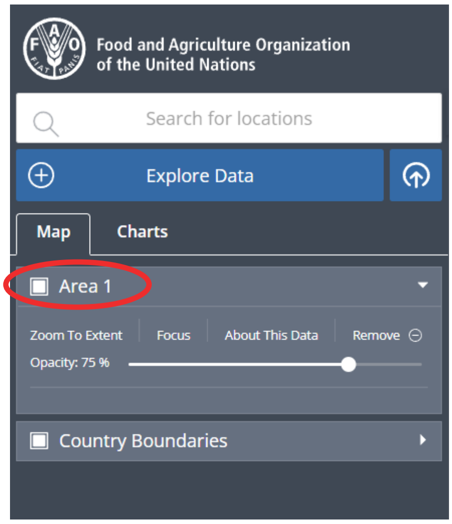
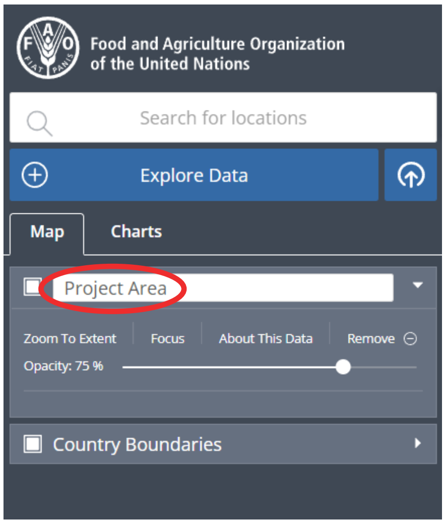
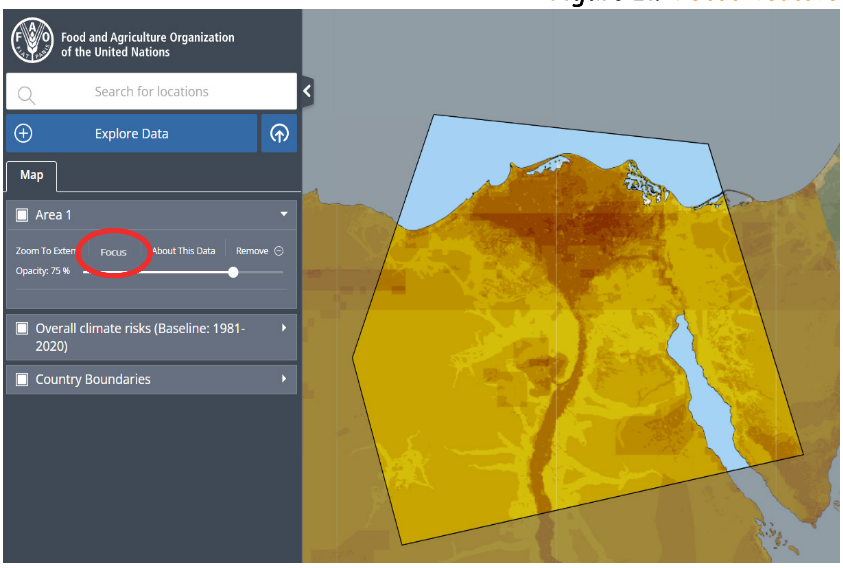


Figure 20. Feature for changing the name of the drawn area



• To better visualize data in the map, users can precisely zoom-in the selected area by clicking "Focus" within the Area × layer on the left-side (Figure 21).

Figure 21. "Focus" feature



- Users can use the "Explore Data" button to open-up the repository of layers (Figure 22).

- Users can select specific risk components on the top tab (hazard, exposure, vulnerability, or adaptive capacity) and click ⊕ to show individual layers on the map.

Note: users can retrieve the Metadata Link to obtain further information about the raw data behind each layer, which appears on the right side after clicking on the name of the layer.

Figure 22. "Explore Data" feature

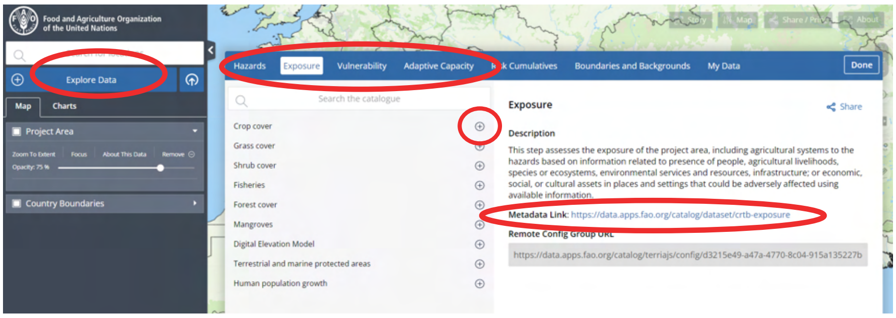


Figure 23. Visualization of the selected layers in the map

- The selected layer's legend is shown on the left-side (Figure 23).

- Users can click inside the white square next to the layers to hide/ show data in the map.

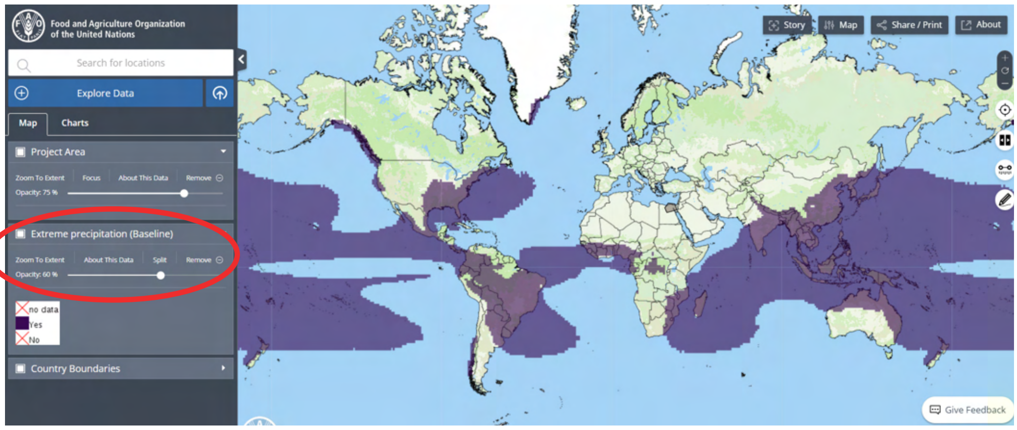
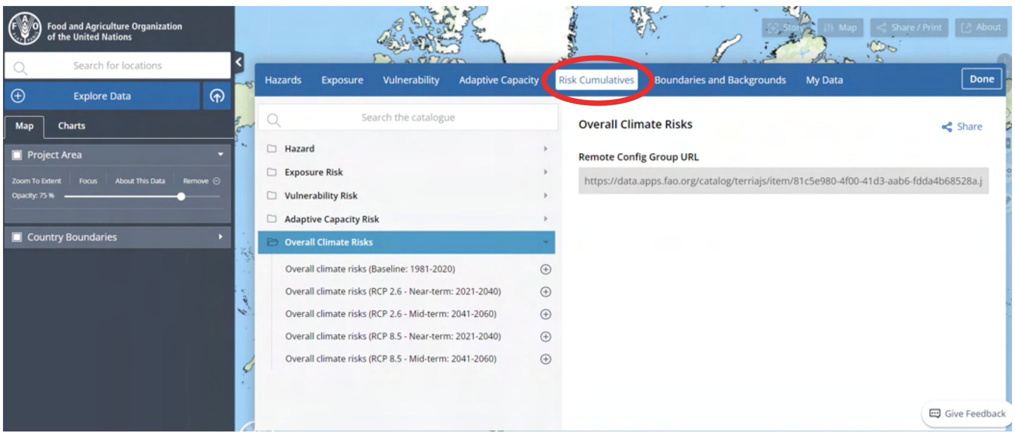


Figure 24. Visualization of the "Risk Cumulatives" layers

- Under "Explore Data" and "Cumulative Risks", the user can visualize cumulative hazards, exposure, vulnerability, adaptive capacity layers, and climate risk layers for the specific time period and SSPs (Figure 24).



Interpretation of the legends for cumulative climate risk components and overall climate risk

The legend for the cumulative hazards, exposure, vulnerability, and overall climate risk presents four classes of risk (Figure 25).

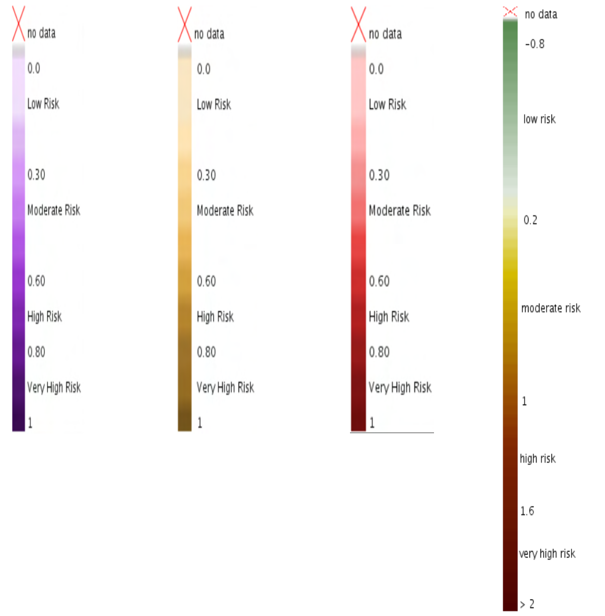
- Low risk
- Moderate risk
- High risk
- Very high risk

Since the adaptive capacity layers reduce the overall climate risk, the legend for the cumulative adaptive capacity layer presents reversed values (Figure 26).

- Very high adaptive capacity
- High adaptive capacity
- Moderate adaptive capacity
- Low adaptive capacity

Figure 25. Legends for the cumulative hazard, exposure, vulnerability, and climate risk layers (from left to right)

Cumulative hazard | Cumulative exposure | Cumulative vulnerability | Climate risk



FAO. 2022b. Climate Risk Toolbox. In: *FAO*. Rome. Cited 22 September 2022. https://data.apps.fao.org/crtb/

Figure 26. Legend for the cumulative adaptive capacity layer

Cumulative adaptive capacity

FAO. 2022b. Climate Risk Toolbox. In: *FAO*. Rome. Cited 22 September 2022. https://data.apps.fao.org/crtb/

5

TECHNICAL SPECIFICATIONS OF THE CRTB

The section below shows the key steps followed to perform the computation of the climate risk within the CRTB.

1. Identification of geospatial layers and thresholds for each climate risk component:

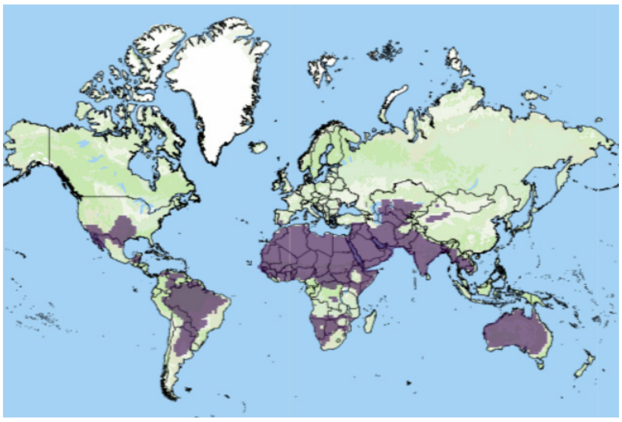
Hazards (Baseline - 1981–2010) layers and thresholds:

Areas where the values of the selected layer exceed the specific threshold as defined below in each layer description.

Q1- Extreme high temperatures: areas where maximum temperatures are above 35 °C for at least 30 days on average per year (Figure 27).

Data was reanalysed from Gutiérrez et al. (2021).

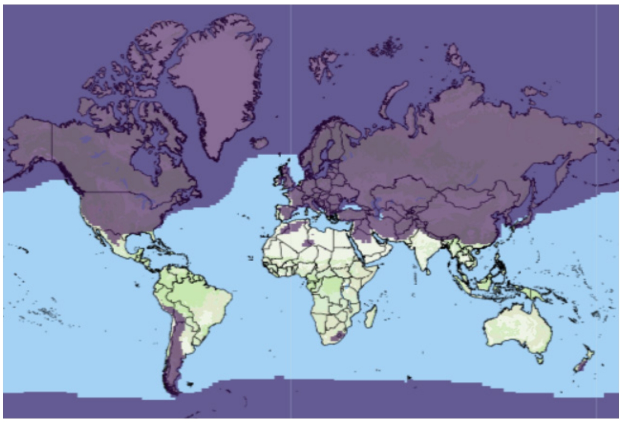
Figure 27. Extreme high temperatures layer (Baseline)



Q2- Extreme low temperatures: areas where minimum temperatures are below 0 °C for at least 15 days on average per year (Figure 28).

Data was reanalysed from Gutiérrez et al. (2021).

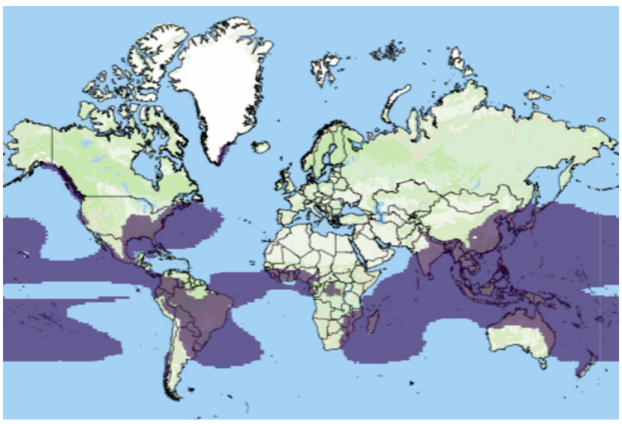
Figure 28 Extreme low temperatures layer (Baseline)



Q3- Extreme precipitation: areas where maximum 1-day precipitation is above 50 mm on average per year (Figure 29).

Data was reanalysed from Gutiérrez et al. (2021).

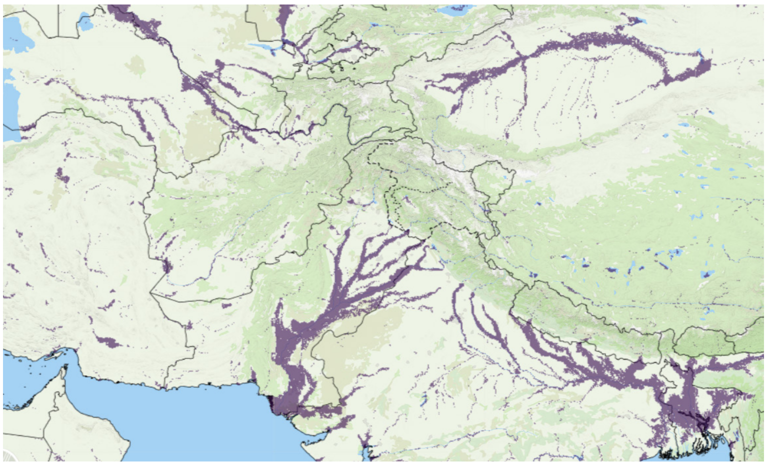
Figure 29. Extreme precipitation layer (Baseline)



Q4- Floods: areas prone to flood events with 100-year return period (Figure 30).

Data was reanalysed from UNISDR (2015).

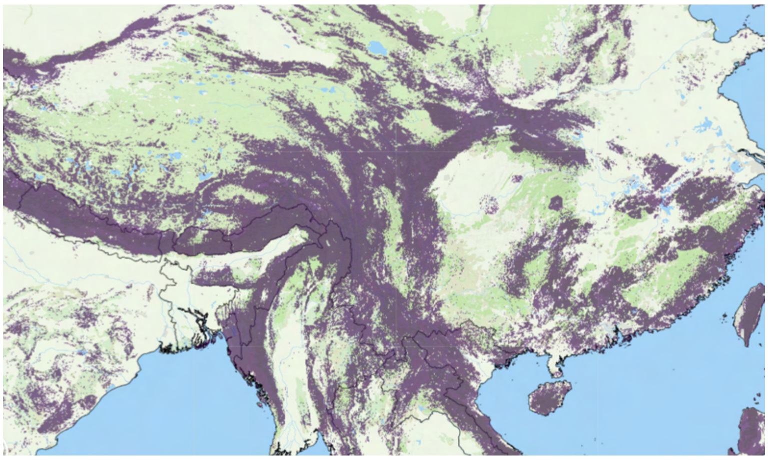
Figure 30. Floods layer (Baseline) (enlarged example)



Q5- Landslide: areas where median annual rainfall-triggered landslide occurrence is above 0 (Figure 31).

Data was reanalysed from the World Bank (2020).

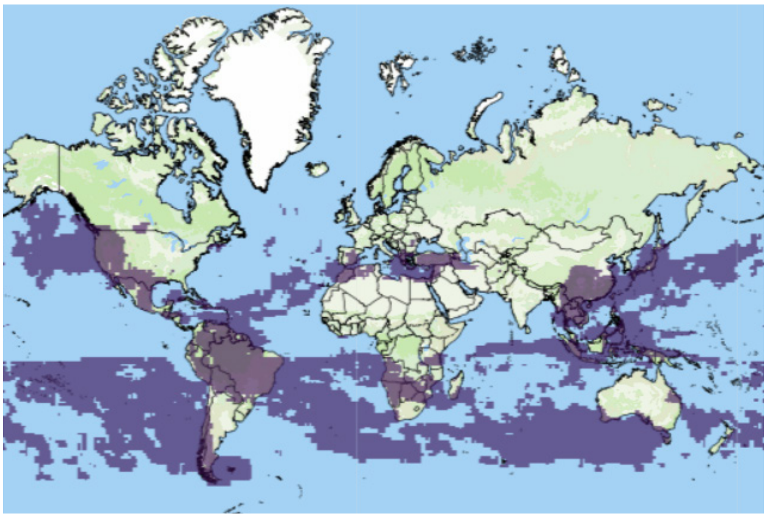
Figure 31. Landslide layer (Baseline) (enlarged example)



Q6- Drought: areas where the Standardized Precipitation Index (SPI) is below 0 (Figure 32).

Data was reanalysed from Gutiérrez et al. (2021).

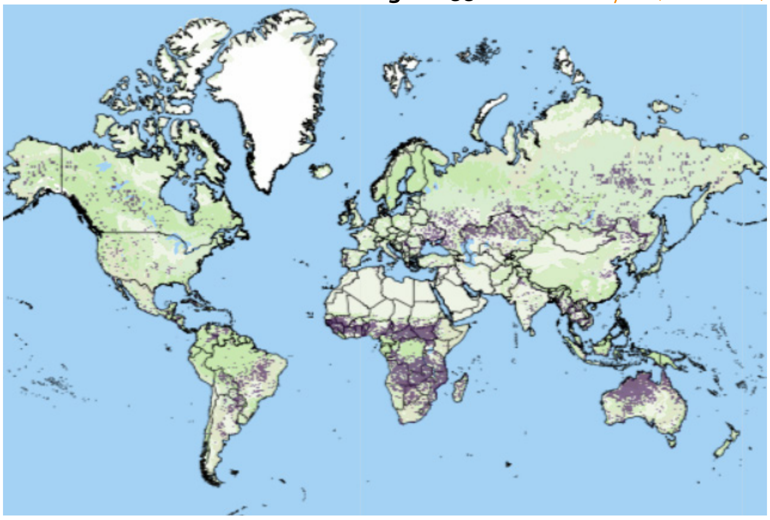
Figure 32. Drought layer (Baseline)



Q7- Wildfires: areas where the fire frequency is above 1 on average per year (Figure 33).

Data was reanalysed from Giglio et al. (2015).

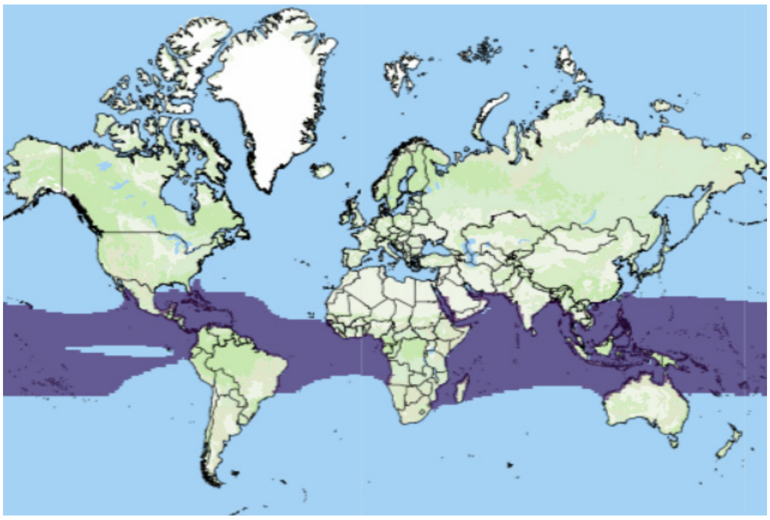
Figure 33. Wildfire layer (Baseline)



Q8- Ocean temperature: areas where the sea surface temperature is above 25 °C (Figure 34).

Data was reanalysed from Gutiérrez et al. (2021).

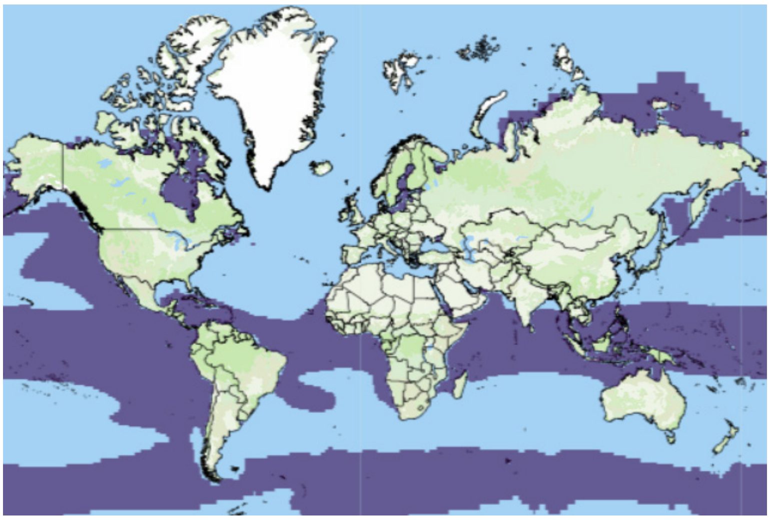
Figure 34. Ocean temperature layer (Baseline)



Q9- Ocean acidification: areas where pH sea surface is below 8.085 (Figure 35).

Data was reanalysed from Gutiérrez et al. (2021).

Figure 35. Ocean acidification layer (Baseline)

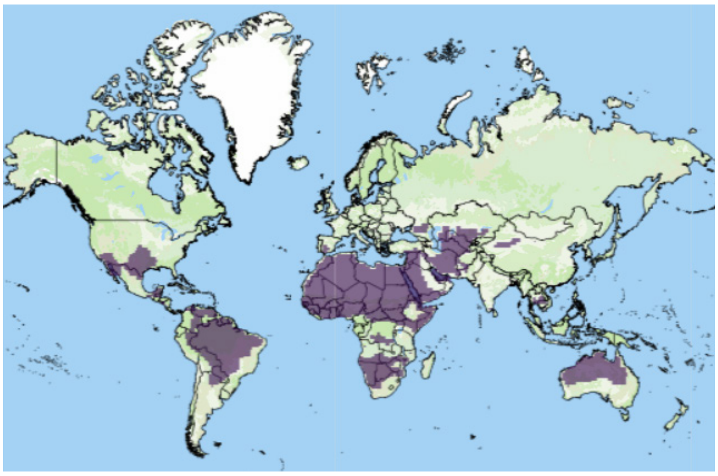


Hazards (Near-term: 2021–2040 - SSP1-2.6) layers and thresholds:

Q1- Extreme high temperatures: areas where the number of days per year with maximum temperatures above 35 °C will increase by more than 15 days (Figure 36).

Data was reanalysed from Gutiérrez et al. (2021).

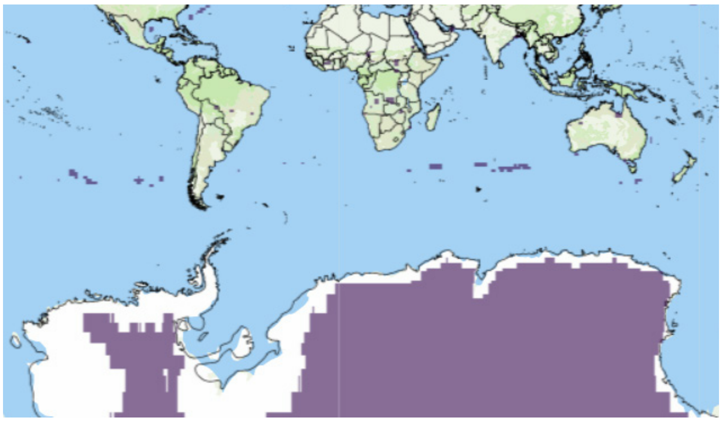
Figure 36. Extreme high temperatures layer (SSP1-2.6 - Near-term: 2021–2040).



Q2- Extreme low temperatures: areas where the number of days per year with minimum temperatures below 0 °C will increase by more than 1 day (Figure 37).

Data was reanalysed from Gutiérrez et al. (2021).

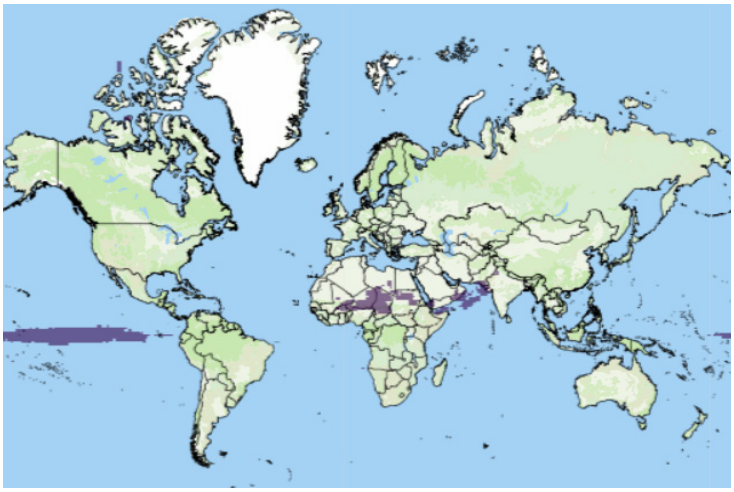
Figure 37. Extreme low temperatures layer (SSP1-2.6 - Near-term: 2021–2040)



Q3- Extreme precipitation: areas where the change in the average maximum 1-day precipitation is above 20 percent (Figure 38).

Data was reanalysed from Gutiérrez et al. (2021).

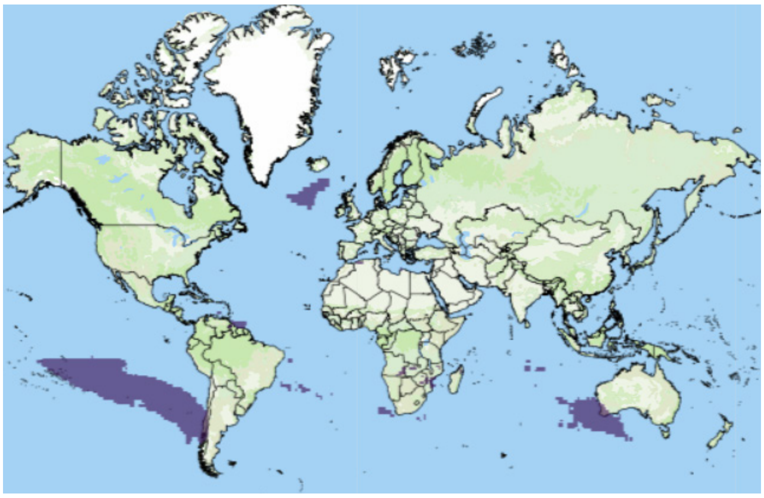
Figure 38. Extreme precipitation layer (SSP1-2.6 - Near-term: 2021–2040)



Q4- Drought: areas where the change in the Standardized Precipitation Index (SPI) is below -20 percent (Figure 39).

Data was reanalysed from Gutiérrez et al. (2021).

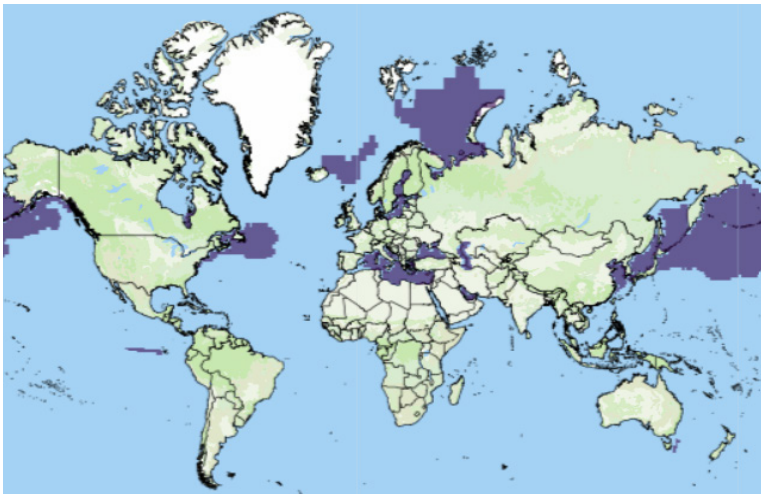
Figure 39. Drought layer (SSP1-2.6 - Near-term: 2021–2040)



Q5- Ocean temperature: areas where the change in sea surface temperature is above 1 °C (Figure 40).

Data was reanalysed from Gutiérrez et al. (2021).

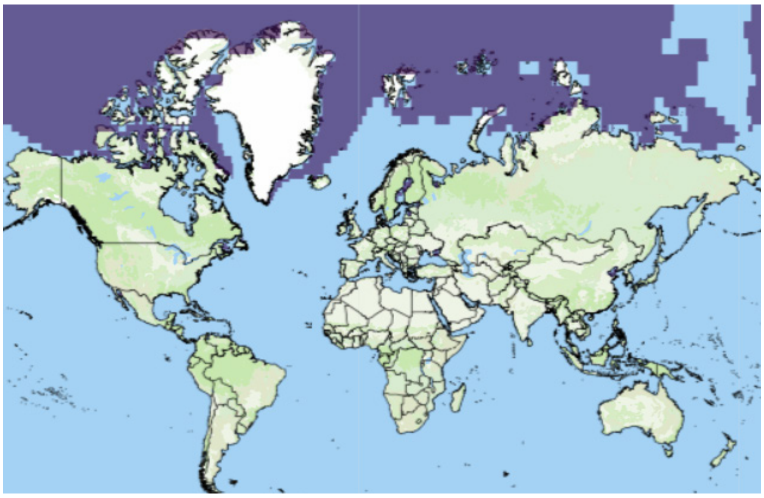
Figure 40. Ocean temperature layer (SSP1-2.6 - Near-term: 2021–2040)



Q6- Ocean acidification: areas where the change in pH is below -0.1 (Figure 41).

Data was reanalysed from Gutiérrez et al. (2021).

Figure 41. Ocean acidification layer (SSP1-2.6 - Near-term: 2021–2040)

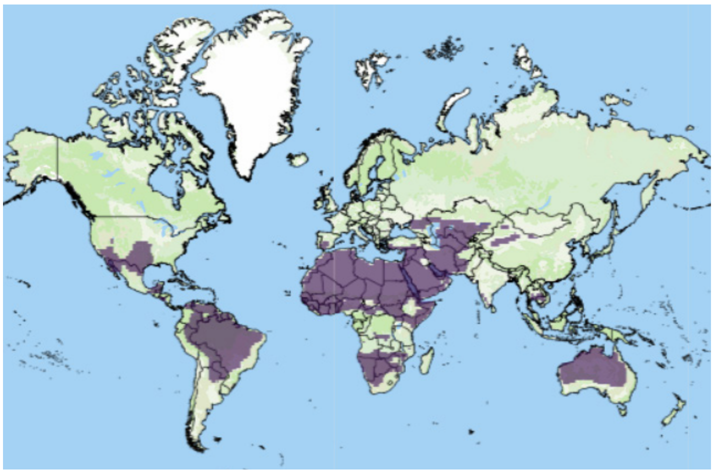


Hazards (Near-term: 2021–2040 - SSP5-8.5) layers and thresholds:

Q1- Extreme high temperatures: areas where the number of days per year with maximum temperatures above 35 °C will increase by more than 15 days (Figure 42).

Data was reanalysed from Gutiérrez et al. (2021).

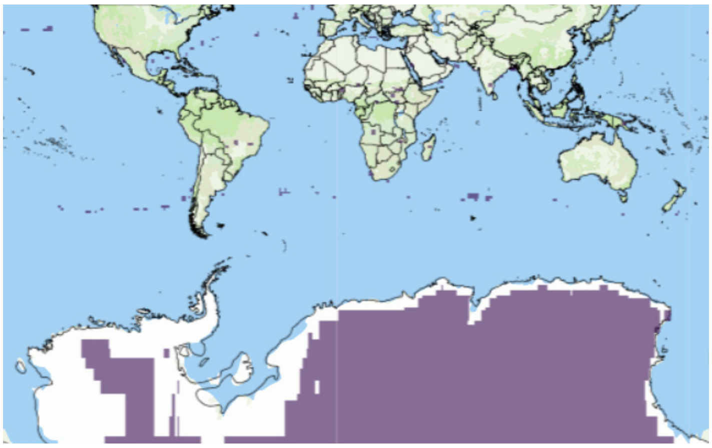
Figure 42. Extreme high temperatures layer (SSP5-8.5 - Near-term: 2021–2040)



Q2- Extreme low temperatures: areas where the number of days per year with minimum temperatures below 0 °C will increase by more than 1 day (Figure 43).

Data was reanalysed from Gutiérrez et al. (2021).

Figure 43. Extreme low temperatures layer (SSP5-8.5 - Near-term: 2021–2040))



Q3- Extreme precipitation: areas where the change in the average maximum 1-day precipitation is above 20 percent (Figure 44).

Data was reanalysed from Gutiérrez et al. (2021).

Figure 44. Extreme precipitation layer (SSP5-8.5 - Near-term: 2021–2040)

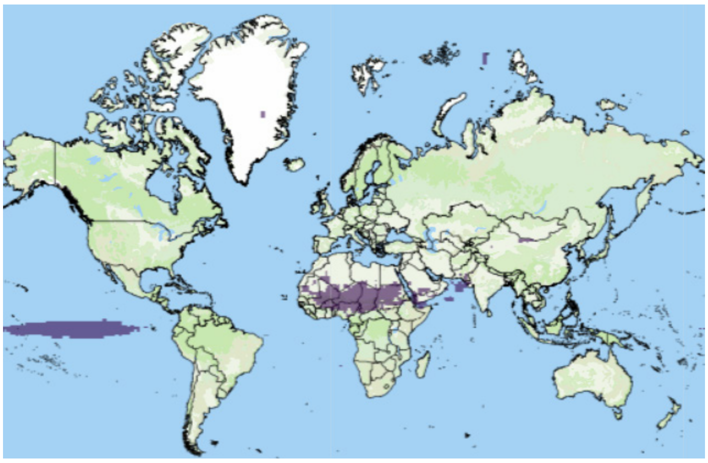
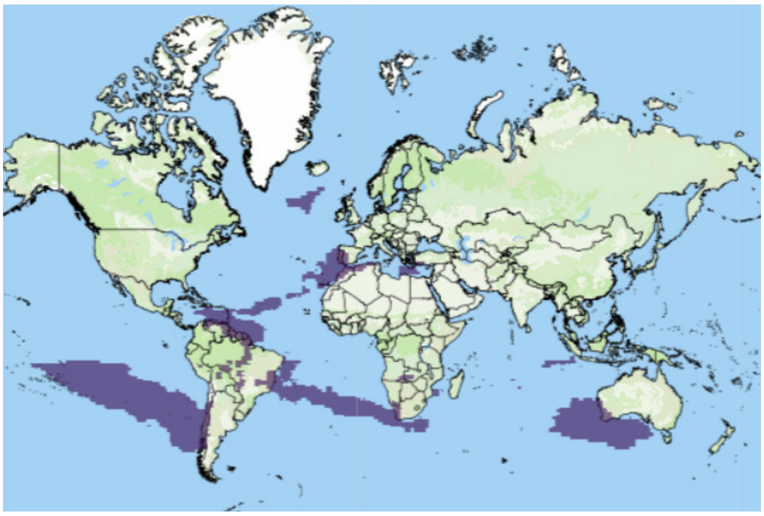


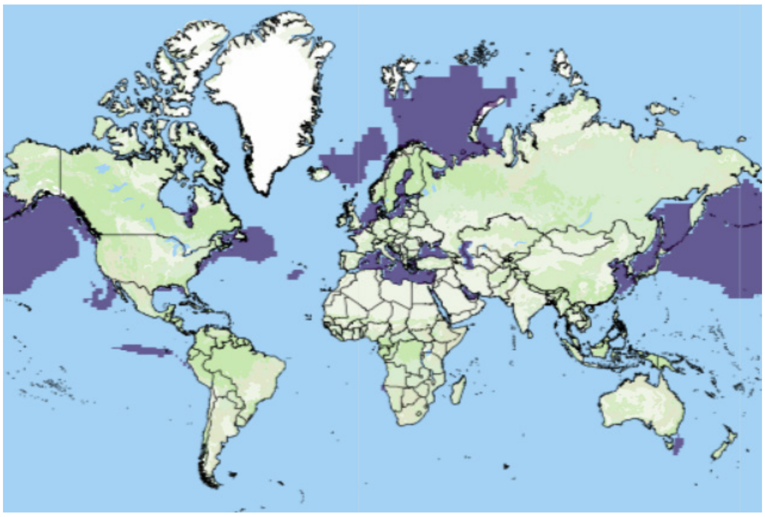
Figure 45. Drought layer (SSP5-8.5 - Near-term: 2021–2040)



Q4- Drought: areas where the change in the Standardized Precipitation Index (SPI) is below -20 percent (Figure 45).

Data was reanalysed from Gutiérrez et al. (2021).

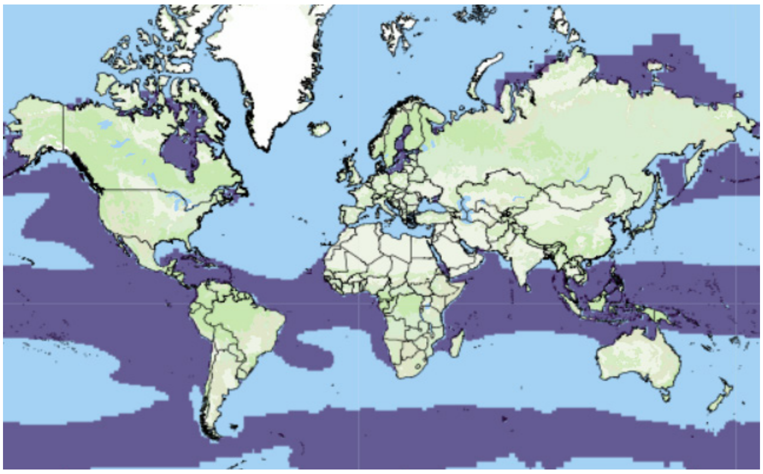
Figure 46. Ocean temperature layer (SSP5-8.5 - Near-term: 2021–2040)



Q5- Ocean temperature: areas where the change in sea surface temperature is above 1 °C (Figure 46).

Data was reanalysed from Gutiérrez et al. (2021).

Figure 47. Ocean acidification layer (SSP5-8.5 - Near-term: 2021–2040)

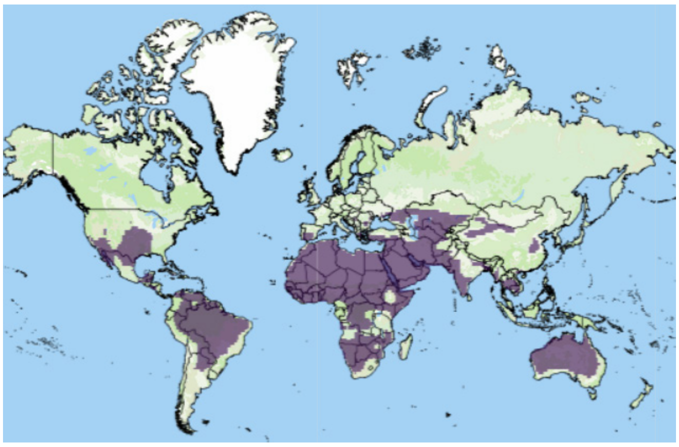


Q6- Ocean acidification: areas where the pH change is below -0.1 (Figure 47).

Data was reanalysed from Gutiérrez et al. (2021).

Hazards (Mid-term: 2041–2060 - SSP1-2.6) layers and thresholds:

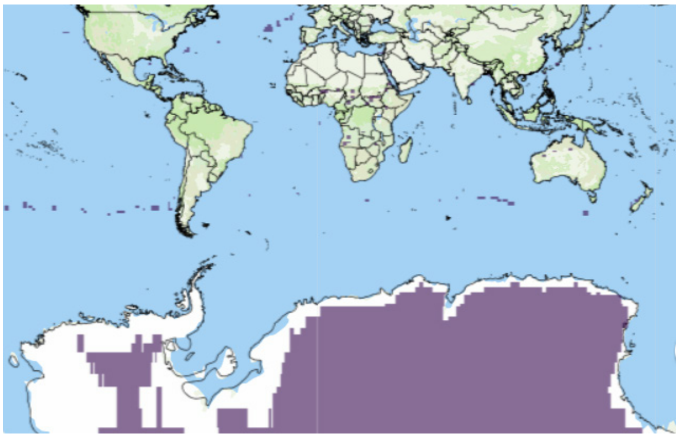
Figure 48. Extreme high temperatures layer (SSP1-2.6 - Mid-term: 2041–2060)



Q1- Extreme high temperatures: areas where the number of days per year with maximum temperatures above 35 °C will increase by more than 15 days (Figure 48).

Data was reanalysed from Gutiérrez et al. (2021).

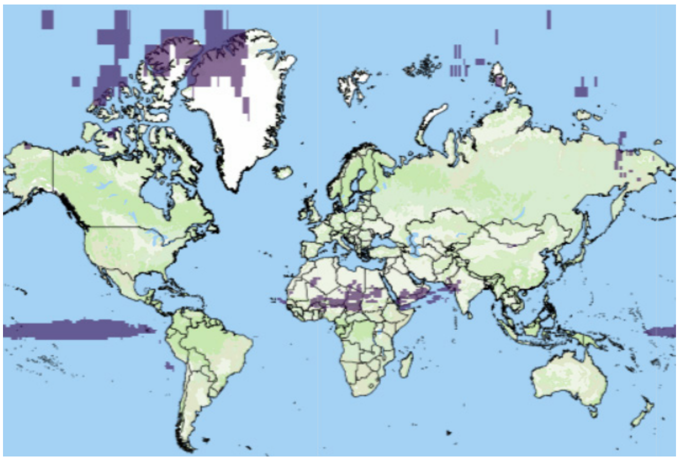
Figure 49. Extreme low temperatures layer (SSP1-2.6 - Mid-term: 2041–2060)



Q2- Extreme low temperatures: areas where the number of days per year with minimum temperatures below 0 °C will increase by more than 1 day (Figure 49).

Data was reanalysed from Gutiérrez et al. (2021).

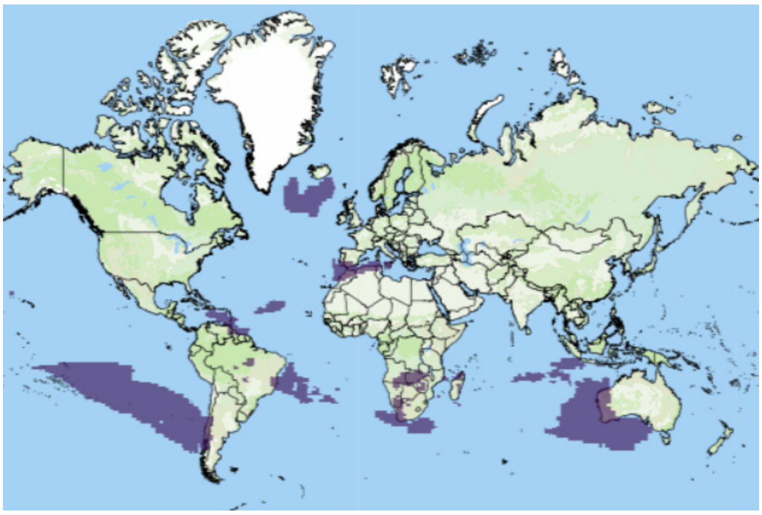
Figure 50. Extreme precipitation layer (SSP1-2.6 - Mid-term: 2041–2060)



Q3- Extreme precipitation: areas where the change in the average maximum 1-day precipitation is above 20 percent (Figure 50).

Data was reanalysed from Gutiérrez et al. (2021).

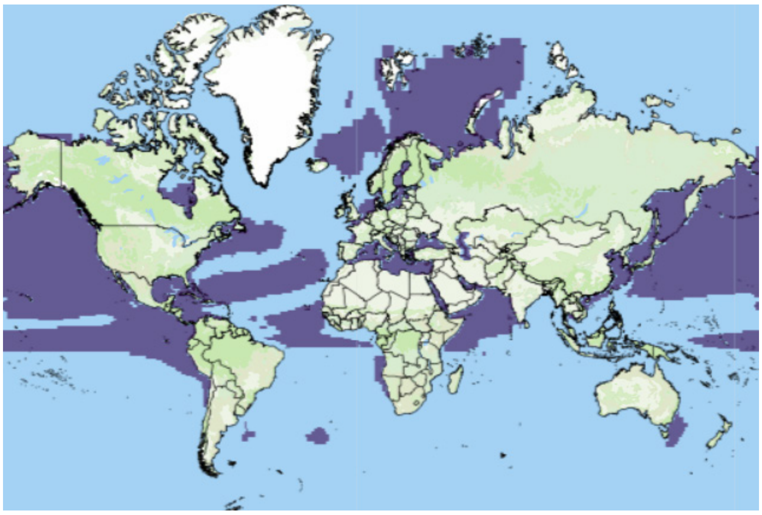
Figure 51. Drought layer (SSP1-2.6 - Mid-term: 2041–2060)



Q4- Drought: areas where the change in the Standardized Precipitation Index (SPI) is below -20 percent (Figure 51).

Data was reanalysed from Gutiérrez et al. (2021).

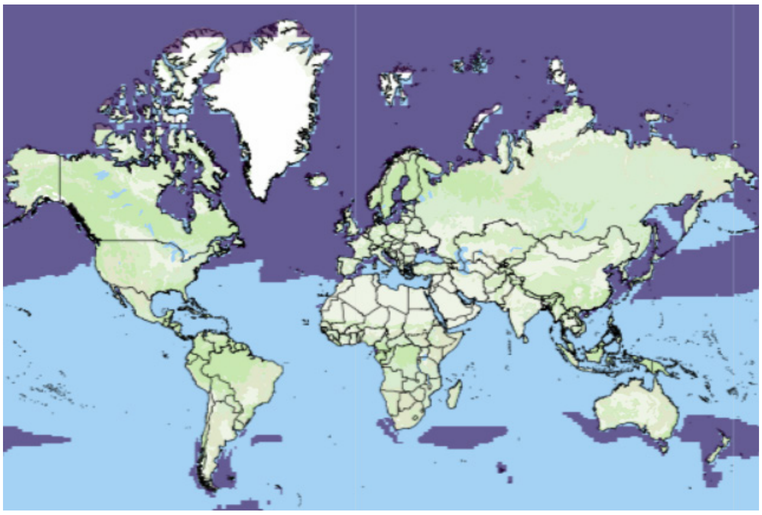
Figure 52. Ocean temperature layer (SSP1-2.6 - Mid-term: 2041–2060)



Q5- Ocean temperature: areas where the change in sea surface temperature is above 1 °C (Figure 52).

Data was reanalysed from Gutiérrez et al. (2021).

Figure 53. Ocean acidification layer (SSP1-2.6 - Mid-term: 2041–2060)



Q6- Ocean acidification: areas where the pH change is below -0.1 (Figure 53).

Data was reanalysed from Gutiérrez et al. (2021).

Hazards (Mid-term: 2041–2060 - SSP5-8.5) layers and thresholds:

Figure 54. Extreme high temperatures layer (SSP5-8.5 - Mid-term: 2041–2060)

Q1- Extreme high temperatures: areas where the number of days per year with maximum temperatures above 35 °C will increase by more than 15 days (Figure 54).

Data was reanalysed from Gutiérrez et al. (2021).

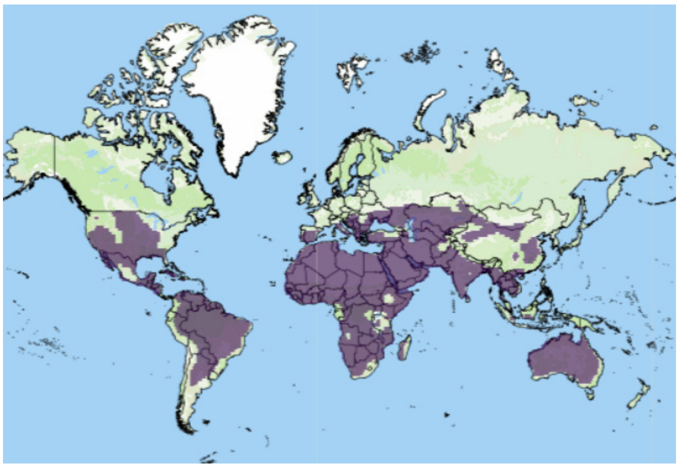


Figure 55. Extreme low temperatures layer (SSP5-8.5 - Mid-term: 2041–2060)

Q2- Extreme low temperatures: areas where the number of days per year with minimum temperatures below 0 °C will increase by more than 1 day (Figure 55).

Data was reanalysed from Gutiérrez et al. (2021).

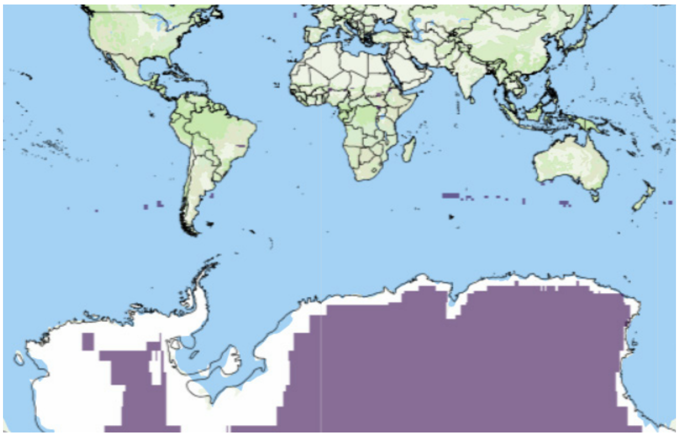
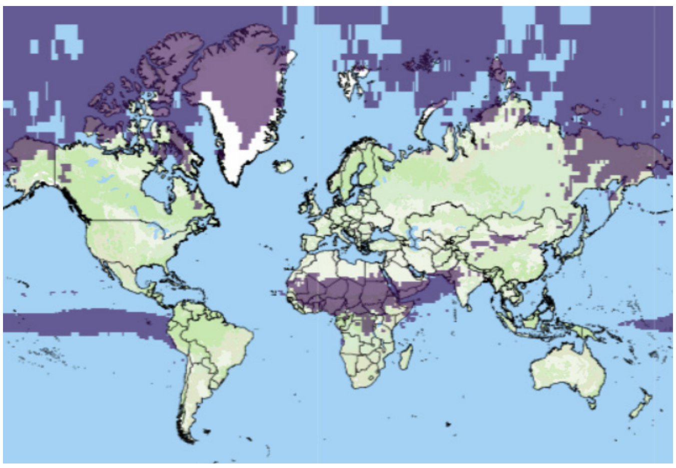


Figure 56. Extreme precipitation layer (SSP5-8.5 - Mid-term: 2041–2060)

Q3- Extreme precipitation: areas where the change in the average maximum 1-day precipitation is above 20 percent (Figure 56).

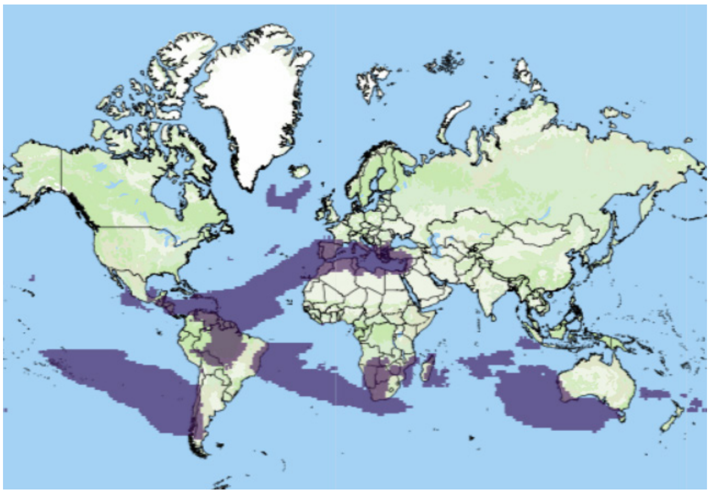
Data was reanalysed from Gutiérrez et al. (2021).



Q4- Droughts: areas where the change in the Standardized Precipitation Index (SPI) is below -20 percent (Figure 57).

Data was reanalysed from Gutiérrez et al. (2021).

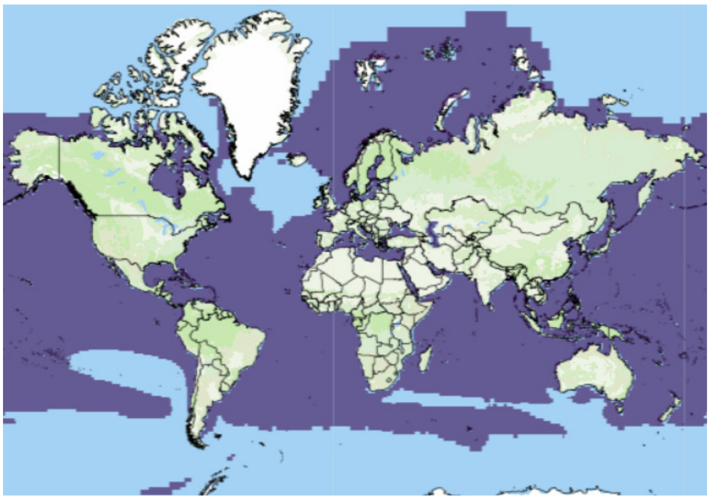
Figure 57. Drought layer (SSP5-8.5 - Mid-term: 2041–2060)



Q5- Ocean temperature: areas where the change in temperature of the sea at surface level is above 1 °C(Figure 58).

Data was reanalysed from Gutiérrez et al. (2021).

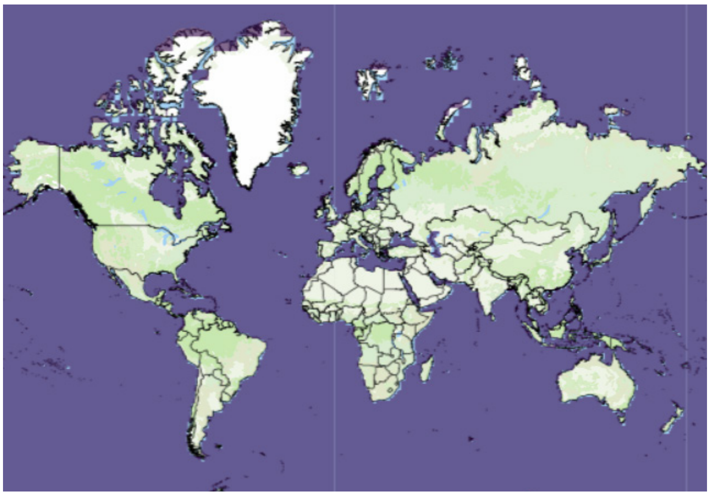
Figure 58. Ocean temperature layer (SSP5-8.5 - Mid-term: 2041–2060)



Q6- Ocean acidification: areas where the pH change is below -0.1 (Figure 59).

Data was reanalysed from Gutiérrez et al. (2021).

Figure 59. Ocean acidification layer (SSP5-8.5 - Mid-term: 2041–2060)



Exposure layers and thresholds:

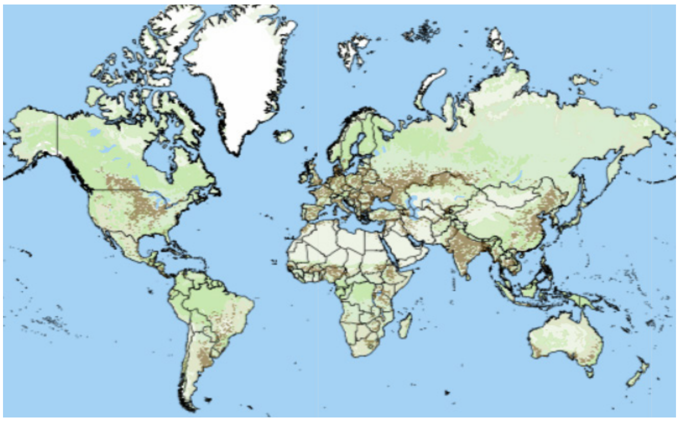
Areas where the values of the selected layer exceed the specified threshold.

Note: For ocean layers, values with no data correspond to pixels within inland areas, and viceversa for inland layers.

Q1- Crop cover: areas where crop cover is above 30 percent (Figure 60).

Data was reanalysed from Buchhorn et al. (2020).

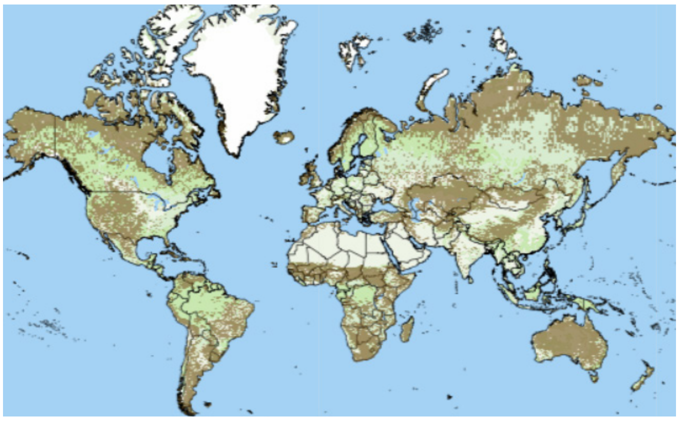
Figure 60. Crop cover layer



Q2- Grass cover: areas where grass cover is above 30 percent (Figure 61).

Data was reanalysed from Buchhorn et al. (2020).

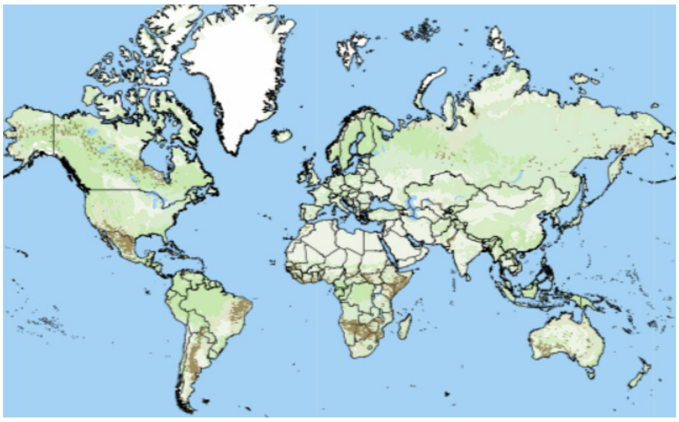
Figure 61. Grass cover layer



Q3- Shrub cover: areas where shrub cover is above 30 percent (Figure 62).

Data was reanalysed from Buchhorn et al. (2020).

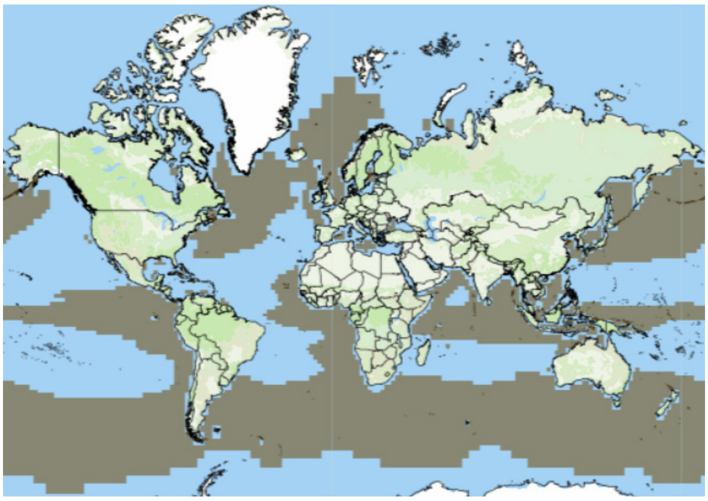
Figure 62. Shrub cover layer



Q4- Fisheries: areas where total fish biomass is above the 50th percentile (Figure 63).

Data was reanalysed from Tittensor et al. (2018).

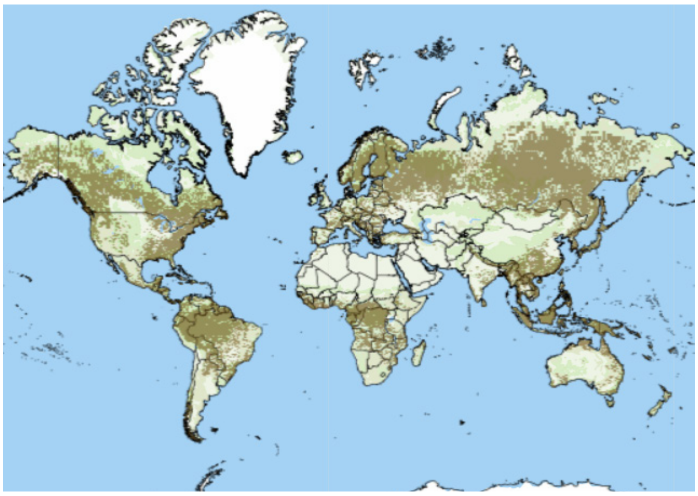
Figure 63. Fisheries layer



Q5- Forest cover: areas where forest cover is above 30 percent (Figure 64).

Data was reanalysed from Buchhorn et al. (2020).

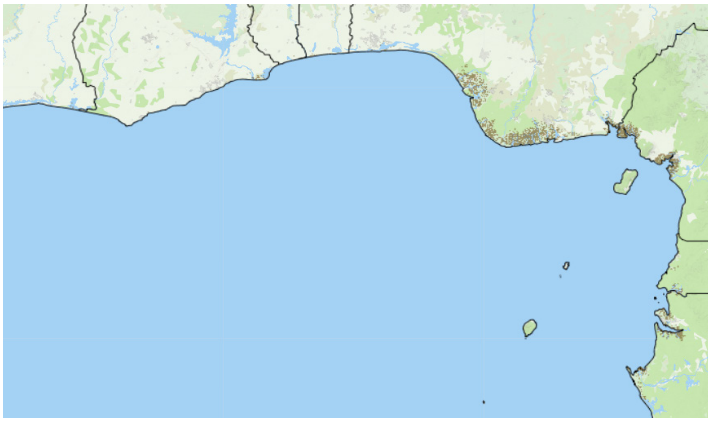
Figure 64. Forest cover layer



Q6- Biodiversity: areas where there is presence of mangroves (Figure 65).

Data was reanalysed from Giri et al. (2011).

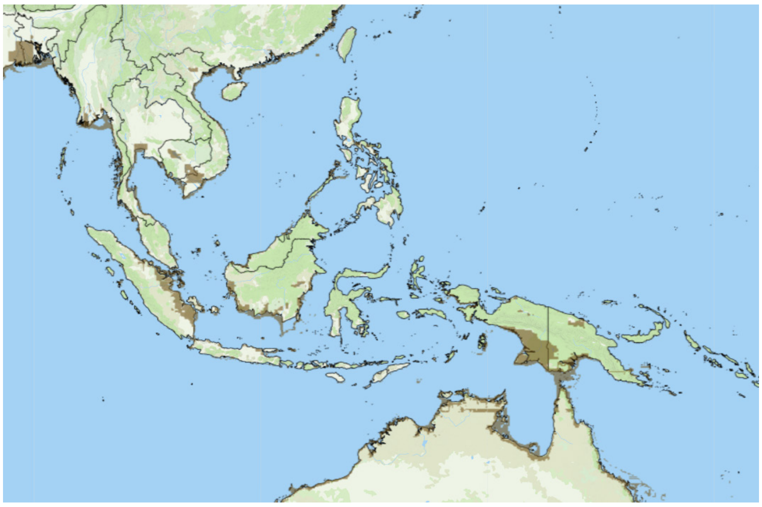
Figure 65. Biodiversity layer (enlarged example)



Q7- Lowland areas: areas located between 10 meters above sea level (Figure 66).

Data was reanalysed from the National Oceanic and Atmospheric Administration (1988).

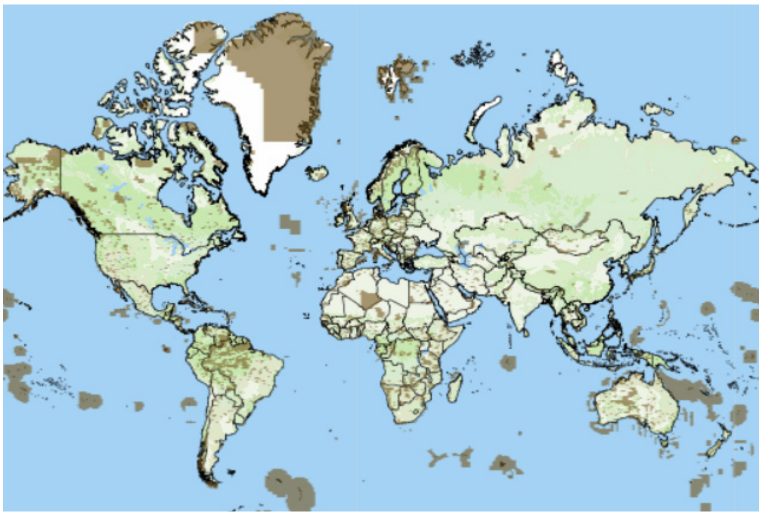
Figure 66. Lowland areas layer (enlarged example)



Q8- Biodiversity: terrestrial and marine protected areas (Figure 67).

Data was reanalysed from IUCN and UNEP-WCMC (2020).

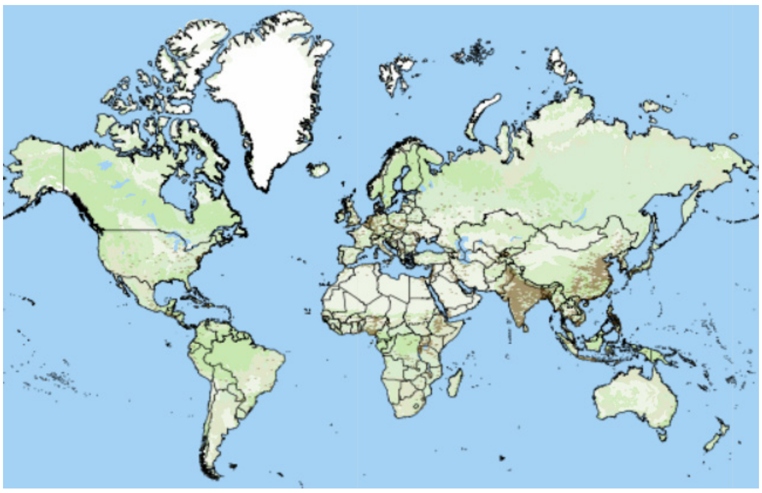
Figure 67. Biodiversity layer



Q9- Population density: areas where population is >100hab/km² (Figure 68).

Data was reanalysed from the WorldPop (2022) project.

Figure 68. Population density layer



Vulnerability layers and thresholds:

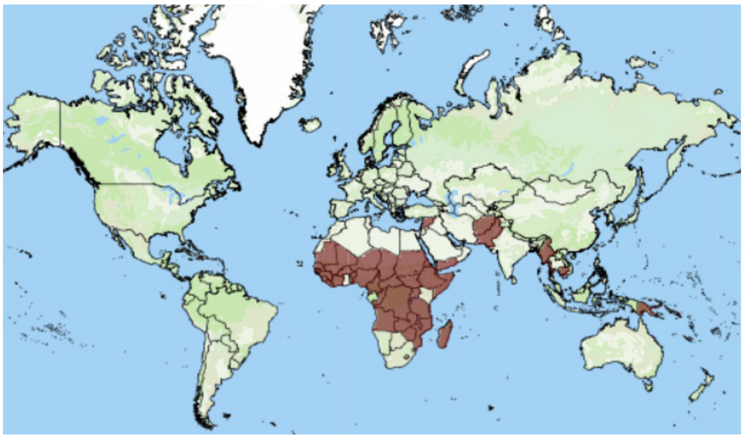
Areas where the values of the selected layer exceed the specified threshold.

Note: values with no data correspond to pixels within ocean areas.

Q1- Development: countries where the Human Development Index (HDI) is below 0.6 (Figure 69).

Data was reanalysed from the United Nations Development Programme (2022).

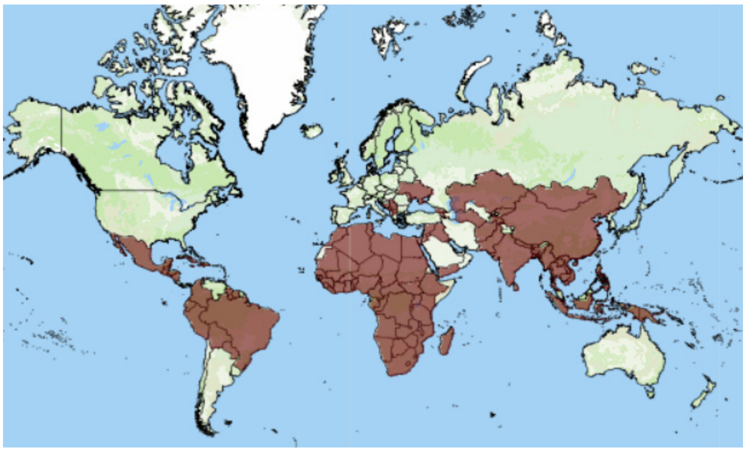
Figure 69. Human Development Index layer



Q2- Development: countries where the Multidimensional Poverty Index (MPI) is below 0.6 (Figure 70).

Data was reanalysed from the United Nations Development Programme, OPHI (2022).

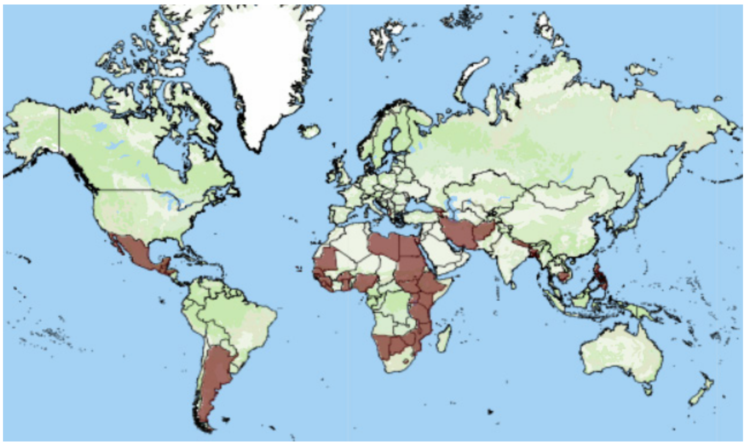
Figure 70. Multidimensional Poverty Index layer



Q3- Food insecurity: countries where the food insecurity prevalence is above 30 percent (Figure 71).

Data was reanalysed from the World Bank (2022a).

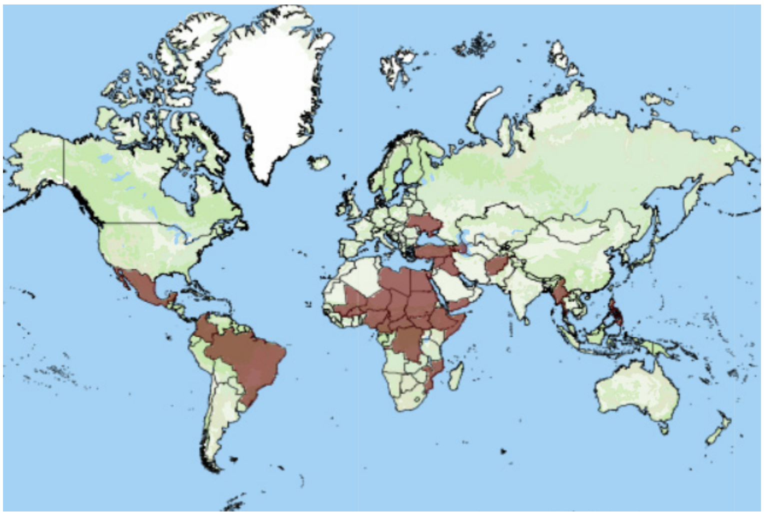
Figure 71. Food insecurity layer



Q4- Armed conflicts: countries where conflict is exacerbating population sensitivity to weather related hazards (Figure 72).

Data was reanalysed from the Heidelberg Institute for International Conflict Research (2022).

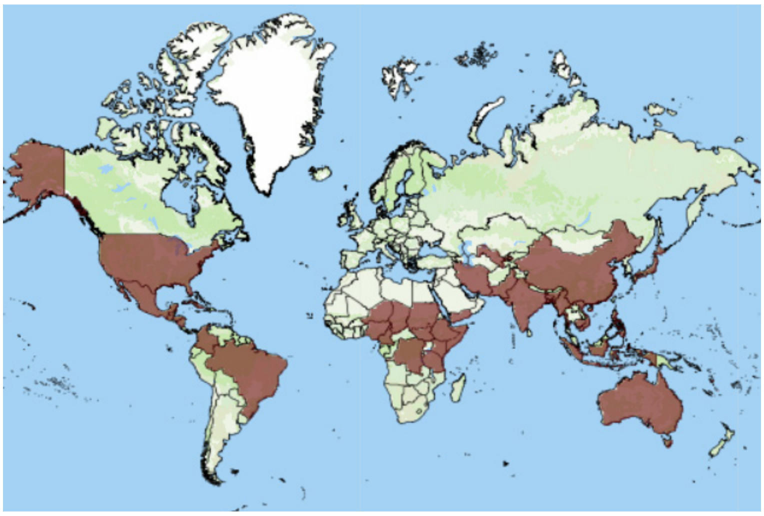
Figure 72. Armed conflicts layer



Q5- Migration: countries where extreme weather displaced more than 50 000 people in a year (Figure 73).

Data was reanalysed from the Internal Displacement Monitoring Centre (2022).

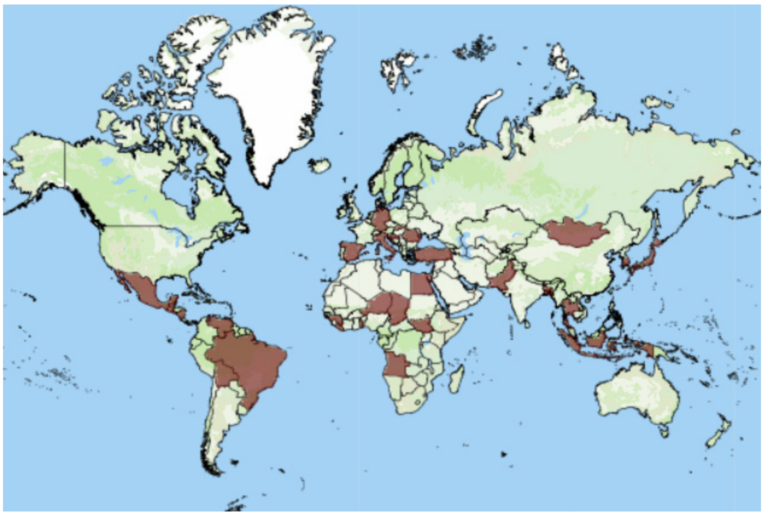
Figure 73. Migration layer



Q6- Epidemics: countries where humanitarian crises, including health crises, are impeding the population to address the potential impacts of climate change (Figure 74).

Data was reanalysed from the Inter-Agency Standing Committee and the European Commission (2022).

Figure 74. Epidemics layer



Q7- Economic: countries where more than 30 percent of the population is employed in the agricultural sector (Figure 75).

Data was reanalysed from the World Bank (2022b).

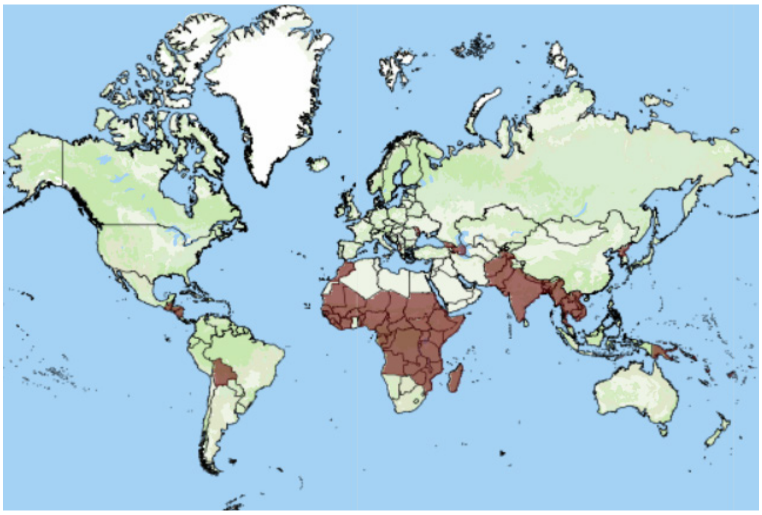


Figure 75. Economic layer

Q8- Inequalities: countries where there are sensitive groups (Indigenous Peoples or other marginalized groups) likely to be affected by climate change impacts.

no layer - required user input during the climate risk screening process in the CRTB (see Chapter 2)

Q9- Inequalities: countries where gender inequalities are likely to be exacerbated by climate change (Figure 76).

Data was reanalysed from the United Nations Development Programme (2022b).

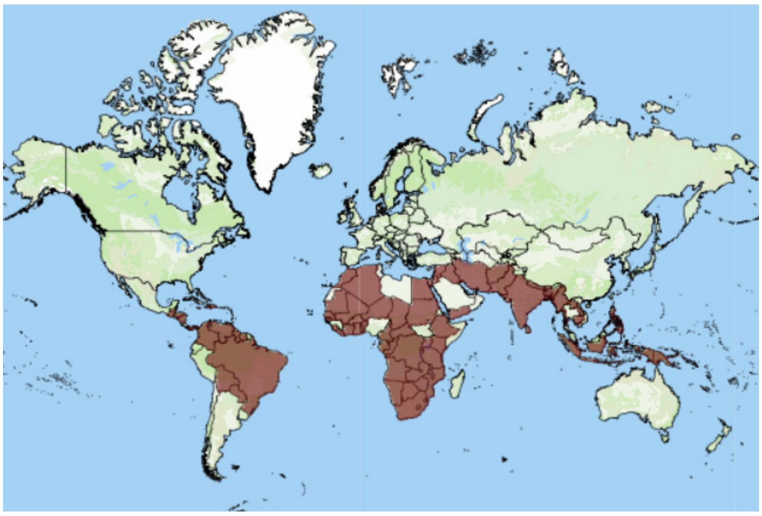


Figure 76. Inequalities layer

Adaptive Capacity layers and thresholds:

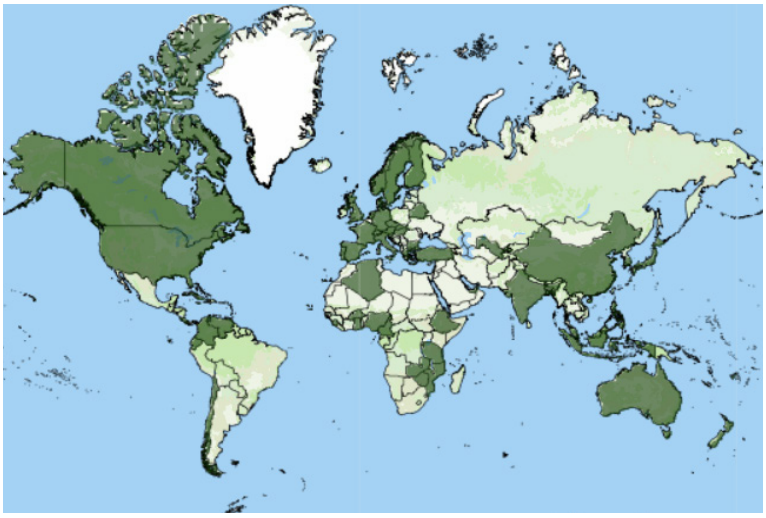
Areas where the values of the selected layer exceed the specified threshold.

Note: values with no data correspond to ocean areas.

Q1- Disaster risk reduction: countries where there is an adaptation plan and/ or robust disaster risk reduction measures (Figure 77).

Data was reanalysed from the Inter-Agency Standing Committee and the European Commission (2020).

Figure 77. Disaster risk reduction layer



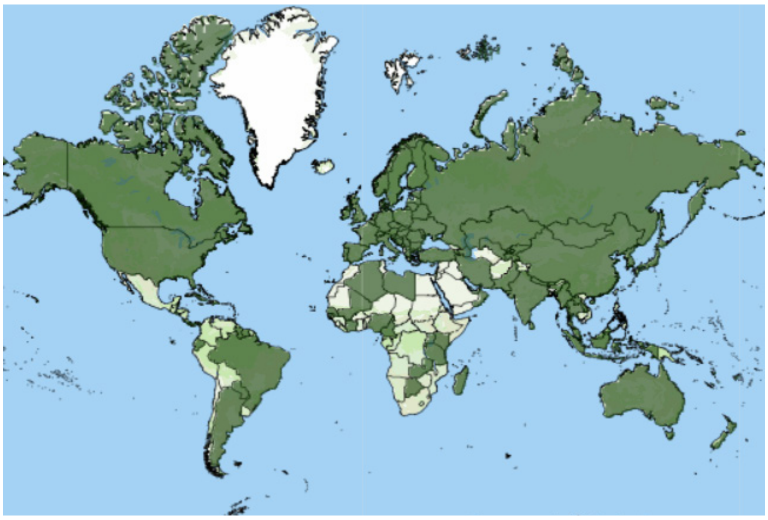
Q2- Climate information: countries where there are climate information services relevant for the agriculture sector.

no layer - required user input during the climate risk screening process in the CRTB (see Chapter 2)

Q3- Weather information: countries where there are weather forecasts available (Figure 78).

Data was reanalysed from the World Meteorological Organization (2022).

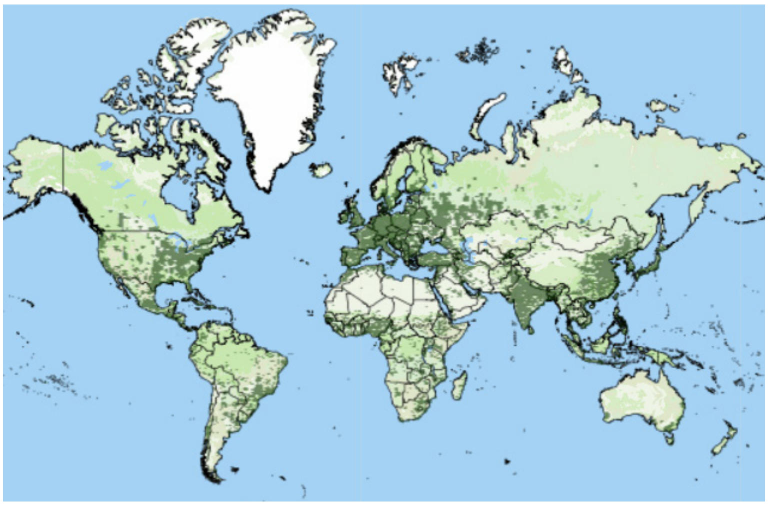
Figure 78. Weather information layer



Q4- Infrastructure: distance to roads and markets (less than 1h) (Figure 79).

Data was reanalysed from Cattaneo et al. (2020).

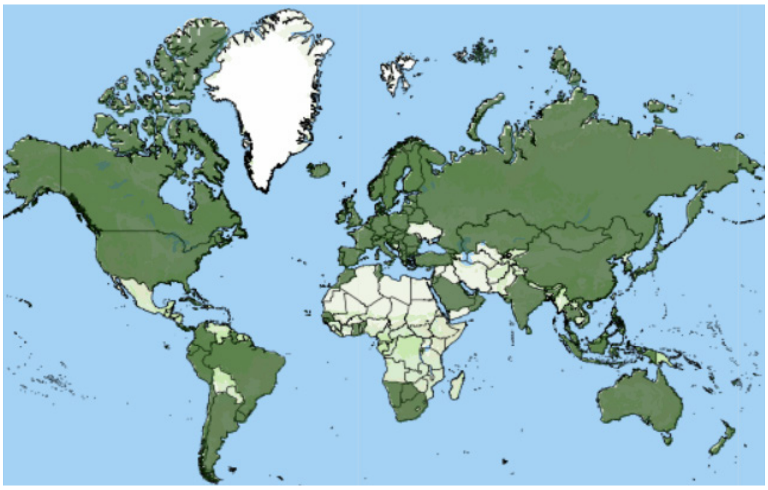
Figure 79. Infrastructure layer



Q5- Government effectiveness: countries where the government effectively supports local communities to adapt and/ or mitigate climate change (Figure 80).

Data was reanalysed from the Inter-Agency Standing Committee and the European Commission (2022).

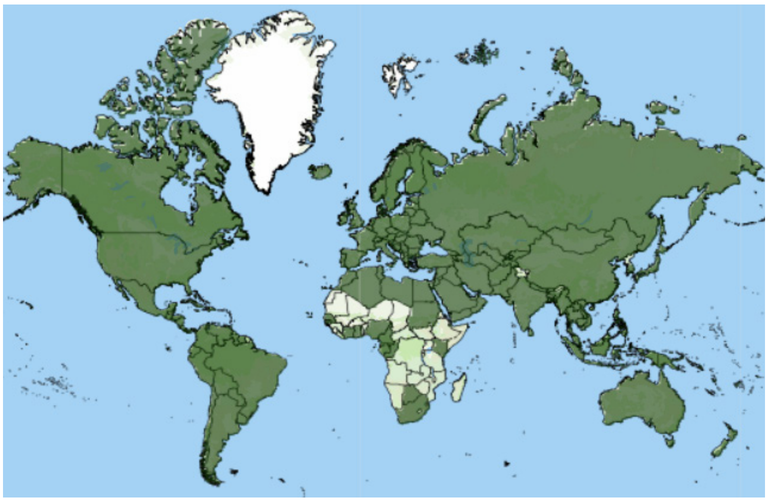
Figure 80. Government effectiveness layer



Q6- Access to electricity: countries where most of the population has access to electricity (Figure 81).

Data was reanalysed from the World Bank (2022c).

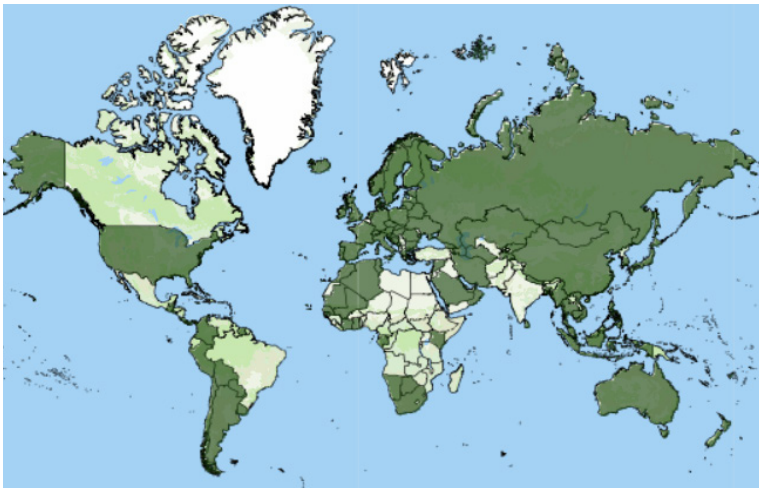
Figure 81. Access to electricity layer



Q7- Access to information: countries where communities have access to information through ICTs, phones, or other means (Figure 82).

Data was reanalysed from the Inter-Agency Standing Committee and the European Commission (2022).

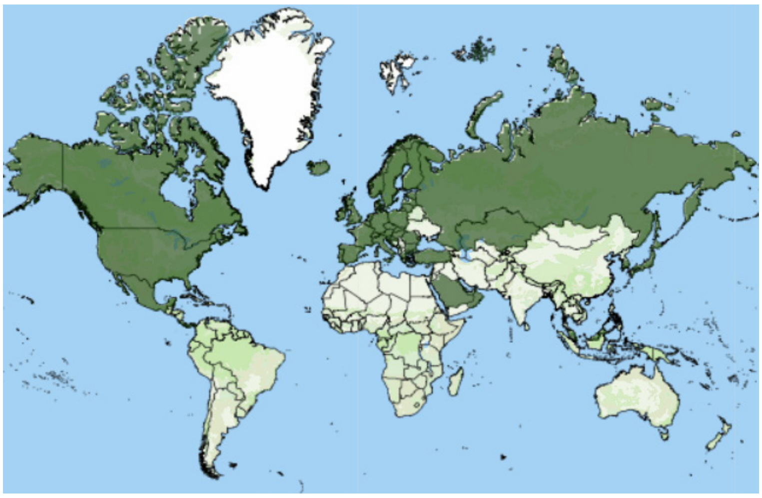
Figure 82. Access to information layer



Q8- Economic means: countries where the community has the economic means (>20 000 USD/year) to adapt to climate change and associated hazards (Figure 83).

Data was reanalysed from the World Bank (2022d).

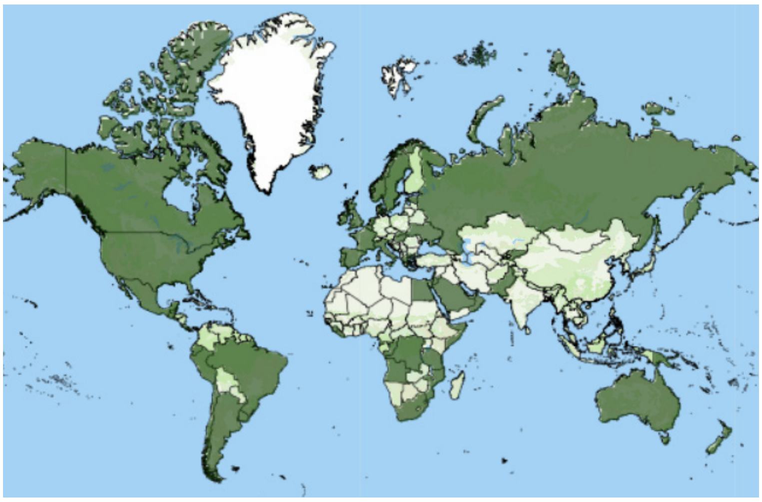
Figure 83. Economic means layer



Q9- Agricultural economic expenditure: share of total government expenditure in agriculture, forestry, and fishing (Figure 84).

Data was reanalysed from FAO (2022d).

Figure 84. Agricultural economic expenditure layer



2. Layers data aggregation for each climate risk component:

Each layer is associated with a screening question in the checklist (See Chapter 3 – Figure 16).
For each layer of the different climate risk components exceeding the specified threshold, based on the extent to which the layer covers the drawn area, the definition of "Yes" and "No" answers in the screening checklist is calculated as follows:

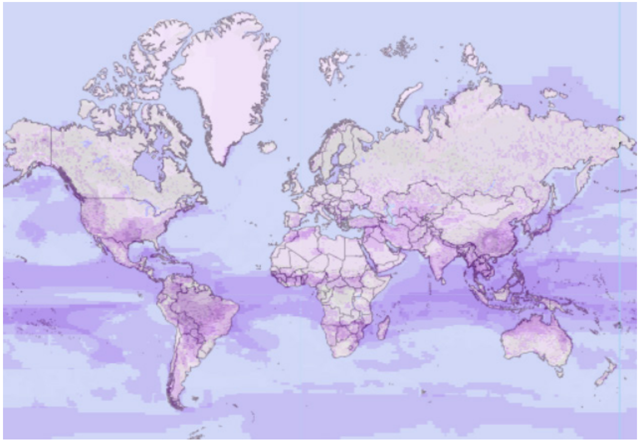
Yes = The geospatial layer exceeding the threshold covers at least 50 percent of the selected area
No = The geospatial layer exceeding the threshold covers less than 50 percent of the selected area
cu
Note: for the specific layers with a higher resolution (e.g. 1km), "Yes" and "No" answers in the screening checklist are calculated as follows:
Yes = The geospatial layer exceeding the thresholds covers at least 20 percent of the selected area
No = The geospatial layer exceeding the thresholds covers less than 20 percent of the selected area

Figures below show the cumulative layers as a result of the overlay of all the layers for each risk component.

To obtain a result between 0 and 1, the final value for each cumulative risk component is calculated as follows: (Yes answers/Total answers)

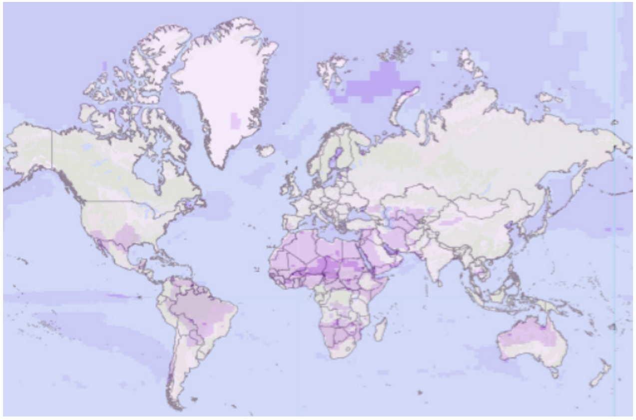
Cumulative hazard risk (Baseline) (Figure 85).

Figure 85. Cumulative hazard risk (Baseline) layer



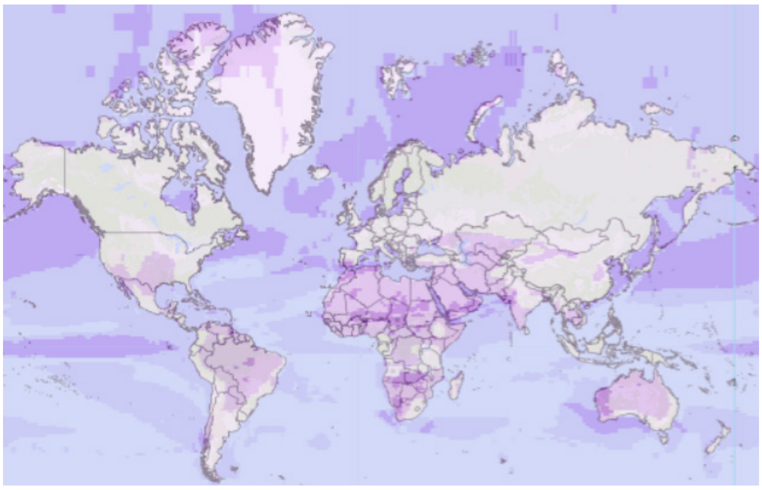
Cumulative hazard risk (SSP1-2.6 - Near-term: 2021-2040) (Figure 86).

Figure 86. Cumulative hazard risk (SSP1-2.6 - Near-term: 2021-2040) layer



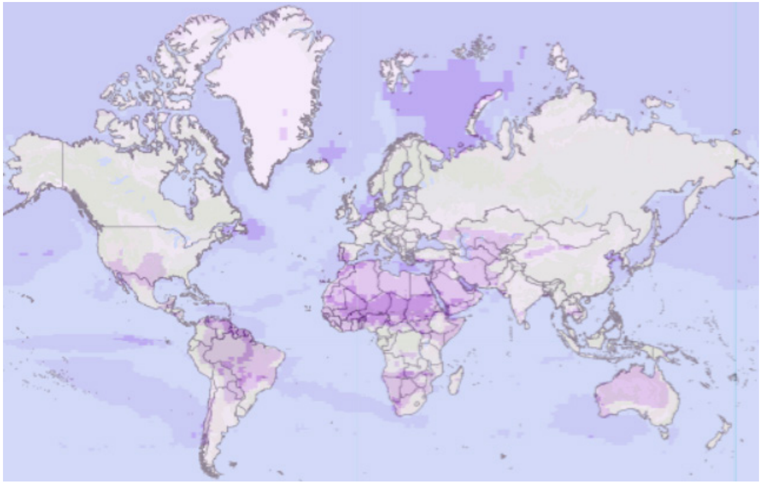
Cumulative hazard risk (SSP1-2.6 - Mid-term: 2041-2060) (Figure 87).

Figure 87. Cumulative hazard risk (SSP1-2.6 - Mid-term: 2041-2060) layer



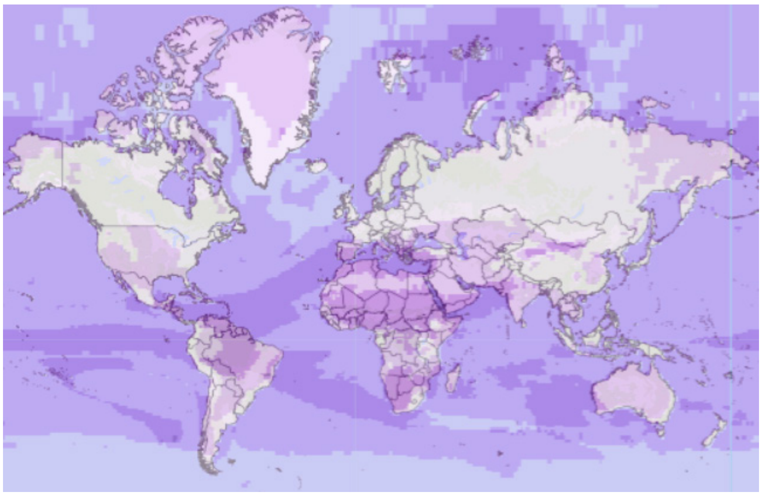
Cumulative hazard risk (SSP5-8.5 - Near-term: 2021-2040) (Figure 88).

Figure 88. Cumulative hazard risk (SSP5-8.5 - Near-term: 2021-2040) layer



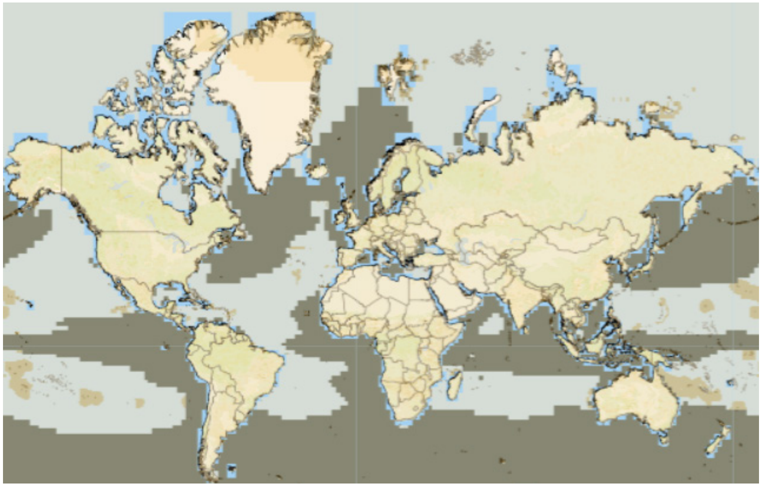
Cumulative hazard risk (SSP5-8.5 - Mid-term: 2041-2060) (Figure 89

Figure 89. Cumulative hazard risk (SSP5-8.5 - Mid-term: 2041-2060) layer



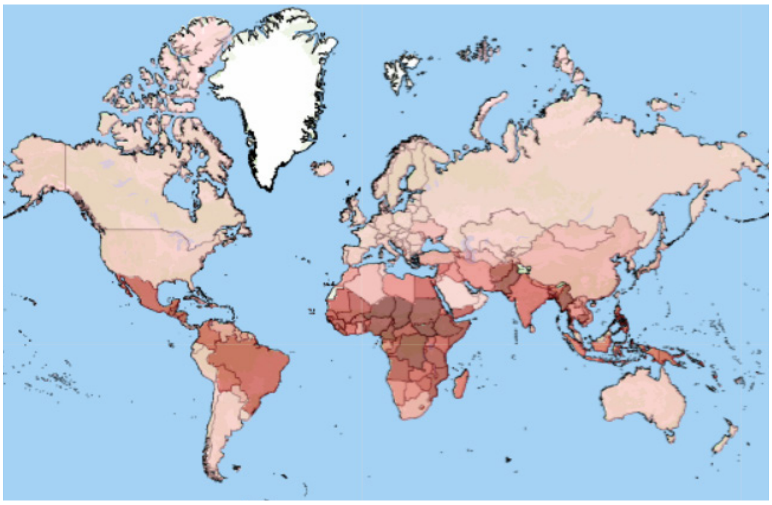
Cumulative exposure risk (Figure 90).

Figure 90. Cumulative exposure risk layer



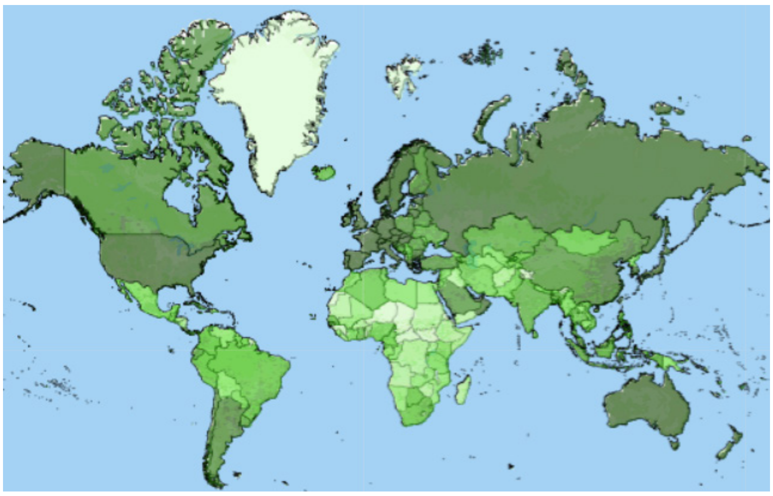
Cumulative vulnerability risk (Figure 87).

Figure 91. Cumulative vulnerability risk layer



Cumulative adaptive capacity (Figure 88).

Figure 92. Cumulative adaptive capacity layer



3. Defining equations to compute the climate risk::

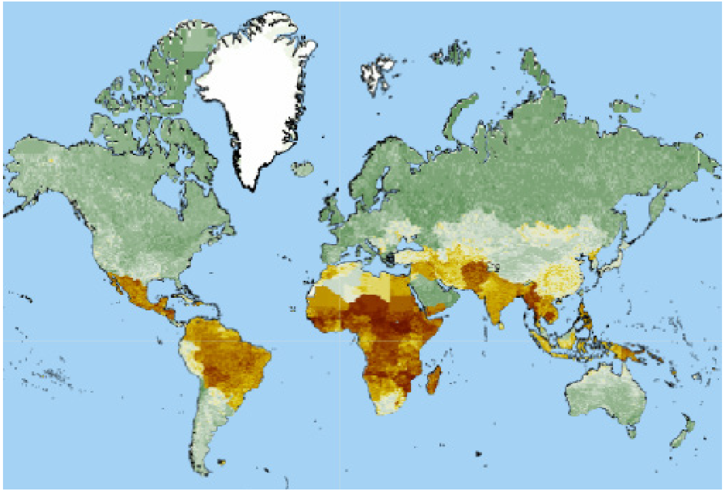
The computation of the climate risk is obtained through the aggregation of all the cumulative risk components

3.1. Aggregation of different risk components for the computation of climate risk in the baseline period:

Climate risk (Baseline) (Figure 93):

(Cumulative hazard risk baseline + Cumulative exposure risk + Cumulative vulnerability risk) – Cumulative adaptive capacity

Figure 93. Climate risk (Baseline) layer

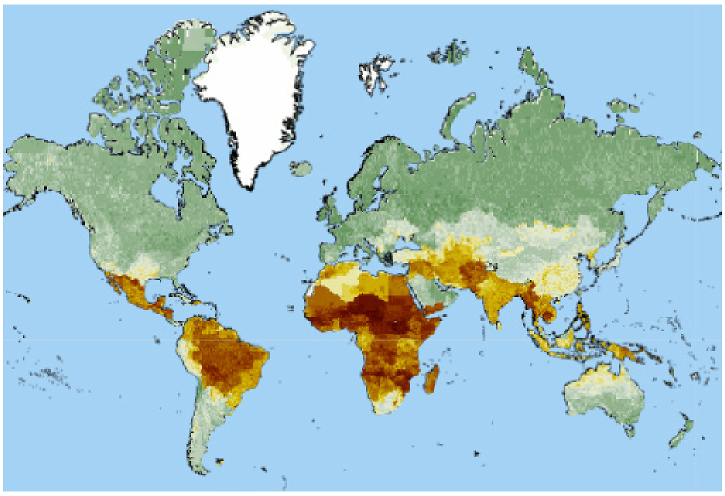


3.2. Aggregation of different risk components for the computation of future climate risk (near-term or mid-term) under SSP1-2.6 (note: future cumulative hazards are multiplied by a coefficient of 0.25):

Climate risk (SSP1-2.6 - Near-term: 2021-2040) (Figure 94):

(Cumulative hazard risk baseline + Cumulative hazard risk SSP1-2.6 near-term × 0.25 + Cumulative exposure risk + Cumulative vulnerability risk) – Cumulative adaptive capacity

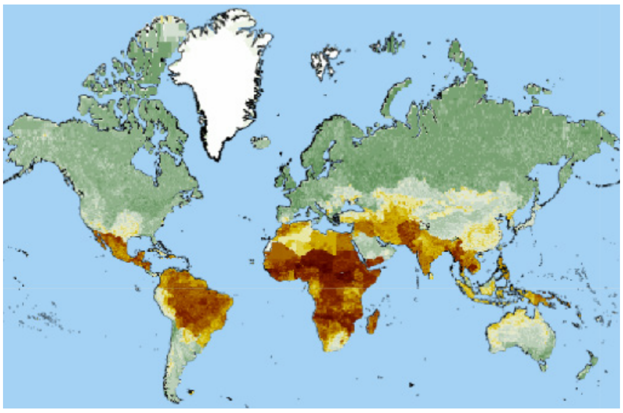
Figure 94. Climate risk (SSP1-2.6 - Near-term: 2021-2040) layer



Climate risk (SSP1-2.6 - Mid-term: 2041-2060) (Figure 95):

(Cumulative hazard risk baseline + Cumulative hazard risk SSP1-2.6 mid-term × 0.25 + Cumulative exposure risk + Cumulative vulnerability risk) – Cumulative adaptive capacity

Figure 95. Climate risk (SSP1-2.6 - Mid-term: 2041-2060) layer

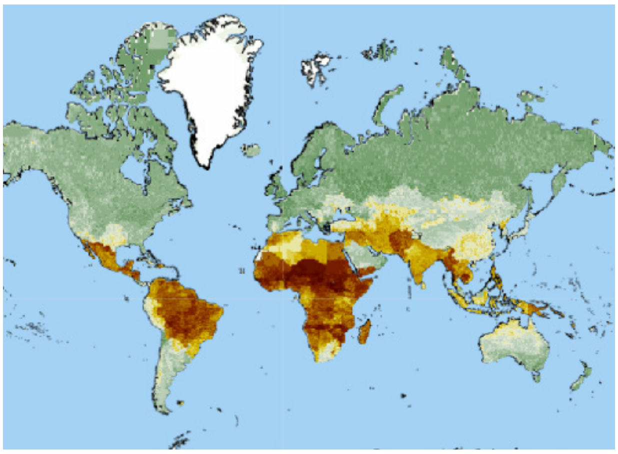


3.3. Aggregation of different risk components for the computation of future climate risk (near-term or mid-term) under SSP5-8.5 (note: future cumulative hazards are multiplied by a coefficient of 0.25):

Climate risk (SSP5-8.5 - Near-term: 2021-2040) (Figure 96):

(Cumulative hazard risk baseline + Cumulative hazard risk SSP5-8.5 near-term × 0.25 + Cumulative exposure risk + Cumulative vulnerability risk) – Cumulative adaptive capacity

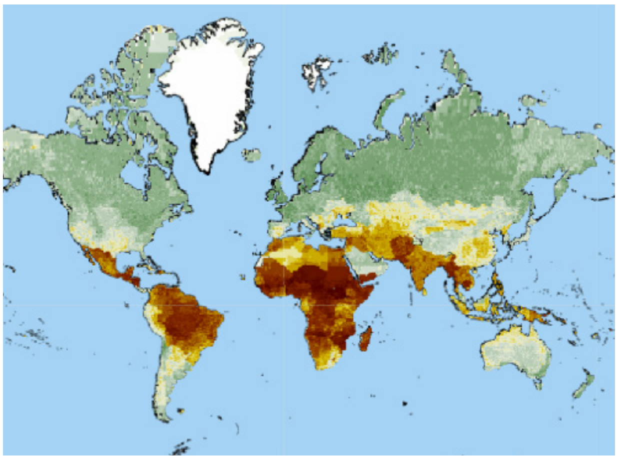
Figure 96. Climate risk (SSP5-8.5 - Near-term: 2021-2040) layer



Climate risk (SSP5-8.5 - Mid-term: 2041-2060) (Figure 97):

(Cumulative Hazards Baseline + Cumulative Hazards SSP5-8.5 Mid-term × 0.25 + Cumulative Exposure + Cumulative Vulnerability) – Cumulative Adaptive Capacity

Figure 97. Climate risk (SSP5-8.5 - Mid-term: 2041-2060) layer



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