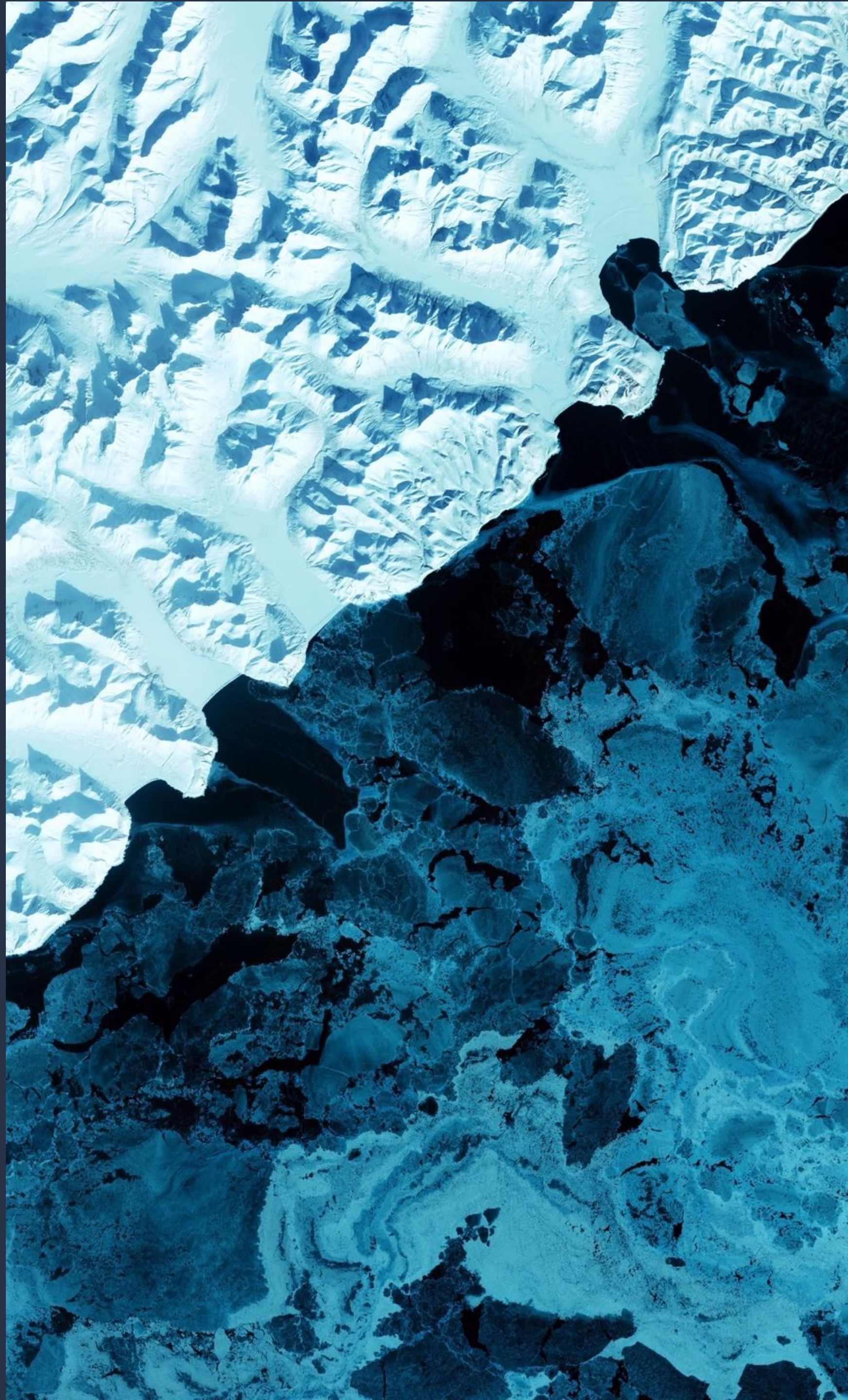
carbone4 | consulting

June, 2025

BRD - climate screening tool

Methodological report



Gabriel Follin-Arbelet gabriel.follin-arbelet@carbone4.com
Madeleine d'Arrentières madeleine.darrentieres@carbone4.com
Violaine Lepousez violaine.lepousez@carbone4.com

Context and Introduction

- **Development Bank of Rwanda (BRD)** is a development bank in Rwanda. The bank began its operations in 1967, as a long-term financial services provider, with the financing geared towards national development projects. Its areas of intervention include Agriculture, Energy, Building and Infrastructure, or Manufacturing and Equipment.
- In response to the worsening impacts of climate change in Rwanda, **BRD seeks to systematically integrate climate risk assessment into the analysis of the projects it supports.**
- **A feasibility analysis has been carried out in 2024** by Carbone 4 and its IT partner Majba, *via* several workshops and working meetings with BRD teams (including the IT & Innovation and Data Security departments) and technical partners (RWB, MINEMA, Rwanda Meteorology Agency, MINAGRI, REMA, REG). This collective work led to the conclusion that high-quality data exists at national level and would enable **the development of a detailed of a climate risk tool at the GPS coordinate level of a project.**
- **BRD's Climate Risk Tool was developed by Carbone 4 and Majba in 2025, in collaboration with BRD team and technical partners, and the financing support of AFD**. The aim of this document is to detail the methodology used to assess climate risks for BRD-financed projects. This document contains the methodological principles, the scoring formulas and the data used to calculate risk scores.

Disclaimers

- **The tool assessment does not purport to be exhaustive or to contain all the information required to make certain investment decisions.**
- **Carbone 4 and its respective officers, employees and agents expressly disclaim any and all liability that may be based on the tool's assessment and any errors or omissions therein**. In particular, no warranty is given as to the achievement or reasonableness of future projections, management objectives, estimates, prospects or returns, if any.
- Tool's evaluation does not constitute any form of recommendation on the part of Carbone 4 with respect to the sale or purchase of securities or any of the businesses or assets described herein. Neither Carbone 4's valuation nor any other written or oral information made available to BRD, its shareholders, or other parties should form the exclusive basis for investment decisions or any other decision or action.
- The delivery of this document is, moreover, governed by the terms of engagement agreed between Carbone 4 and BRD. The data contained in this report is based on information received up to April 25th,2025.

Table of content

Table of content

The methodology of the tool is based on the definition of risk as proposed in the latest IPCC reports (since AR5)

Aggregation for Exposure and Hazard is at GPS coordinate level, whereas vulnerability depends on adaptation capacity at project level and district level (see next slide)

Risk : […] **potential for adverse consequences** for human or ecological systems. […] Risks result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system.[1]

Climate Risk

Exposure
Can the hazard theoretically occur in the project area?

Climate Hazard
How will climate hazards evolve in terms of intensity, frequency or occurrence?

Vulnerability
To what extent can a project be affected (physical and/or economic impact) if the hazard occurs?

Exposure :

[…] **presence** of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets **in places and settings that could be adversely affected.**[1]

Hazard :

[…] **affected by current and future changes** in climate, including altered climate variability and shifts in frequency and intensity of extreme events.[1]

Vulnerability :

[…] **predisposition to be adversely affected**. It includes sensitivity or susceptibility to harm and lack of capacity to cope and adapt.[1]

1 IPCC, AR6, Impacts Adaptation and Vulnerability, Chapter 1 – Point of departure and key concepts

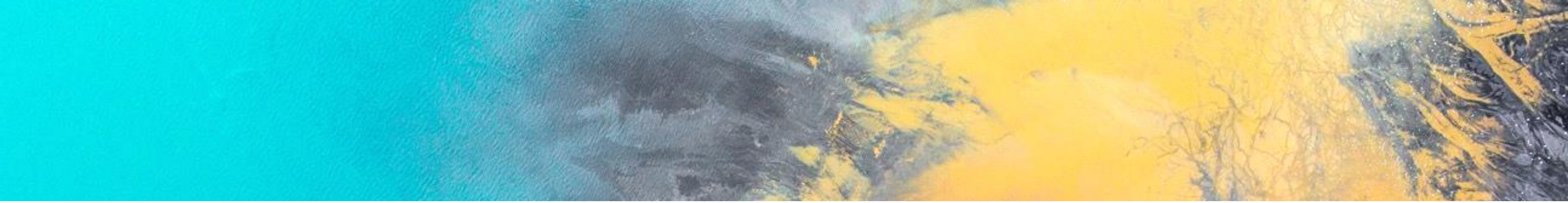


Table of content

Construction of the Risk Score

- This section details the process of constructing the climate risk score.
- The **final risk score is calculated by combining exposure to climate hazards at a given location and the project's vulnerability**, then it is converted into a risk level (very high, high, moderate, low, or very low).
- To assess the evolution of climate hazards, an indicator is chosen, and potential aggravating factors are studied.
- The section explains how historical and future data are normalized to obtain scores between 0 and 1, and how these scores are combined with aggravating factors to generate the raw hazard score, which is then normalized. Concrete calculation examples are provided.

The methodology is based on the definition of risk as proposed in the latest IPCC reports (since AR5)

Climate Risk

Exposure
Can the hazard theoretically occur in the project area?

Climate Hazard
How will climate hazards evolve in terms of intensity, frequency or occurrence?

Vulnerability
To what extent can a project be affected (physical and/or economic impact) if the hazard occurs?

➔ Exposure :

[…] **presence** of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets **in places and settings that could be adversely affected.**[1]

➔ Hazard :

[…] **affected by current and future changes** in climate, including altered climate variability and shifts in frequency and intensity of extreme events.[1]

➔ Vulnerability :

[…] **predisposition to be adversely affected.** It includes sensitivity or susceptibility to harm and lack of capacity to cope and adapt.[1]

1 IPCC, AR6, Impacts Adaptation and Vulnerability, Chapter 1 – Point of departure and key concepts

Local context is studied to assess the exposure of the project to the climate hazard

Exposition

E.g. : for the hazard River flood

Exposure factor

Local context making possible for the hazard to occur

E.g. : River flood prone area (proximity with a river)

Exposure is studied for **some specific hazards:**

Wildfires: Burnable area (vegetation of a certain type)

River flooding: Areas prone to fluvial flooding (less than 1km away from a river)

Other hazards occur everywhere.

The methodology is based on the definition of risk as proposed in the latest IPCC reports (since AR5)

Climate Risk

Exposure
Can the hazard theoretically occur in the project area?

Climate Hazard
How will climate hazards evolve in terms of intensity, frequency or occurrence?

Vulnerability
To what extent can a project be affected (physical and/or economic impact) if the hazard occurs?

Exposure :

[…] **presence** of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets **in places and settings that could be adversely affected.**[1]

Hazard :

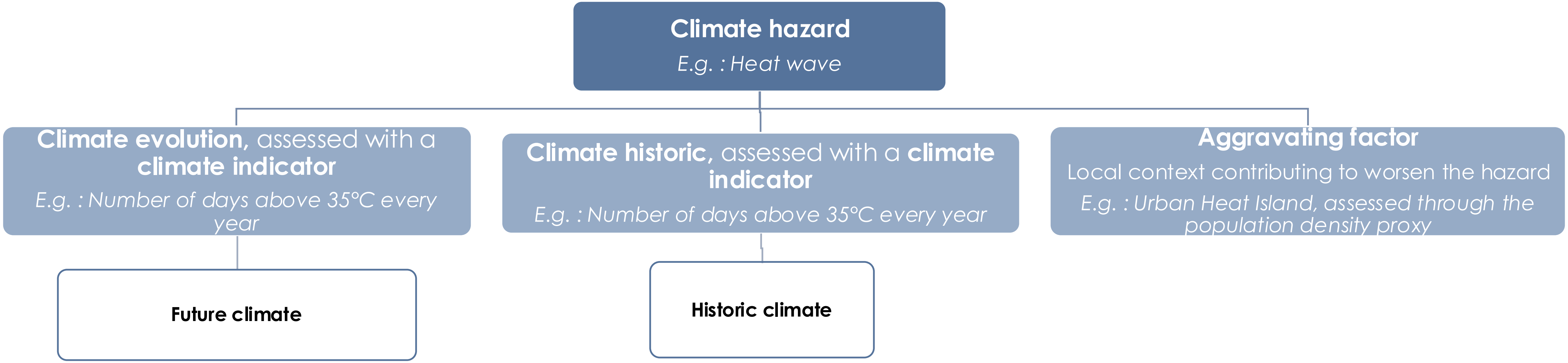
[…] **affected by current and future changes** in climate, including altered climate variability and shifts in frequency and intensity of extreme events.[1]

Vulnerability :

[…] **predisposition to be adversely affected.** It includes sensitivity or susceptibility to harm and lack of capacity to cope and adapt.[1]

1 IPCC, AR6, Impacts Adaptation and Vulnerability, Chapter 1 – Point of departure and key concepts

To assess the evolution of the climate hazard, an indicator is chosen and potential aggravating factors are studied



Historic climate data, future climate data and aggravating factor will be **combined** to obtain a **climate hazard evolution score**, reflecting the evolution of the hazard at a given location.

In the process of interpreting climate data, a distinction must be made between data, indicator, hazard and score

A **climate hazard** is a climate event likely to cause damage**.** To characterize its evolution, we need to rely on climate data, indicators and hazard evolution scores.

Climate models provide **daily data** corresponding to different models, time periods and scenarios

Example:

Daily temperature

To make sense of this climate data, **we need to define indicators**

Example:

Number of days above 30°C

To interpret the results and compare climate hazards, we need to define a **hazard evolution score**

Example:

40 days above 30°C equals a hazard score of 1

In the process of interpreting climate data, a distinction must be made between data, indicator, hazard and score

A **climate hazard** is a climate event likely to cause damage. To characterize its evolution, we need to rely on climate data, indicators and hazard evolution scores.

Climate models provide **daily data** corresponding to different models, time periods and scenarios

Example:

Daily temperature

To make sense of this climate data, **we need to define indicators**

Example:

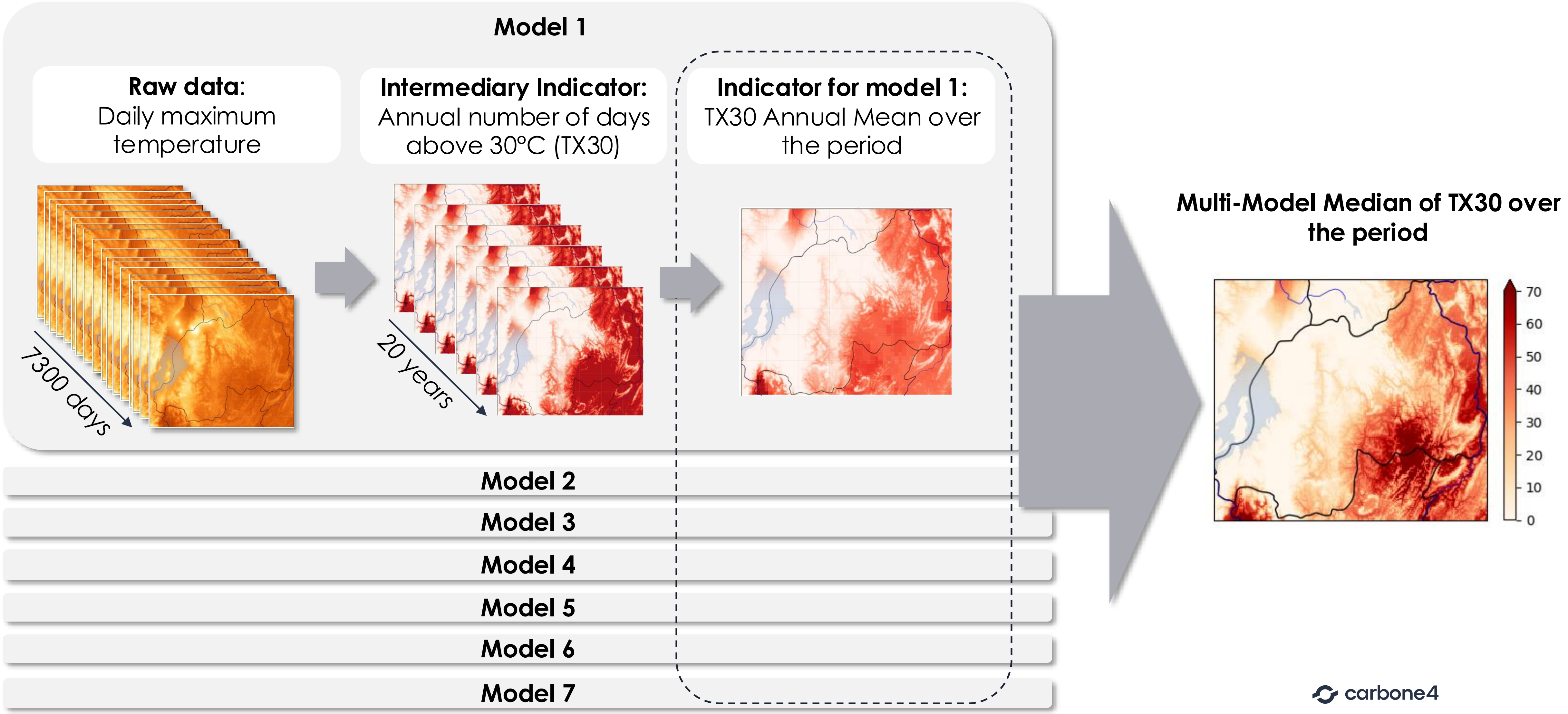
Number of days above 30°C

To interpret the results and compare climate hazards, we need to define a **hazard evolution score**

Example:

40 days above 30°C equals a hazard score of 1

Indicators were calculated from raw data provided by Meteo Rwanda for 7 models, 2 scenarios, 40 future years (2021-2060) and 20 past years (1986-2005)



carbone4

Note: all maps are illustrative

In the process of interpreting climate data, a distinction must be made between data, indicator, hazard and score

A **climate hazard** is a climate event likely to cause damage. To characterize its evolution, we need to rely on climate data, indicators and hazard evolution scores.

Climate models provide **daily data** corresponding to different models, time periods and scenarios

Example:

Daily temperature

To make sense of this climate data, **we need to define indicators**

Example:

Number of days above 30°C

To interpret the results and compare climate hazards, we need to define a **hazard evolution score**

Example:

40 days above 30°C equals a hazard score of 1

As a second step, each indicator is normalized to obtain scores between 0 and 1

Indicator data

Physical unit (°C, mm, days etc.)

Linear normalization :

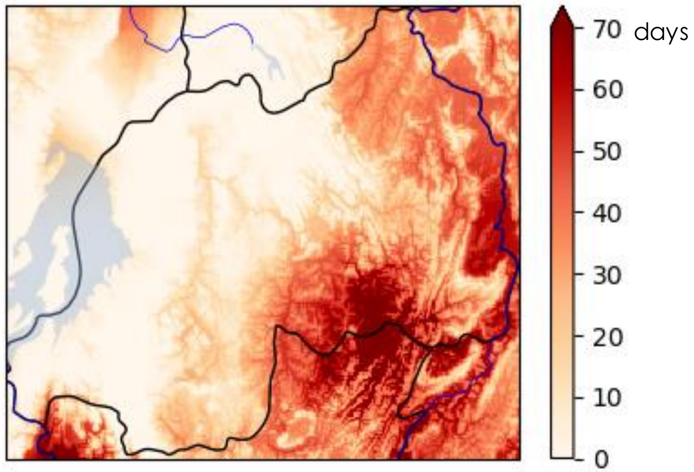
All values are divided by **a defined threshold (ex : 40 days)**

Values above the threshold are set to 1

Indicator score

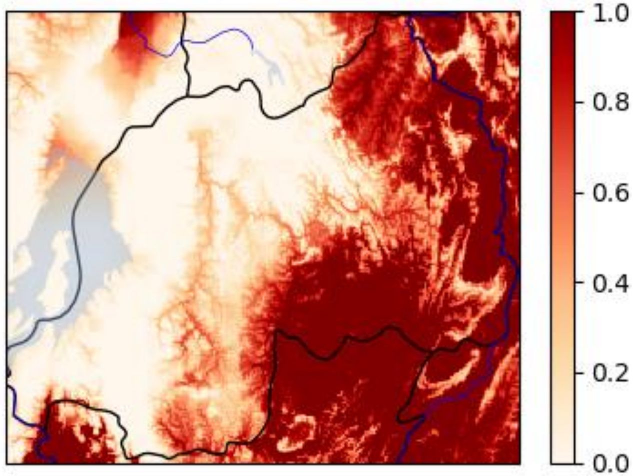
Normalized between 0 and 1

Multi-model median for TX30 (number of days where Tmax > 30°C)

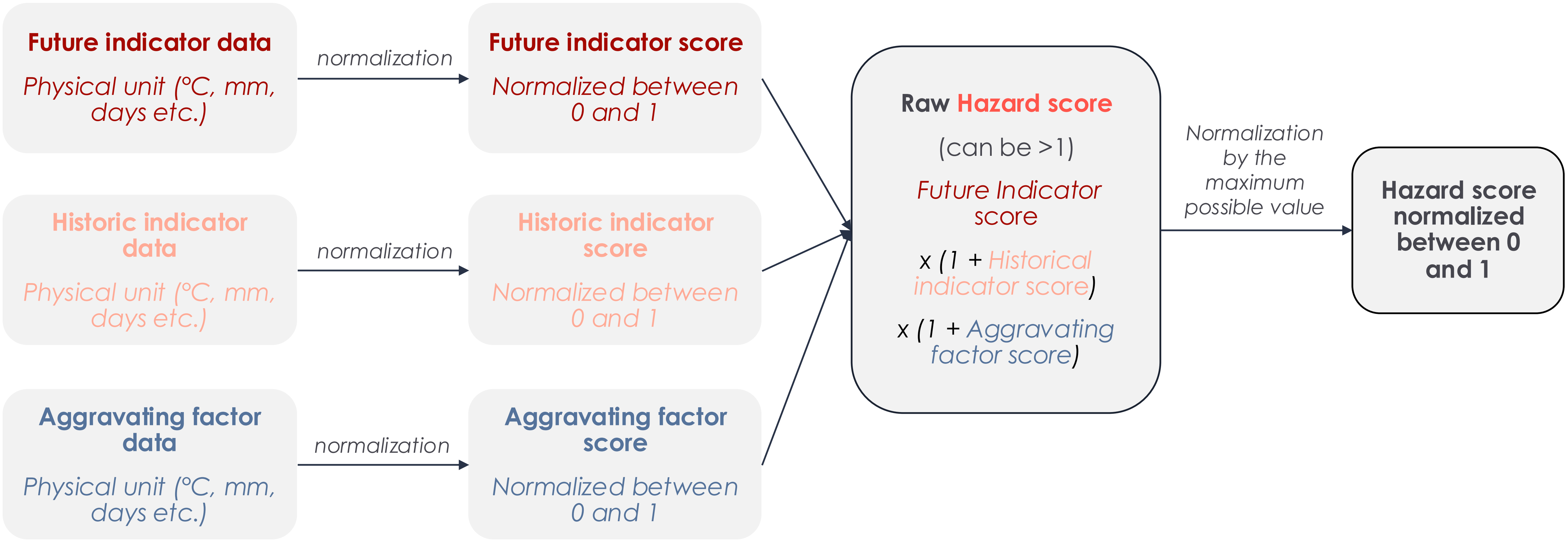


Threshold: 40 days

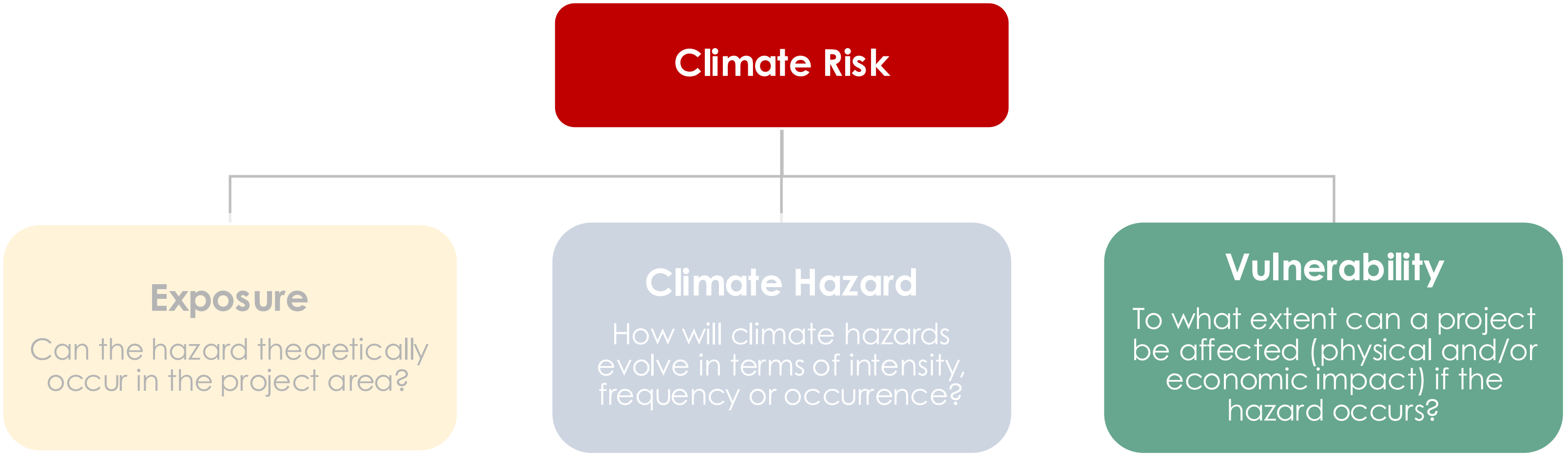
Indicator score for TX30 (number of days where Tmax > 30°C)



The data set of each parameters are combined to create the hazard score



The methodology is based on the definition of risk as proposed in the latest IPCC reports (since AR5)



Exposure :

[…] **presence** of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets **in places and settings that could be adversely affected.**[1]

Hazard :

[…] **affected by current and future changes** in climate, including altered climate variability and shifts in frequency and intensity of extreme events.[1]

Vulnerability :

[…] **predisposition to be adversely affected.** It includes sensitivity or susceptibility to harm and lack of capacity to cope and adapt.[1]

1 IPCC, AR6, Impacts Adaptation and Vulnerability, Chapter 1 – Point of departure and key concepts

Vulnerability is the combination of the sensitivity of the project towards the studied hazard and its adaptability

Vulnerability

- **Sensitivity**
  How is the project affected by an occurrence of the hazard
  - **Operational sensitivity**
    Potential impacts of the hazard on the project's operation (working conditions, equipment)
  - **Structural sensitivity**
    Potential impacts of the hazard on the projects structure (buildings)
- **Adaptability**
  What is already in place to face an occurrence of the hazard
  - **Project adaptability**
    Project's readiness to face climate hazards (assessed through user inputs)
  - **District adaptability**
    District's readiness to face climate hazards (assessed through ASSESSMENT OF CLIMATE CHANGE VULNERABILITY IN RWANDA - 2018)

Operational and structural sensitivity are assessed through project matrixes detailing impacts of every kind of hazard on every kind of project and providing a score. District adaptability is already scored by the REMA study, and project adaptability based on user inputs.

Vulnerability is the combination of the sensitivity of the project towards the studied hazard and its adaptability

- **Vulnerability**
  - **Sensitivity**
    How is the project affected by an occurrence of the hazard
    - **Operational sensitivity**
      Potential impacts of the hazard on the project's operation (working conditions, equipment)
    - **Structural sensitivity**
      Potential impacts of the hazard on the projects structure (buildings)
  - **Adaptability**
    What is already in place to face an occurrence of the hazard
    - **Project adaptability**
      Project's readiness to face climate hazards (assessed through user inputs)
    - **District adaptability**
      District's readiness to face climate hazards (assessed through ASSESSMENT OF CLIMATE CHANGE VULNERABILITY IN RWANDA - 2018)

Operational and structural sensitivity are assessed through project matrixes detailing impacts of every kind of hazard on every kind of project and providing a score. District adaptability is already scored by the REMA study, and project adaptability based on user inputs.

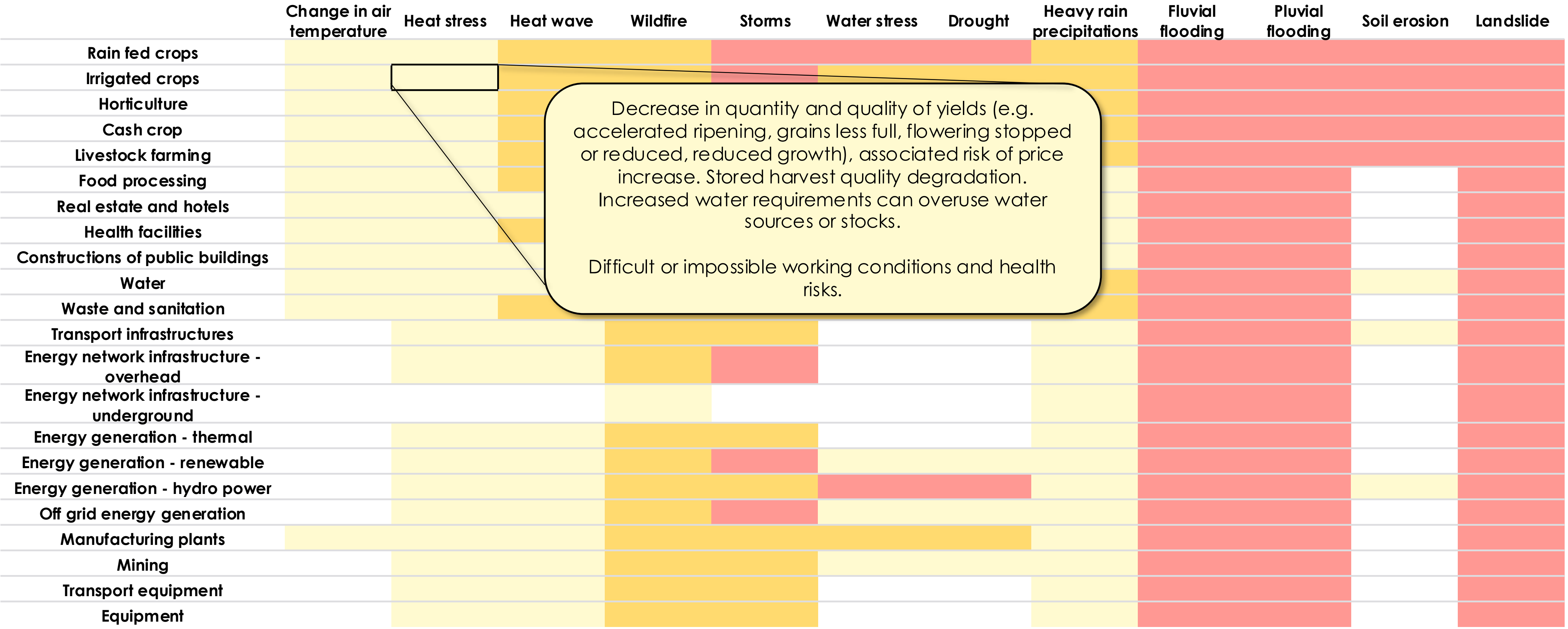
Operational sensitivity scores and associated impacts were defined for every project type and every hazard

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms	Water stress	Drought	Heavy rain precipitations	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Rain fed crops	Low	Low	Medium	Medium	High	High	High	Medium	High	High	High	High
Irrigated crops	Low	Low	Medium	Medium	High	Medium	Medium	Medium	High	High	High	High
Horticulture	Low	Low	Medium	Medium	High	High	High	Medium	High	High	High	High
Cash crop	Low	Low	Medium	Medium	High	High	High	Medium	High	High	High	High
Livestock farming	Low	Low	Medium	Medium	High	High	High	Medium	High	High	High	High
Food processing	Low	Low	Medium	Medium	Medium	High	High	Low	High	High		High
Real estate and hotels	Low	Low	Low	Medium	Medium	Low	Low	Low	High	High		High
Health facilities	Low	Low	Medium	Medium	Medium	Low	Low	Low	High	High		High
Constructions of public buildings	Low	Low	Low	Medium	Medium	Low	Low	Low	High	High		High
Water	Low	Low	Low	Medium	Medium	High	High	Medium	High	High	Low	High
Waste and sanitation	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	High	High		High
Transport infrastructures		Low	Low	Medium	Medium			Low	High	High	Low	High
Energy network infrastructure - overhead		Low	Low	Medium	High			Low	High	High		High
Energy network infrastructure - underground				Low				Low	High	High		High
Energy generation - thermal		Low	Low	Medium	Medium			Low	High	High		High
Energy generation - renewable		Low	Low	Medium	High	Low	Low	Low	High	High		High
Energy generation - hydro power		Low	Low	Medium	Medium	High	High	Low	High	High	Low	High
Off grid energy generation		Low	Low	Medium	High	Low	Low	Low	High	High		High
Manufacturing plants	Low	Low	Low	Medium	Medium	Medium	Medium	Low	High	High		High
Mining		Low	Low	Medium	Medium	Low	Low	Low	High	High		High
Transport equipment		Low	Low	Medium	Medium			Low	High	High		High
Equipment		Low	Low	Medium	Medium			Low	High	High		High

Operational sensitivity		
Not concerned	NA	-
Low	0,3	Activity impacted only slightly or for a short period
Medium	0,6	Activity is significantly impacted or for a substantial period
High	0,9	The activity is stopped

carbone4

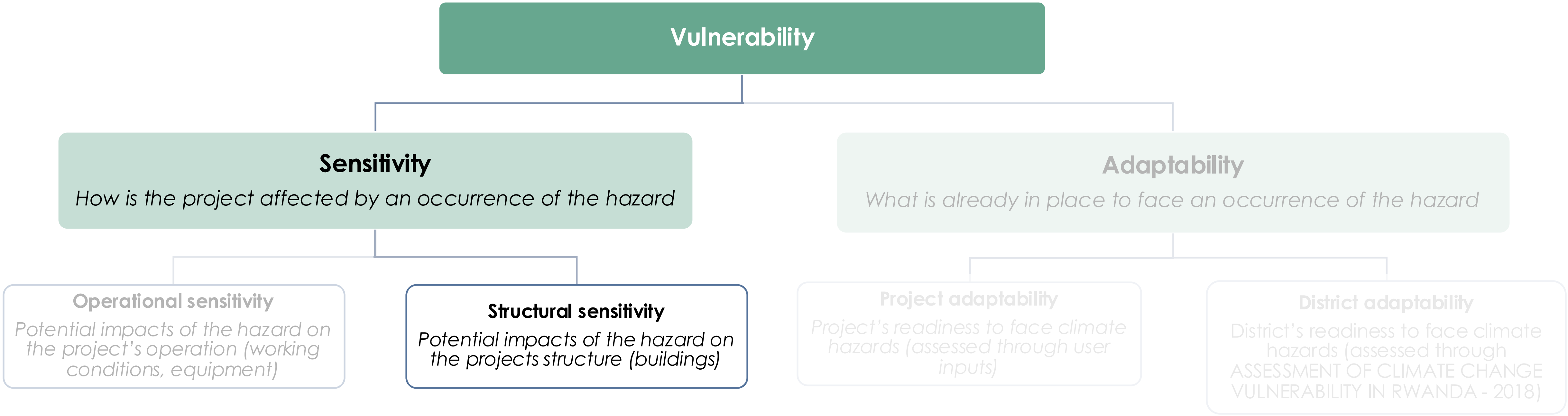
Operational sensitivity scores and associated impacts were defined for every project type and every hazard



Operational sensitivity		
Not concerned	NA	-
Low	0,3	Activity impacted only slightly or for a short period
Medium	0,6	Activity is significantly impacted or for a substantial period
High	0,9	The activity is stopped

carbone4

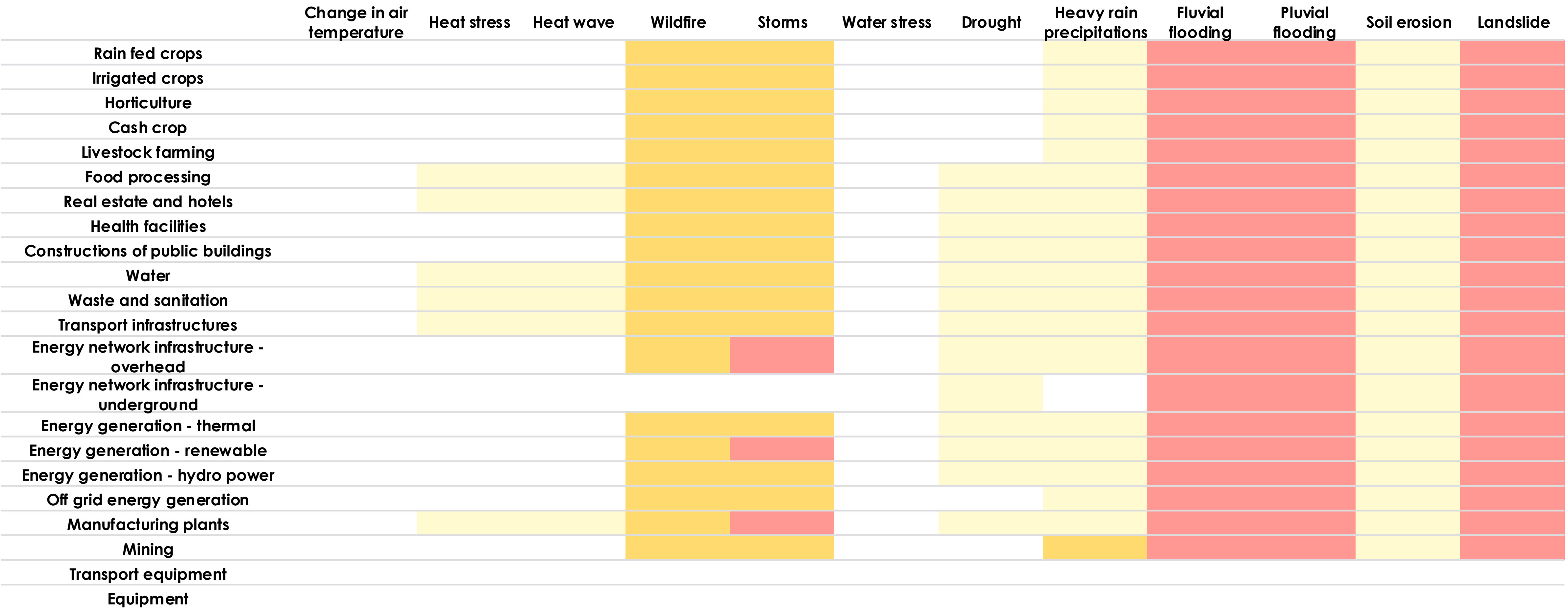
Vulnerability is the combination of the sensitivity of the project towards the studied hazard and its adaptability



Operational and structural sensitivity are assessed through project matrixes detailing impacts of every kind of hazard on every kind of project and providing a score. District adaptability is already scored by the REMA study, and project adaptability based on user inputs.

carbone4

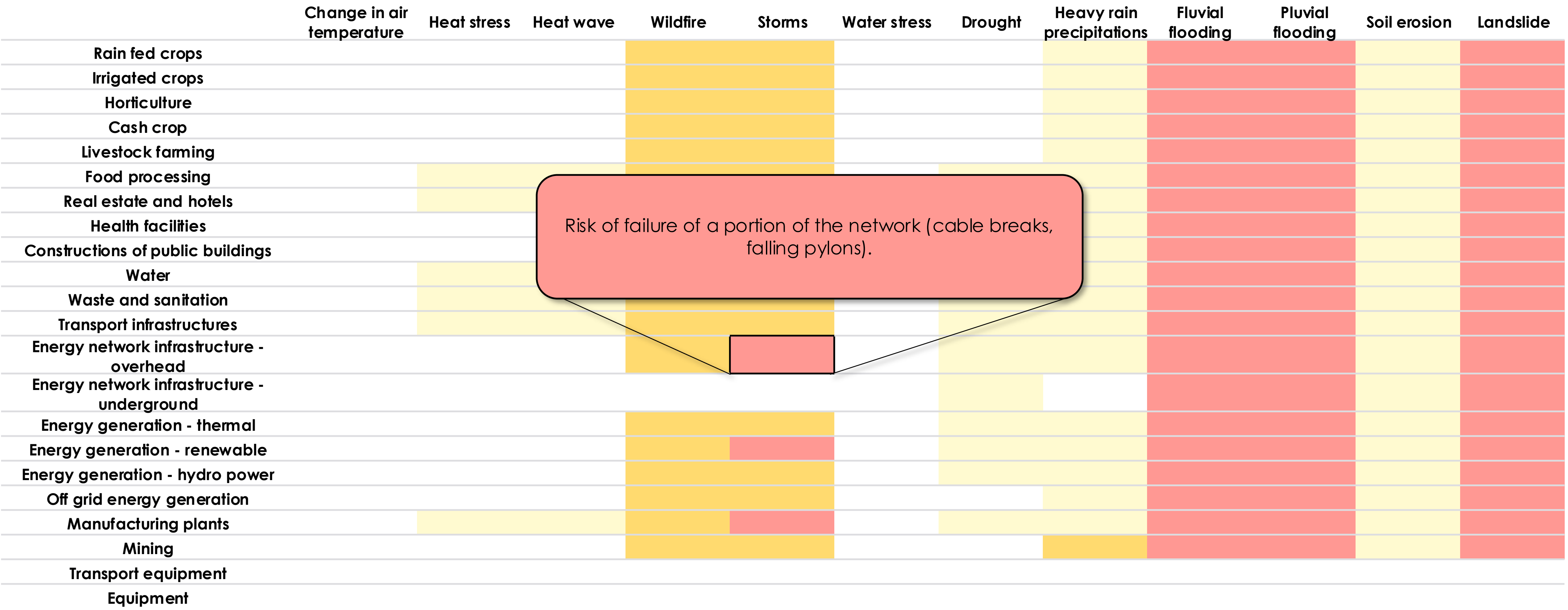
Structural sensitivity scores and associated impacts were defined for every project type and every hazard



Structural sensitivity		
Not concerned	NA	-
Low	0,3	Low level of investments required (e.g. light repair work)
Medium	0,6	Major investments are necessary (requiring a partial shutdown of the business, for example)
High	0,9	100% of fixed assets are lost

carbone4

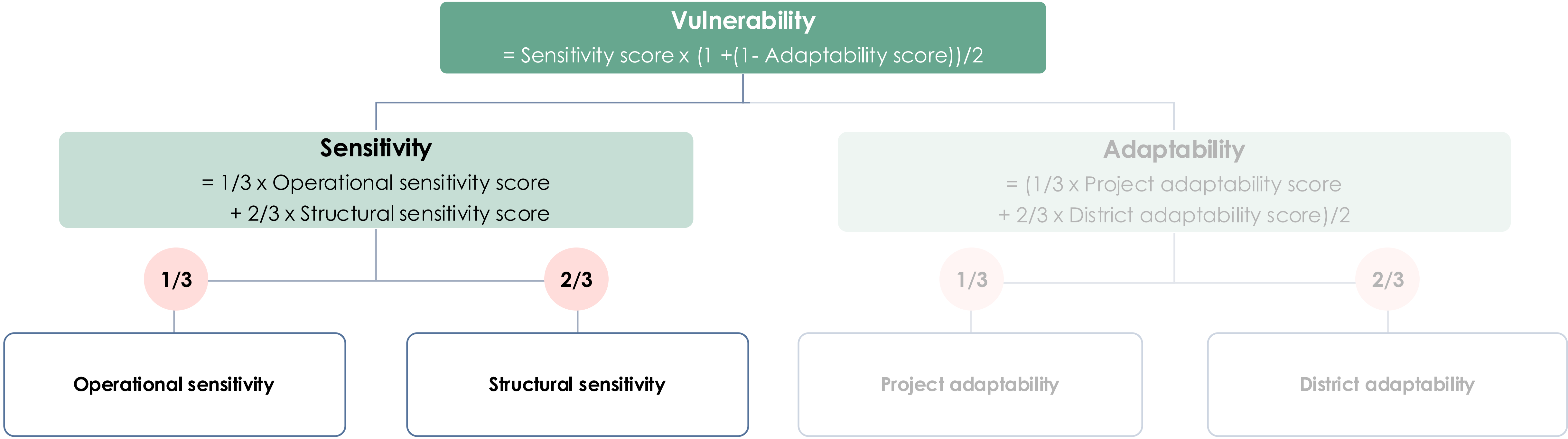
Structural sensitivity scores and associated impacts were defined for every project type and every hazard



Structural sensitivity		
Not concerned	NA	-
Low	0,3	Low level of investments required (e.g. light repair work)
Medium	0,6	Major investments are necessary (requiring a partial shutdown of the business, for example)
High	0,9	100% of fixed assets are lost

carbone4

Vulnerability is the combination of the sensitivity of the project towards the studied hazard and its adaptability



Vulnerability is the combination of the sensitivity of the project towards the studied hazard and its adaptability

Vulnerability

- **Sensitivity**
  How is the project affected by an occurrence of the hazard
  - **Operational sensitivity**
    Potential impacts of the hazard on the project's operation (working conditions, equipment)
  - **Structural sensitivity**
    Potential impacts of the hazard on the projects structure (buildings)
- **Adaptability**
  What is already in place to face an occurrence of the hazard
  - **Project adaptability**
    Project's readiness to face climate hazards (assessed through user inputs)
  - **District adaptability**
    District's readiness to face climate hazards (assessed through ASSESSMENT OF CLIMATE CHANGE VULNERABILITY IN RWANDA - 2018)

Operational and structural sensitivity are assessed through project matrixes detailing impacts of every kind of hazard on every kind of project and providing a score. District adaptability is already scored by the REMA study, and project adaptability based on user inputs.

The project adaptability score is assessed through four questions asked to the tool's user

User's input on the project's adaptation capacity :

The state of knowledge about the impacts of climate in this sector is good	**Yes or No = 1 or 0**
Natural or climatic risk assessment studies are underway	**Yes or No = 1 or 0**
Adaptation measures are already included in the project	**Yes or No = 1 or 0**
The subject has already been clearly identified by the project coordinator, who wishes to make the project resilient	**Yes or No = 1 or 0**

Score = Sum /4

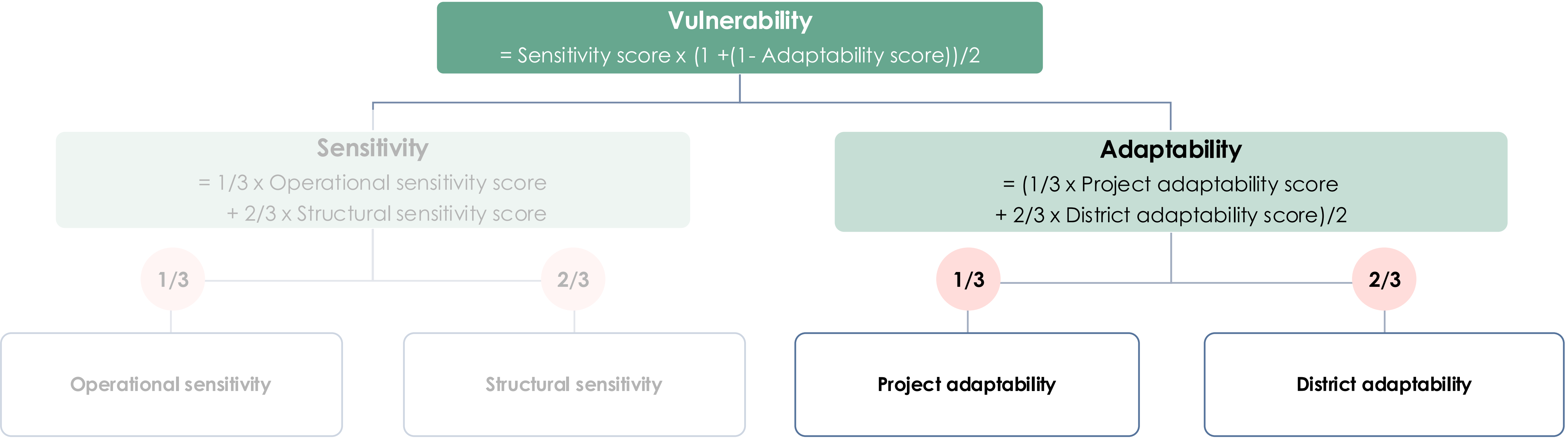
Vulnerability is the combination of the sensitivity of the project towards the studied hazard and its adaptability

Vulnerability

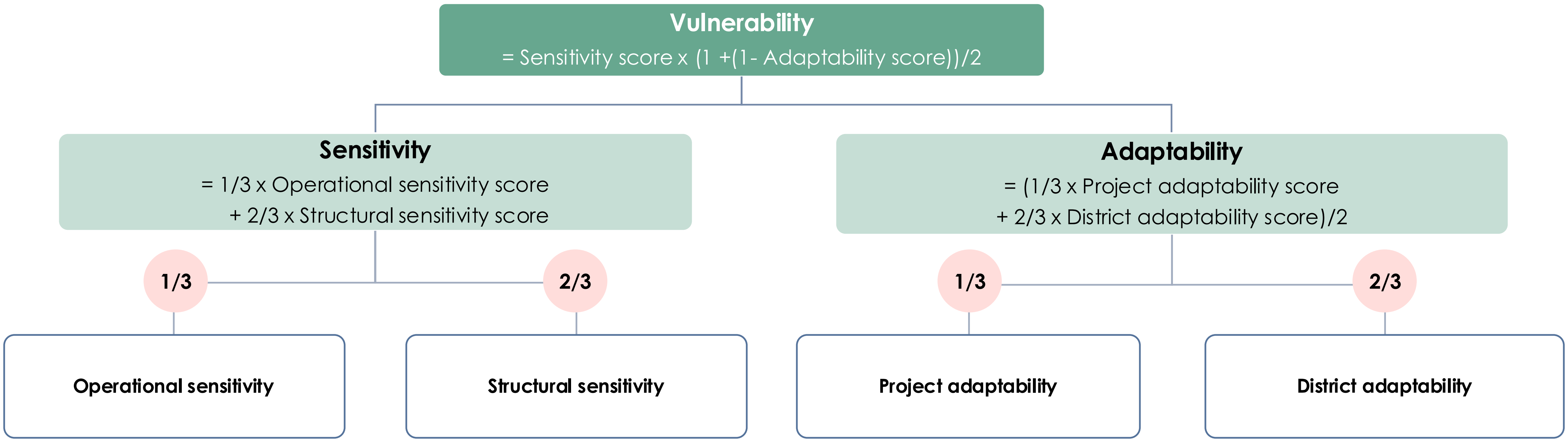
- **Sensitivity**
  How is the project affected by an occurrence of the hazard
  - **Operational sensitivity**
    Potential impacts of the hazard on the project's operation (working conditions, equipment)
  - **Structural sensitivity**
    Potential impacts of the hazard on the projects structure (buildings)
- **Adaptability**
  What is already in place to face an occurrence of the hazard
  - **Project adaptability**
    Project's readiness to face climate hazards (assessed through user inputs)
  - **District adaptability**
    District's readiness to face climate hazards (assessed through ASSESSMENT OF CLIMATE CHANGE VULNERABILITY IN RWANDA - 2018)

Operational and structural sensitivity are assessed through project matrixes detailing impacts of every kind of hazard on every kind of project and providing a score. District adaptability is already scored by the REMA study, and project adaptability based on user inputs.

Vulnerability is the combination of the sensitivity of the project towards the studied hazard and its adaptability



Vulnerability is the combination of the sensitivity of the project towards the studied hazard and its adaptability



The final risk score is calculated combining climate hazard exposure at the location and vulnerability, it is converted in a risk level

Climate Risk

If exposure = 1, $\sqrt{\textbf{Climate hazard} * \textbf{Vulnerability}}$

If exposure = 0, 0

Exposure

Can the hazard theoretically occur in the project area?

Climate Hazard

How will climate hazards evolve in terms of intensity, frequency or occurrence?

Vulnerability

To what extent can a project be affected (physical and/or economic impact) if the hazard occurs?

Risk scale

1 to 0,8	Very high risk
0,8 to 0,6	High risk
0,6 to 0,4	Moderate risk
0,4 to 0,2	Low risk
0,2 to 0	Very low risk

1 IPCC, AR6, Impacts Adaptation and Vulnerability, Chapter 1 – Point of departure and key concepts

For every project type, adaptation directive will be given

Example with rain fed crops

Project	Adaptation directives
Rain fed crops	**The challenge of adapting to climate change is twofold:** **- Modifying production and farming practices to make them more resilient to climate risks;** **- Ensuring that these changes are accompanied by socio-economic and institutional measures to guarantee their success.** It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the project's lifespan, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders. **Possible adaptation options include ensuring worker safety under extreme weather, modifying the agricultural calendar, choosing crop varieties, diversifying crop species, adopting cultivation methods (agro-ecology, agro-forestry) to better retain soil moisture and limit soil erosion, modifying phytosanitary treatments, resizing the irrigation or drainage network, seeking additional water resources, enhance early warning systems and seasonal forecasting for farmers; Promote agroforestry and soil conservation to reduce erosion.**

Example:
Manufacturing plant in Gakenke district
Heavy rain
SSP5-8.5, 2041-2060

SSP5-8.5

2041-2060

Example with a manufacturing plant in Gakenke district and heavy rain, SSP5-8.5, 2041-2060

SSP5-8.5

2041-2060

Climate Risk

If exposure = 1, $\sqrt{\textit{Climate hazard} * \textit{Vulnerability}}$

If exposure = 0, 0

Exposure

Can the heavy rain theoretically occur in the project area?

Climate Hazard

How will heavy rain evolve in terms of intensity, frequency or occurrence?

Vulnerability

To what extent can a manufacturing plant be affected (physical and/or economic impact) by heavy rain?

1 IPCC, AR6, Impacts Adaptation and Vulnerability, Chapter 1 – Point of departure and key concepts

Example with a <u>manufacturing plant</u> in Gakenke district and <u>heavy rain,</u> SSP5-8.5, 2041-2060

SSP5-8.5

2041-2060

Climate Risk

$$= \sqrt{Climate\ hazard * Vulnerability}$$

Exposure

Exposure score = 1

Heavy rain can happen in every location.

Climate Hazard

How will heavy rain evolve in terms of intensity, frequency or occurrence?

Vulnerability

To what extent can a manufacturing plant be affected (physical and/or economic impact) by heavy rain?

1 IPCC, AR6, Impacts Adaptation and Vulnerability, Chapter 1 – Point of departure and key concepts

Example with a manufacturing plant in Gakenke district and heavy rain, SSP5-8.5, 2041-2060

SSP5-8.5

2041-2060

Climate Risk

$= \sqrt{Climate\ hazard * Vulnerability}$

Exposure

Exposure score = 1

Heavy rain can happen in every location.

Climate Hazard

How will heavy rain evolve in terms of intensity, frequency or occurrence?

Vulnerability

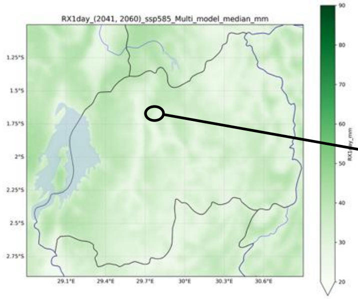
To what extent can a manufacturing plant be affected (physical and/or economic impact) by heavy rain?

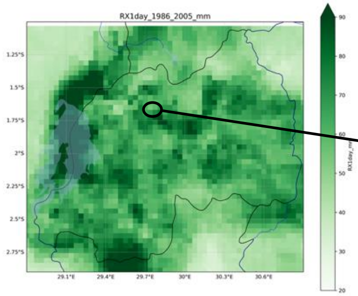
1 IPCC, AR6, Impacts Adaptation and Vulnerability, Chapter 1 – Point of departure and key concepts

Heavy rain at this location has a high score for SSP5-8.5, 2041-2060

SSP5-8.5

2041-2060





Future indicator data

34,83 mm

normalization →

Future indicator score

0,87

Historic indicator data

76,15 mm

normalization →

Historic indicator score

0,84

Aggravating factor data

-

normalization →

Aggravating factor score

-

Raw Hazard score

0,87

x (1 + 0,84)

x (1 + 0)

Normalization by the maximum possible value (2) →

Climate hazard score for heavy rain

0,80

Low hazard intensity 0 → High hazard intensity 1

carbone4

Vulnerability is the third component of the climate risk score

SSP5-8.5

2041-2060

Climate Risk

$= \sqrt{0,80 * Vulnerability}$

Exposure

Exposure score = 1

Climate Hazard

Heavy rain score = 0,80

Vulnerability

Project vulnerability

1 IPCC, AR6, Impacts Adaptation and Vulnerability, Chapter 1 – Point of departure and key concepts

Vulnerability is the combination of the sensitivity of the project towards the studied hazard and its adaptability

Vulnerability
= Sensitivity score x (1 +(1- Adaptability score))/2

Sensitivity score
= 1/3 x Operational sensitivity score
+ 2/3 x Structural sensitivity score

Adaptability score

1/3 — **Operational sensitivity**

2/3 — **Structural sensitivity**

Low sensitivity: 0

High sensitivity: 1

The manufacturing plant in Gakenke district has low operational and structural sensitivity towards heavy rain

Vulnerability

= Sensitivity score x (1 +(1- Adaptability score))/2

Sensitivity score

= 0,3

Adaptability score

1/3

Operational sensitivity = 0,3

Risk of loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.

2/3

Structural sensitivity = 0,3

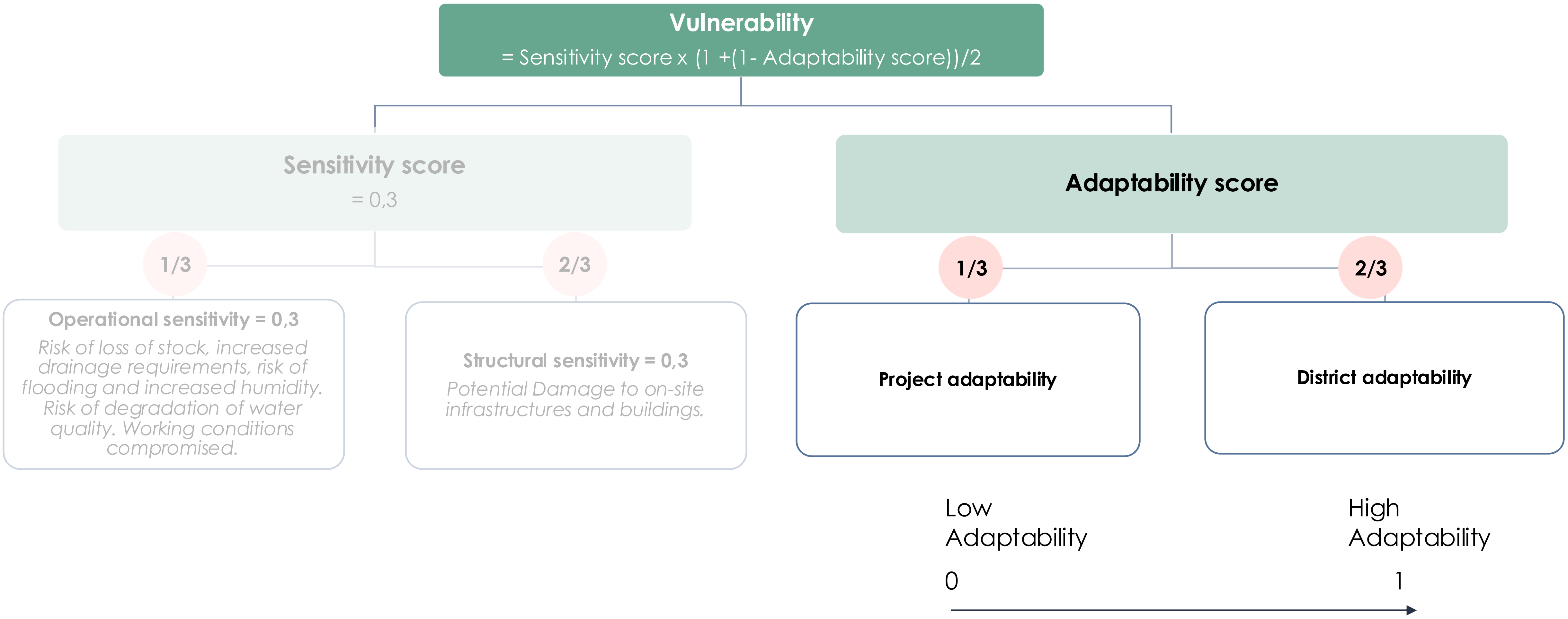
Potential Damage to on-site infrastructures and buildings.

Low sensitivity

High sensitivity

0 → 1

The manufacturing plant in Gakenke district has low operational and structural sensitivity towards heavy rain



The manufacturing plant in Gakenke district has a low adaptability level

User's input on the project's adaptation capacity :

The state of knowledge about the impacts of climate in this sector is good	**Yes = 1**
Natural or climatic risk assessment studies are underway	**No = 0**
Adaptation measures are already included in the project	**No = 0**
The subject has already been clearly identified by the project coordinator, who wishes to make the project resilient	**No = 0**

Score = (1+0+0+0) / 4

= 0,25

Low Adaptability — 0

High Adaptability — 1

Overall vulnerability of the manufacturing plant towards every rain is medium.

Vulnerability

= Sensitivity score x (1 +(1- Adaptability score))/2

Sensitivity score

= 0,3

1/3

Operational sensitivity = 0,3

Risk of loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.

2/3

Structural sensitivity = 0,3

Potential Damage to on-site infrastructures and buildings.

Adaptability score

=(0,25/3+0,49x2/3)/2

=0,21

1/3

Project adaptability = 0,25

The state of knowledge about the impacts of climate in this sector is good but no study are underway, no adaptation measures are taken, and the subject is not clearly identified

2/3

District adaptability = 0,49

Gakenke district score according to *ASSESSMENT OF CLIMATE CHANGE VULNERABILITY IN RWANDA - 2018*

Low Adaptability — 0

High Adaptability — 1

Overall vulnerability of the manufacturing plant towards every rain is medium.

Vulnerability

= Sensitivity score x (1 +(1- Adaptability score))/2

= 0,3 x (1 + (1 – 0,21))/2

= 0,27

Sensitivity score

= 0,3

- **1/3** — **Operational sensitivity = 0,3**
  Risk of loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.
- **2/3** — **Structural sensitivity = 0,3**
  Potential Damage to on-site infrastructures and buildings.

Adaptability score

=(0,25/3+0,49x2/3)/2

=0,21

- **1/3** — **Project adaptability = 0,25**
  The state of knowledge about the impacts of climate in this sector is good but no study are underway, no adaptation measures are taken, and the subject is not clearly identified
- **2/3** — **District adaptability = 0,49**
  Gakenke district score according to *ASSESSMENT OF CLIMATE CHANGE VULNERABILITY IN RWANDA - 2018*

Low vulnerability 0 → High vulnerability 1

Heavy rain generates moderate risk on the activity of the manufacturing plant in Gakenke district

SSP5-8.5

2041-2060

Climate Risk score

$$= \sqrt{0,80 * 0,27}$$

= 0,46

Exposure score
1

Climate Hazard score
0,80

Vulnerability score
0,27

1 to 0,8	Very high risk
0,8 to 0,6	High risk
0,6 to 0,4	**Moderate risk**
0,4 to 0,2	Low risk
0,2 to 0	Very low risk

1 IPCC, AR6, Impacts Adaptation and Vulnerability, Chapter 1 – Point of departure and key concepts

Example with other hazards for a manufacturing plant in the same location

SSP5-8.5

2041-2060

Project	hazard	Exposure score	Climate hazard score	Vulnerability score					Risk score
				Operational Sensitivity	*Structural Sensitivity*	*Project adaptability*	*District adaptability*	**Vulnerability score**	
Manufacturing plant	**Heavy rain**	1	0,80	*0,3*	*0,3*	*0,25*	*0,49*	0,27	**0,46 Moderate risk**
	Landslide	1	0,64	*0,9*	*0,9*			0,81	**0,72 High risk**
	Drought	1	0,25	*0,6*	*0,3*			0,36	**0,30 Low risk**

Example with other projects in the same location

SSP5-8.5

2041-2060

Project	hazard	Exposure score	Climate hazard score	Vulnerability score					Risk score
				Operational Sensitivity	*Structural Sensitivity*	*Project adaptability*	*District adaptability*	**Vulnerability score**	
Manufacturing plants				*0,3*	*0,3*	*0,25*		0,27	**0,46 Moderate risk**
Rain fed crops	**Heavy rain**	1	0,80	*0,6*	*0,3*	*0*	*0,49*	0,37	**0,49 Moderate risk**
Energy generation - renewable				*0,3*	*0,3*	*0,5*		0,26	**0,43 Moderate risk**

Example with the same hazard for a manufacturing plant in another location

SSP5-8.5

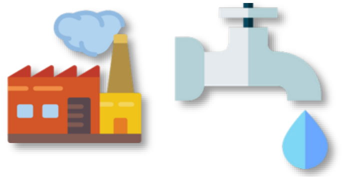
2041-2060

Project	Location	hazard	Exposure score	Climate hazard score	Vulnerability score					Risk score
					Operational Sensitivity	*Structural Sensitivity*	*Project adaptability*	*District adaptability*	**Vulnerability score**	
Manufacturing plant	In Gakenke district	**Heavy rain**	1	0,80	*0,3*	*0,3*	*0,25*	*0,49*	0,27	**0,46 Moderate risk**
	In Kirehe district			0,65				*0,42*	0,27	**0,42 Moderate risk**
	In Gasabo district			0,71				*0,45*	0,27	**0,44 Moderate risk**

Example with droughts for a manufacturing plant in another location

SSP5-8.5

2041-2060



Project	Location	hazard	Exposure score	Climate hazard score	Vulnerability score					Risk score
					Operational Sensitivity	*Structural Sensitivity*	*Project adaptability*	*District adaptability*	**Vulnerability score**	
	In Gasabo district			0,77				*0,49*	0,36	**0,53 Moderate risk**
Manufacturing plant	In Kirehe district	**Drought**	1	0,50	*0,6*	*0,3*	*0,25*	*0,42*	0,36	**0,43 Moderate risk**
	In Gakenke district			0,25				*0,45*	0,36	**0,30 Low risk**

Table of content

Climate and aggravating factor database

- **This section describes in detail the climate hazards** evaluated by the tool: heat waves, heat stress, wildfires, drought, water stress, heavy rain and pluvial flooding, landslides, erosion, fluvial flood, and storms.
- For each hazard**, it specifies the climate indicators used for assessment, the project's exposure context, and relevant aggravating factors.**
- Specific details for each type of hazard are presented, including normalization values and associated exposure or aggravating factors.
- Maps representing the data are also provided as examples. In the appendix, the complete set of maps representing all geographical data used for the tool is provided with each dataset respective source.
- **The data presented in this section is the result of the analysis of data provided by BRD's partners (Meteo Rwanda, REMA, MINEMA, Rwanda Water Board) and public data sources**. Carbone 4 performed several calculations and analysis to convert the provided data into geographical data that can be exploited in the tool.

Disclaimers on data

- Carbone 4 has been selected to construct a Climate Screening tool for BRD's projects using a climate exposure analysis method and data provided by BRD's partners (Meteo Rwanda, RWB, MINEMA, REMA). Carbone 4 has not been retained to verify the accuracy and/or authenticity of information provided.

- Historical data is based on **observations** whereas future data is based on **climate models provided by Meteo Rwanda** (7 models, ssp3-7.0 and ssp5-8.5 scenarios).
  - Historical and future data being from **different sources**, **they cannot be compared**. Historical data is therefore included as an aggravating factor in the scoring methodology.
  - **Future climate data is considered to the best and most specific climate data available for Rwanda** according to Meteo Rwanda. It was selected among different options following discussions between Carbone 4, BRD and Meteo Rwanda.
  - **SSP3-7.0 and SSP5-8.5 are used as they are the only scenarios available to date in Rwanda**. SSP3-7.0 projects higher warming than the previously considered SSP2-4.5 (around +3.5°C instead of +2.7°C in 2100). Short-term horizons (2020–2040) can provide insight into the impacts of less severe climate warming.
  - **Two horizons were chosen for short-term and mid-term** accordingly to the feasibility study. **2021-2040** (20 years centered on 2030) and **2041-2060** (20 years centered on 2050) have been selected to be **consistent with the IPCC choice** of horizons so that the indicators calculated for Rwanda could be compared with CMIP6 global indicators.

Each hazard is assessed through different parameters: climate indicators, exposure context and aggravating factors

Type	Hazard	Climate indicator	Exposure Context	Aggravating factor
TEMPERATURE	**Change in air temperature**	**T** – Average temperature	-	-
	Heat stress	**TXX** – Maximum of Maximum temperature	-	Urban heat island
	Heat wave	**TX30** – Number of days where Tmax > 30°C	-	Urban heat island
	Wildfire	**CDD** – Consecutive dry days	Burnable area (vegetation of a certain type)	-
WIND	**Storms (including thunderstorms)**	-	-	Historical Lightening density
WATER	**Water stress**	**WB** – Water balance	-	drought susceptibility map (season B)
	Drought	**CDD** – Consecutive dry days	-	drought susceptibility map (season B)
	Heavy rain precipitations	**RX1day** – Maximum daily precipitation	-	-
	Fluvial flooding	**RX5days** – Maximum precipitation over 5 days	Areas prone to fluvial flooding	-
	Pluvial flooding	**RX1day**	-	-
SOLID MASSES	**Soil erosion**	**RX5days**	-	Rainfall erosivity
	Landslide	**RX1day**	-	Landslide susceptibility

Climate database content description (1/2)

Column in the databse	'lat'	'lon'	future_climate_data'	historical_climate_data'	'district'	'Adaptation'	'province'	'hazard'	'scenario'	'period'	'indicator_long_name'	'indicator_short_name'	'indicator_unit'	'indicator_nv'
descritption	latitude	longitude	Indicator value for future climate	Indicator value for past climate	District name	Value of district_adaptability score	Province name	Hazard name	Scenario name (2 possibilities)	Horizon (2 possibilities)	Indicator name	Indicator short name	Indicator unit	Normalization value for 'future_climate_data'.
Data type	text	text	numerical value	numerical value	text	numerical value	text	text	text	text	text	text	text	numerical value
usage	to select the nearest data point to the project	to select the nearest data point to the project	calculation of Climate Hazard Score + display of data in appended tables	calculation of Climate Hazard Score + display of data in appended tables	-	adaptability_score calculation	-	Data identification	Data identification according to the user's choice of scenario in the tool	Data identification according to the user's choice of horizon in the tool	Name of indicator to be displayed in appendix data tables	-	Unit of indicator to be displayed in appendix data tables	Climate Hazard Score calculation

Climate database content description (2/2)

Column in the databse	'exposure_name'	'exposure_nv'	'AF_name'	'AF_nv'	'Hist_nv'	'Final_nv'	'AF_data'	'dist_af'	'Exposure_data'	'dist_exp'	'dist_grid'
description	Name of exposure factor	Exposure_data' normalization value	Name of the affraying factor	AF_data' normalization value	Normalization value for 'historical_climate_data'.	Final score normalization value	Value of aggravating factor	Distance with closest AF data point	Exposure value (0 or 1)	Distance with closest exposure data point	Distance with closest climate grid data point (for storms and water stress only)
Data type	text	numerical value	text	numerical value	numerical value	numerical value	numerical value	numerical value	numerical value	numerical value	numerical value
usage	-	Climate Hazard Score calculation	-	Climate Hazard Score calculation	Climate Hazard Score calculation	Climate Hazard Score calculation	Climate Hazard Score calculation	-	Climate Hazard Score calculation	-	-
Case where the value entered by the user is to be taken instead of the data in the DB							For the following hazards, "AF_data » is forced to 1 if the checkbox in the tool is "yes", 0 if « no », database value otherwise. Heat wave -> Urban heat-island or very densely developed area Heat stress -> Urban heat-island or very densely developed area Water stress -> Area subject to water stress		Por the following hazards, force "Exposure_data" is forced to 1 if the checkbox in the tool is "yes", 0 if « no », database value otherwise. Fluvial flood -> Flood-prone area Landslide -> Landslide risk area Erosion -> Erosion risk area Storm -> Storm risk area		

carbone4

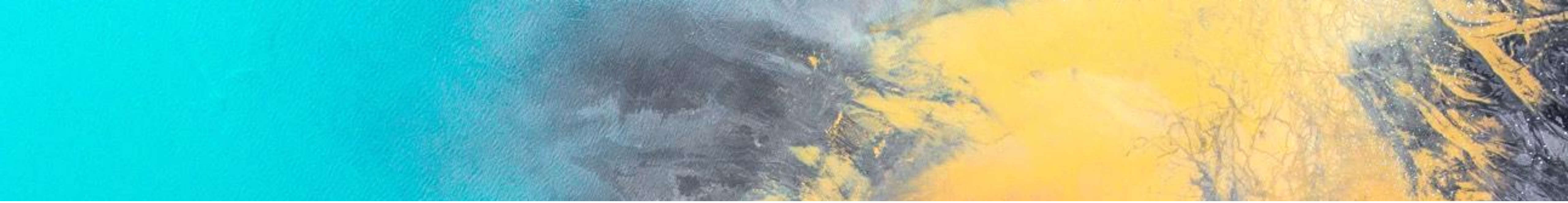


Table of content

Final Score | Heat waves

Parameters

Indicator	*Number of days above 30°C*
Normalization value for future climate data	40 days
Normalization value for historic climate data	40 days
Aggravating factor	*Urban heat island (0 or 0.2)*
Exposure factor	*- (which means equal to 1)*

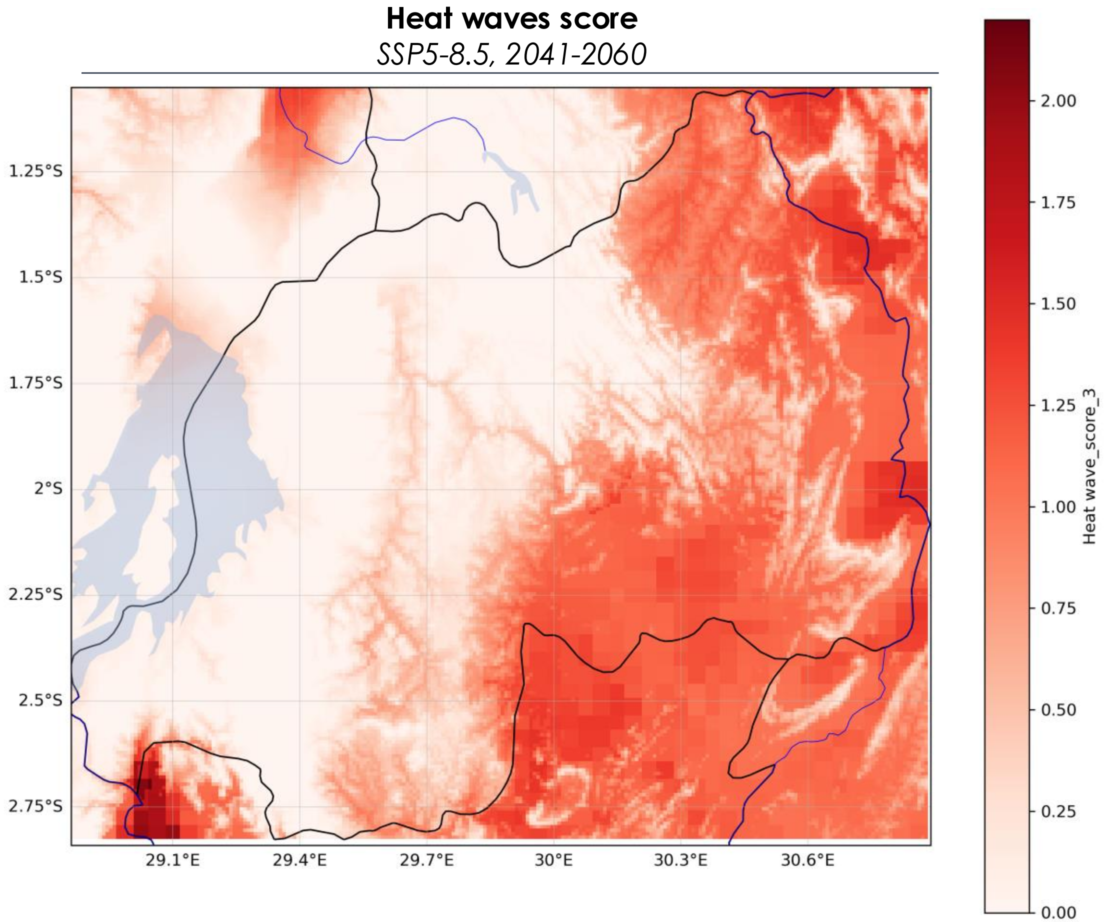
Climate Score calculation method

Future Indicator score

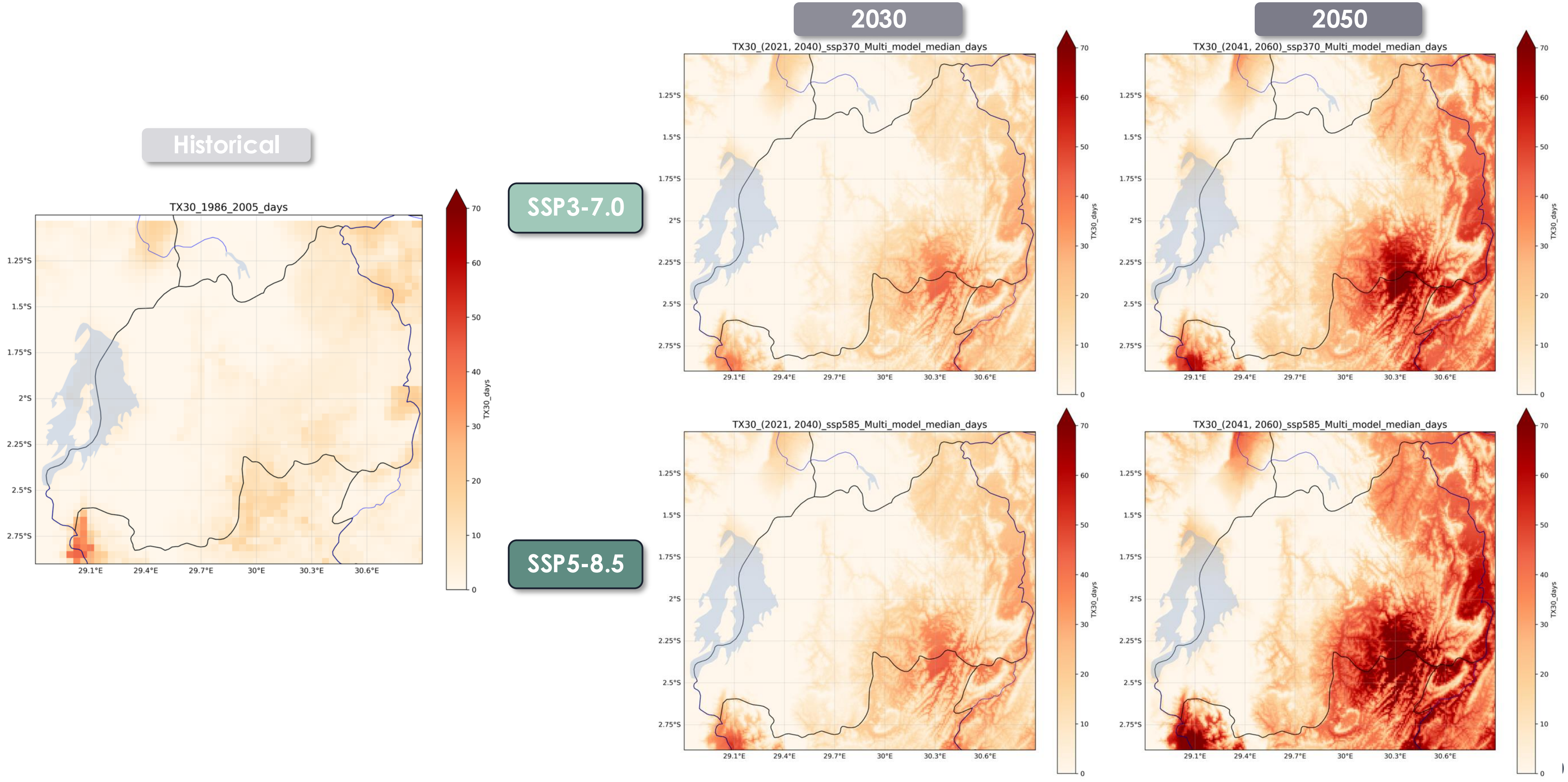
x (1 + Historical indicator score)

x (1 + Aggravating factor score)

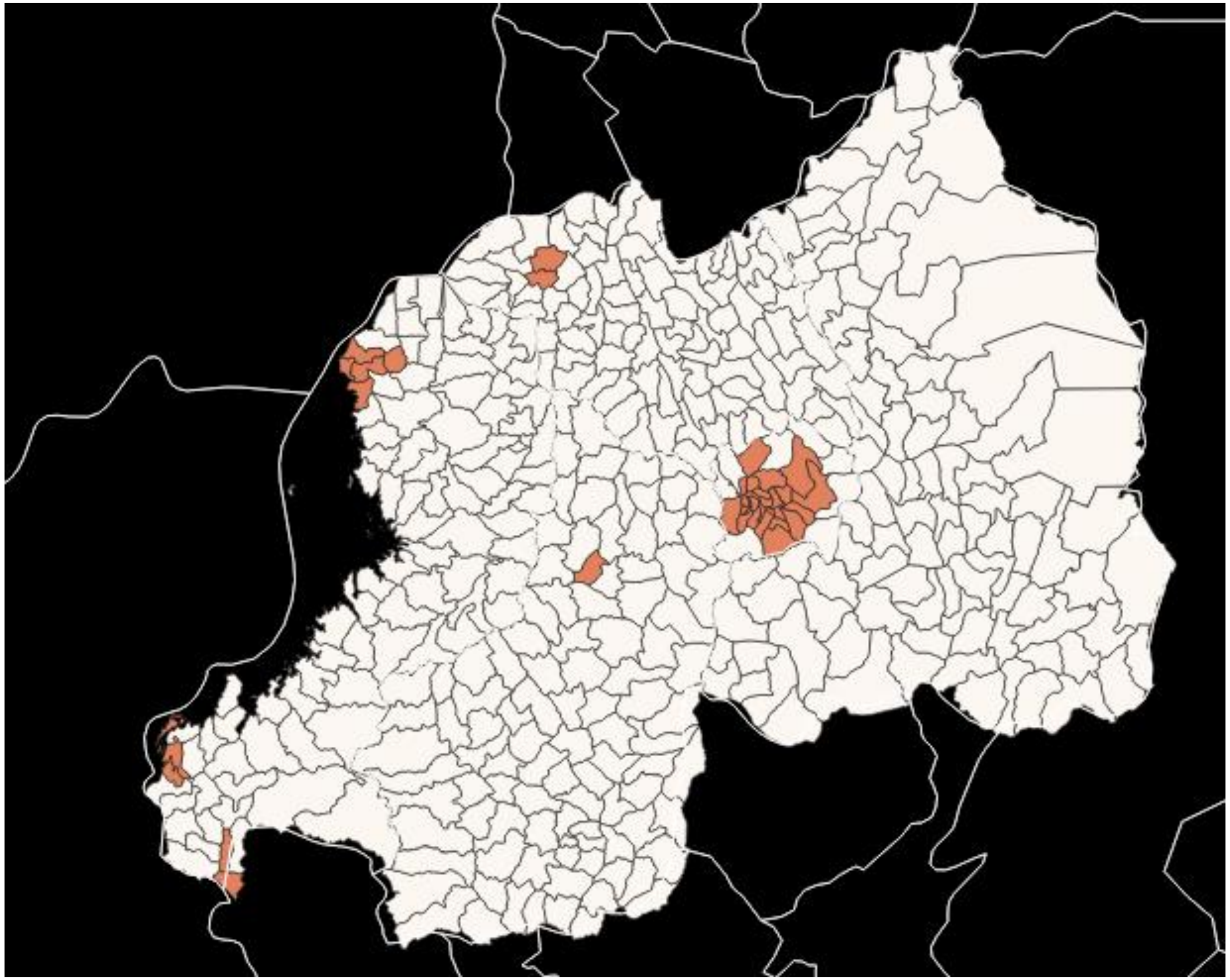
Data visualization



Details and tests | Climate data: Number of days above 30°C



Details and tests | Aggravating factor: Urban heat island



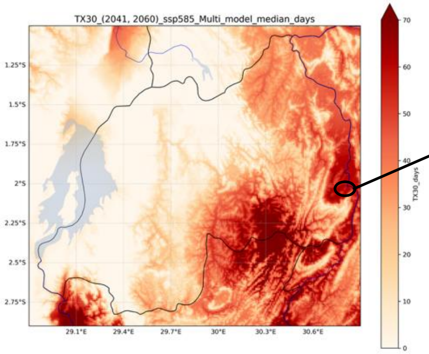
Sectors with high population density (2022)

Source: National Institute of Statistics of Rwanda (NISR)

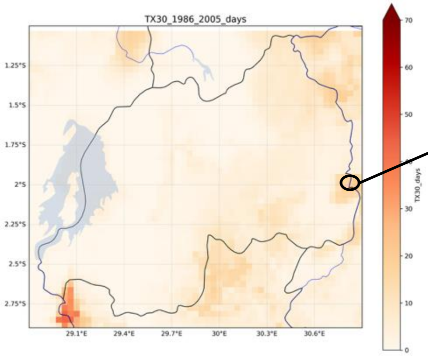
≥ 1500 hab/km²

< 1500 hab/km²

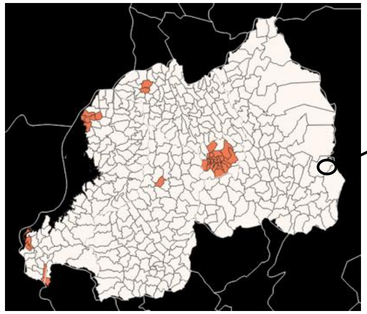
Details and tests | Example of calculation for a specific GPS point



Number of days over 30°C > 40
→ **Future indicator score = 1**



Number of days over 30°C = 20
→ **Historical indicator score = 0,5**



Aggravating factor = 0

Climate Score calculation method

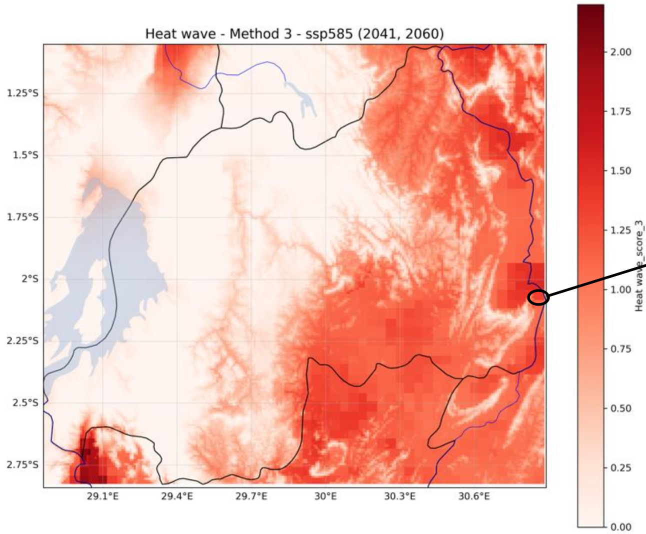
Exposure factor

x *Future Indicator score*

x (*1* + *Historical indicator score*)

x (*1* + *Aggravating factor score*)

Heat waves score
SSP5-8.5, 2041-2060



1 x *1* x (*1* + *0,5*) x (*1* + *0*)
= ***1,5***

Final normalized score =
1,5 / (1 x 1 x 1,5 x 1,2)

= 0,8

carbone4

Table of content

Final Score | Heat stress

Parameters	
Indicator	*Maximum of maximum temperature*
Normalization value for future climate data	36°C
Normalization value for historic climate data	36°C
Aggravating factor	*Urban heat island (Binary: 0 or 0.2)*
Exposure factor	-

Climate Score calculation method

Future Indicator score

x (1 + *Historical indicator score*)

x (1 + *Aggravating factor score*)

Data visualization

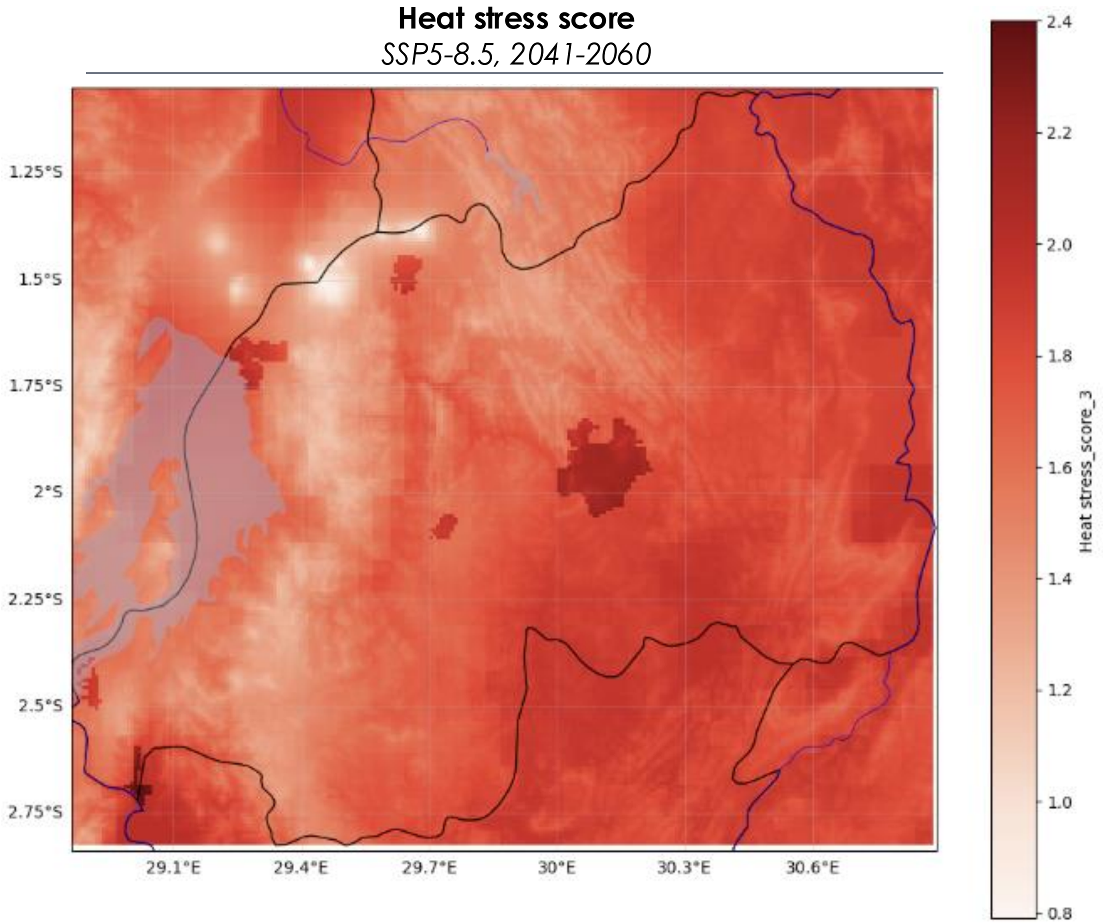


Table of content

Final Score | Change in air temperature

Parameters

Indicator	*Annual average air temperature*
Normalization value for future climate data	30°C
Normalization value for historic climate data	30°C
Aggravating factor	-
Exposure factor	-

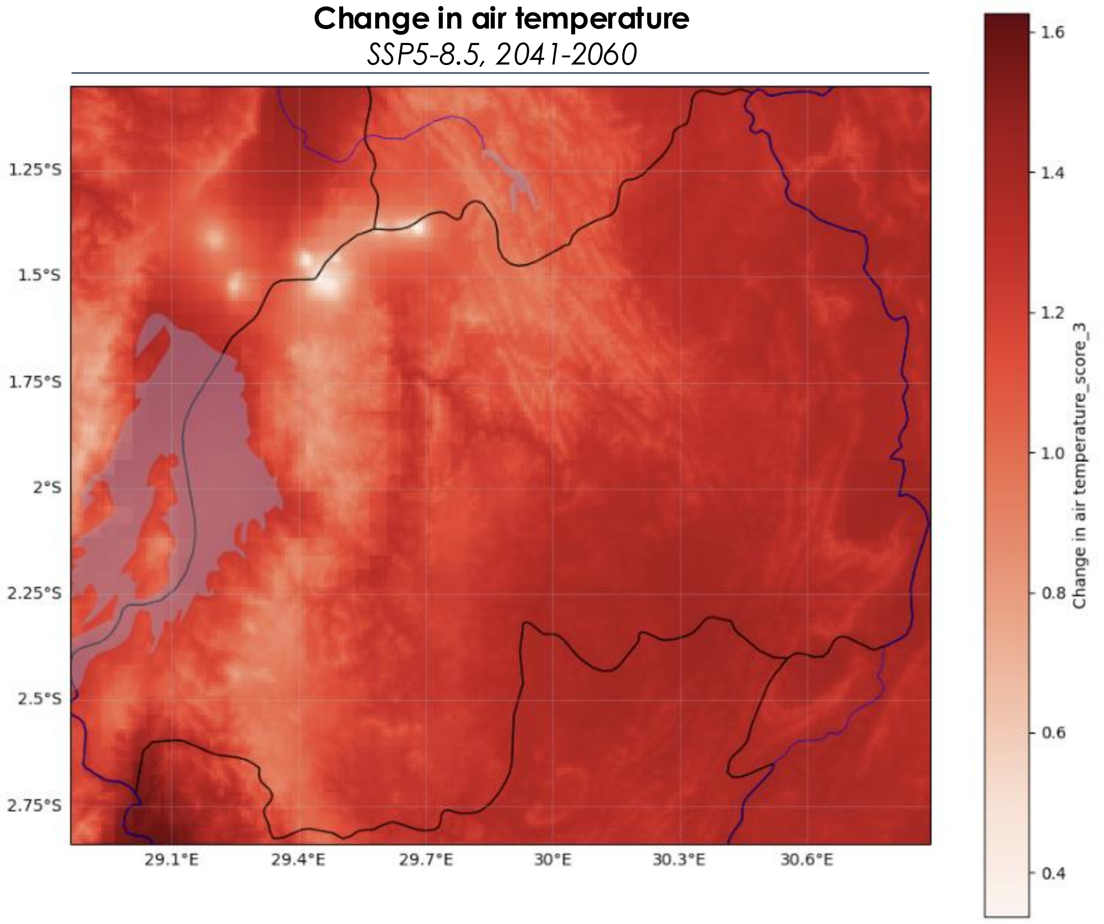
Climate Score calculation method

Future Indicator score

x (*1* + *Historical indicator score*)

x (*1* + *Aggravating factor score*)

Data visualization



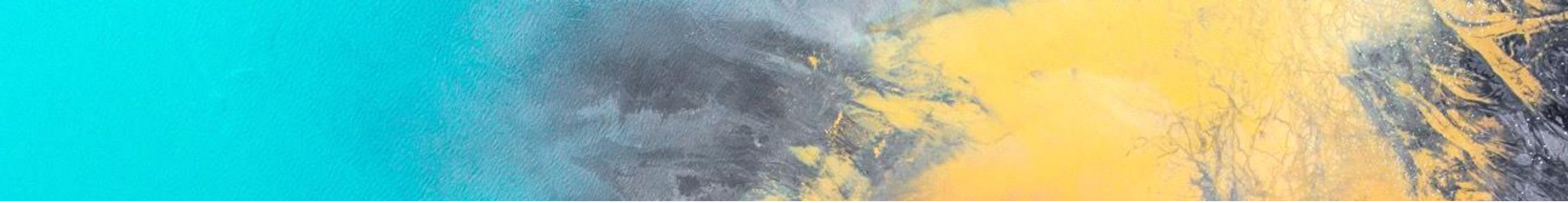


Table of content

Final Score | Wildfire

Parameters

Indicator	*Consecutive dry days*
Normalization value for future climate data	60 days
Normalization value for historic climate data	60 days
Aggravating factor	*Historical Fire Weather index (0 everywhere)*
Exposure factor	*Burnable vegetation (binary)*

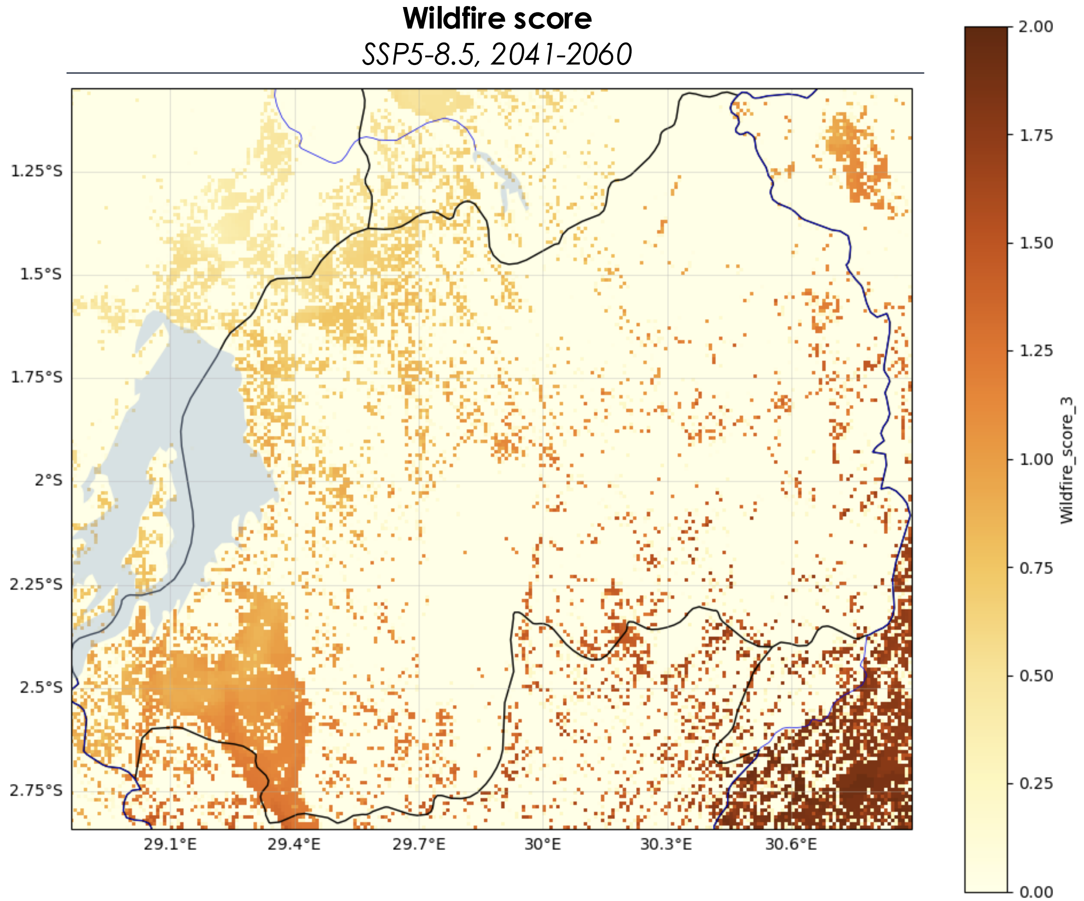
Climate Score calculation method

Future Indicator score

x (1 + Historical indicator score)

x (1 + Aggravating factor score)

Data visualization



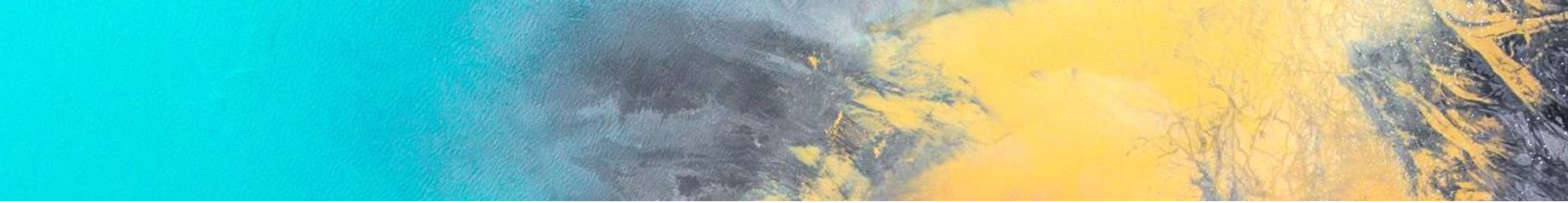


Table of content

Final Score | Drought

Parameters

Indicator	*Consecutive dry days*
Normalization value for future climate data	60 days
Normalization value for historic climate data	60 days
Aggravating factor	*Historical drought area – season B (discrete scores, 0 to 1)*
Exposure factor	-

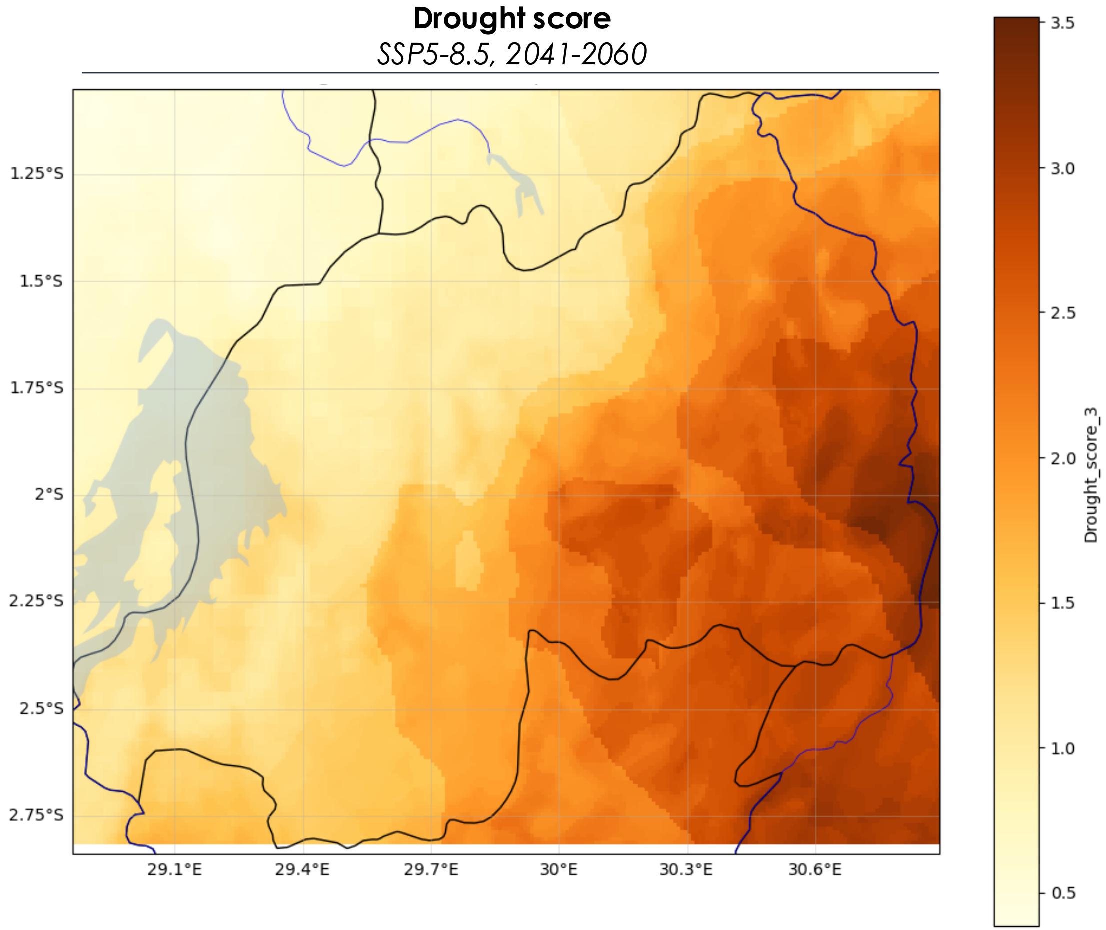
Climate Score calculation method

Future Indicator score

x (1 + Historical indicator score)

x (1 + Aggravating factor score)

Data visualization



carbone4

Table of content

Final Score | Water stress

Parameters

Indicator	*Water balance (source: RWB) per catchment area*
Normalization value for future climate data	-70 MCM/year
Normalization value for historic climate data	-70 MCM/year
Aggravating factor	*Historical drought area – season B (discrete scores, 0 to 1)*
Exposure factor	

Climate Score calculation method

Future Indicator score

x (1 + *Historical indicator score*)

x (1 + *Aggravating factor score*)

Data visualization

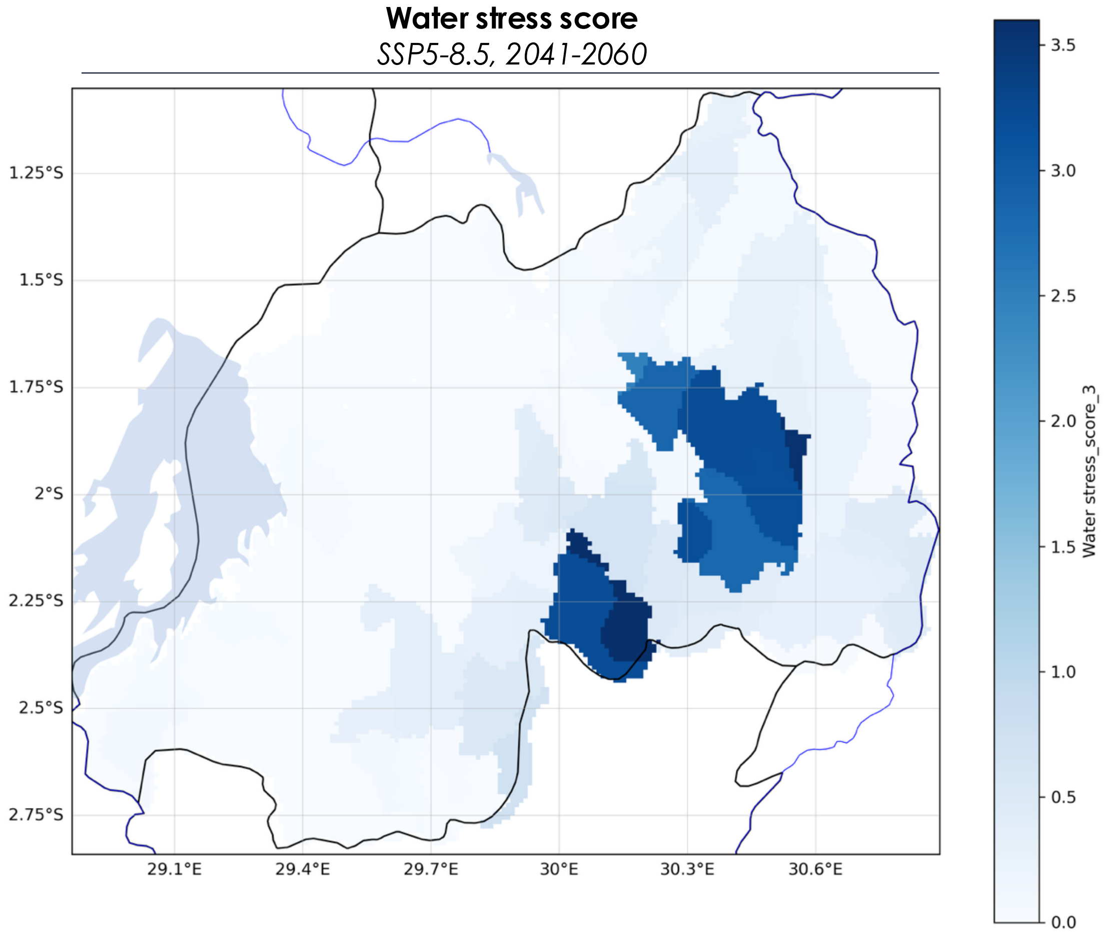


Table of content

Final Score | Heavy rain and pluvial flooding

Parameters

Indicator	*Maximum daily precipitation*
Normalization value for future climate data	40 mm
Normalization value for historic climate data	90 mm
Aggravating factor	-
Exposure factor	-

Climate Score calculation method

Future Indicator score

x (1 + *Historical indicator score*)

x (1 + *Aggravating factor score*)

Data visualization

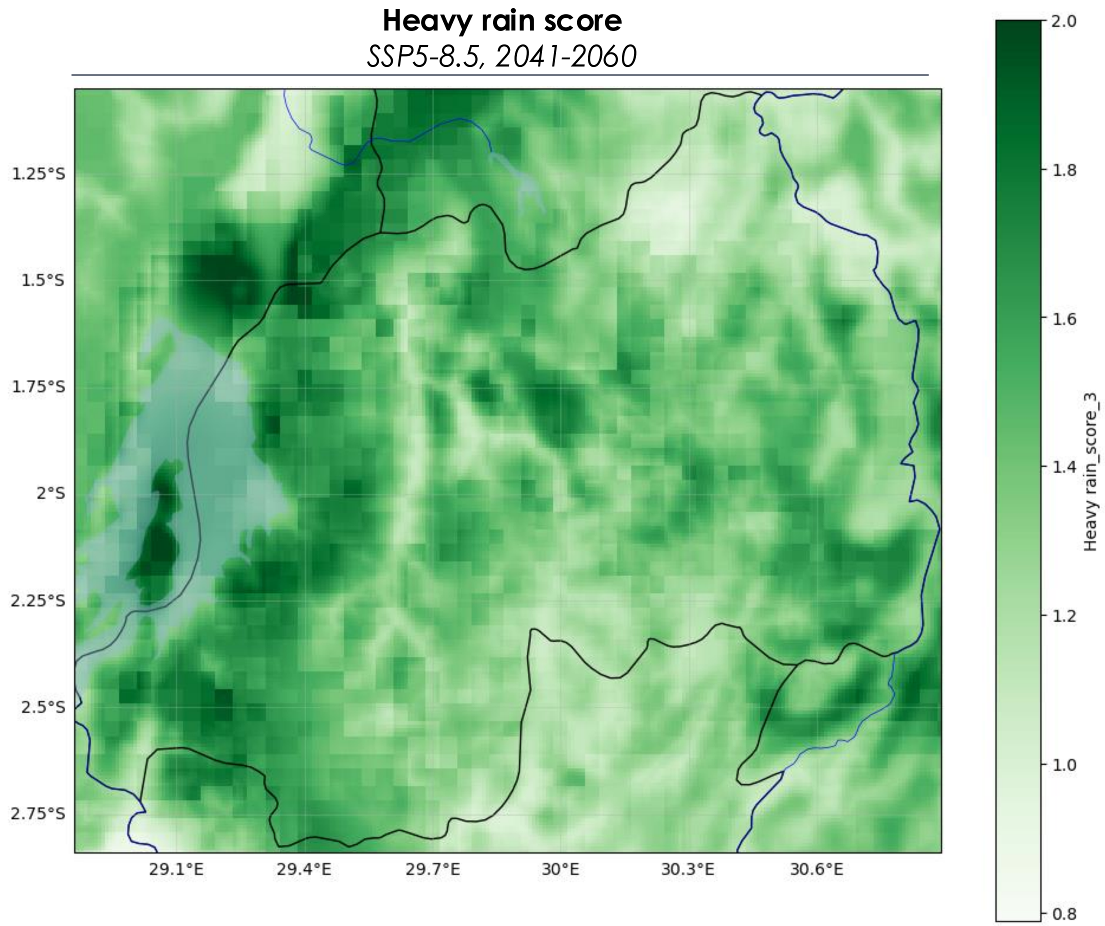


Table of content

Final Score | Landslides

Parameters

Indicator	*Maximum daily precipitation*
Normalization value for future climate data	40 mm
Normalization value for historic climate data	90 mm
Aggravating factor	*Landslide susceptibility ((5 discrete scores, 0 to 1)*
Exposure factor	-

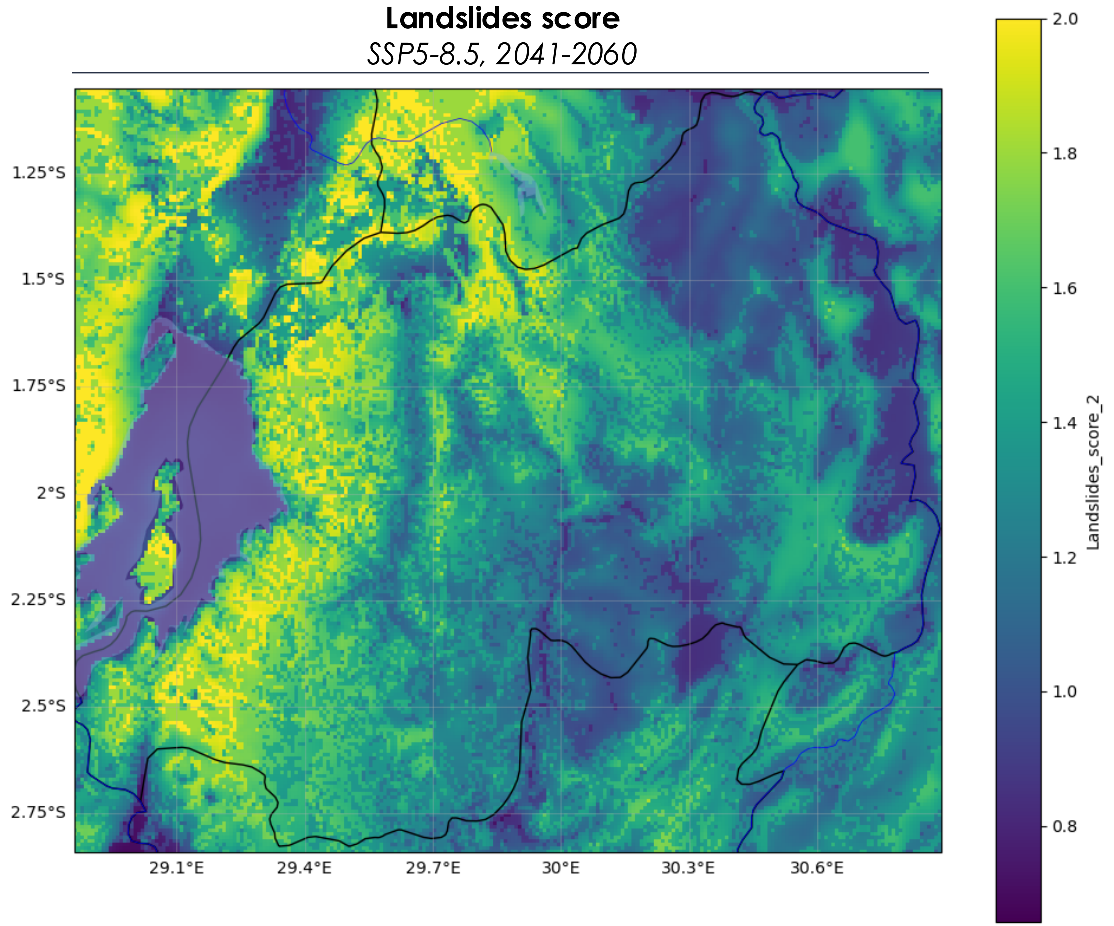
Climate Score calculation method

Future Indicator score

x *(1 + Historical indicator score)*

x *(1 + Aggravating factor score)*

Data visualization



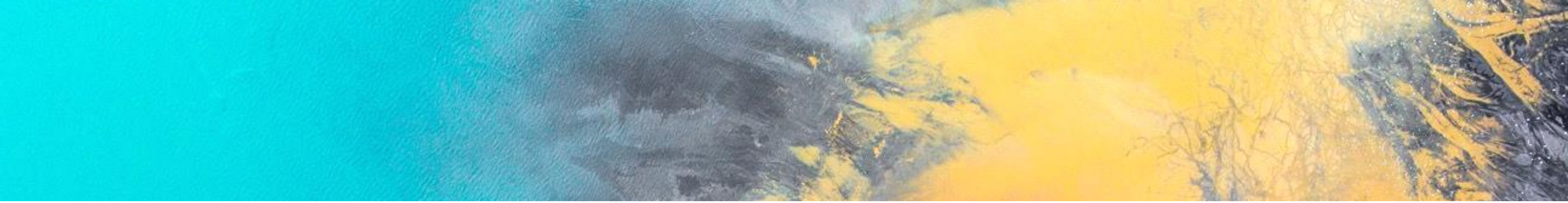


Table of content

Final Score | Erosion

Parameters

Indicator	*Maximum precipitation on a 5 days period*
Normalization value for future climate data	120 mm
Normalization value for historic climate data	120 mm
Aggravating factor	*Rain erositivity (continuous data, normalized from 0 to1)*
Exposure factor	-

Climate Score calculation method

Future Indicator score

x (1 + Historical indicator score)

x (1 + Aggravating factor score)

Data visualization

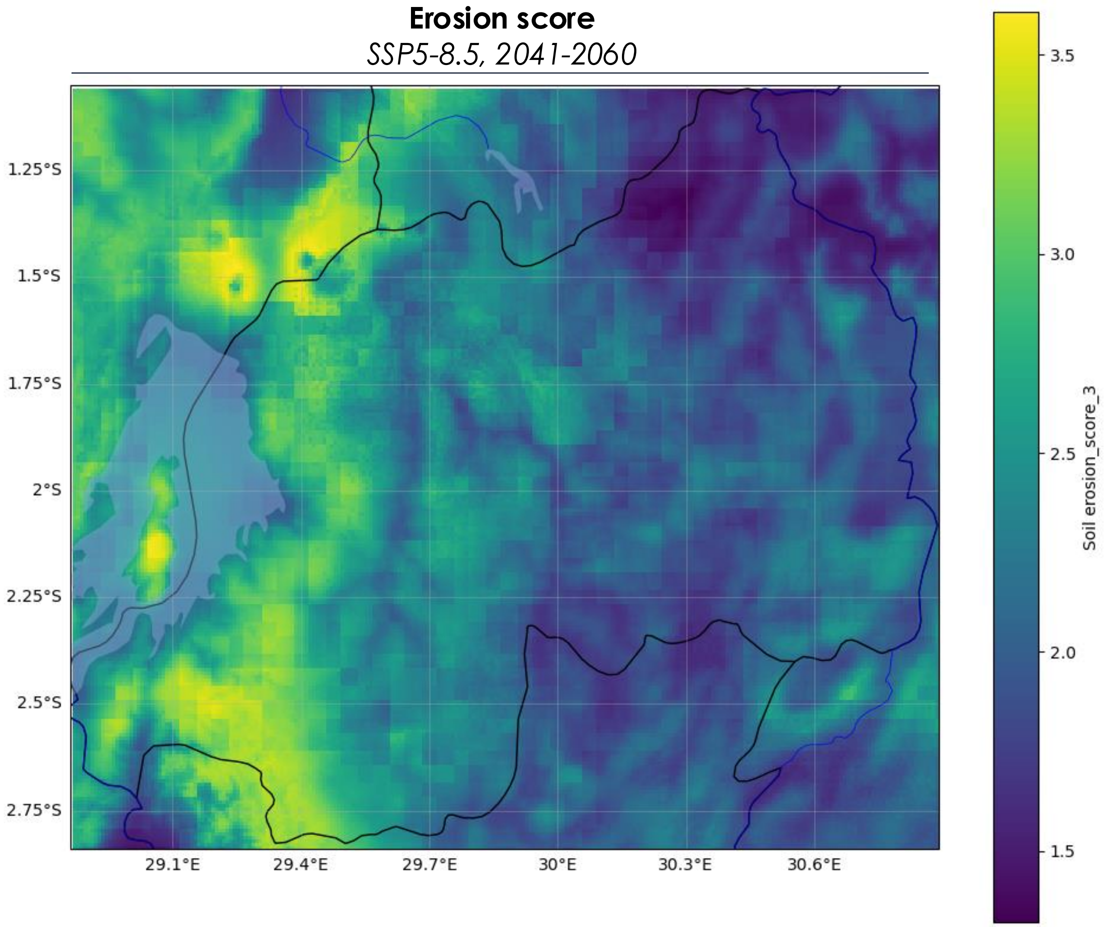


Table of content

Final Score | Fluvial flood

Parameters

Indicator	*Maximum precipitation on a 5 days period*
Normalization value for future climate data	120 mm
Normalization value for historic climate data	120 mm
Aggravating factor	*Districts where flood have occured*
Exposure factor	*Areas 1km around rivers*

Climate Score calculation method

Future Indicator score

x (*1* + *Historical indicator score*)

x (*1* + *Aggravating factor score*)

Data visualization

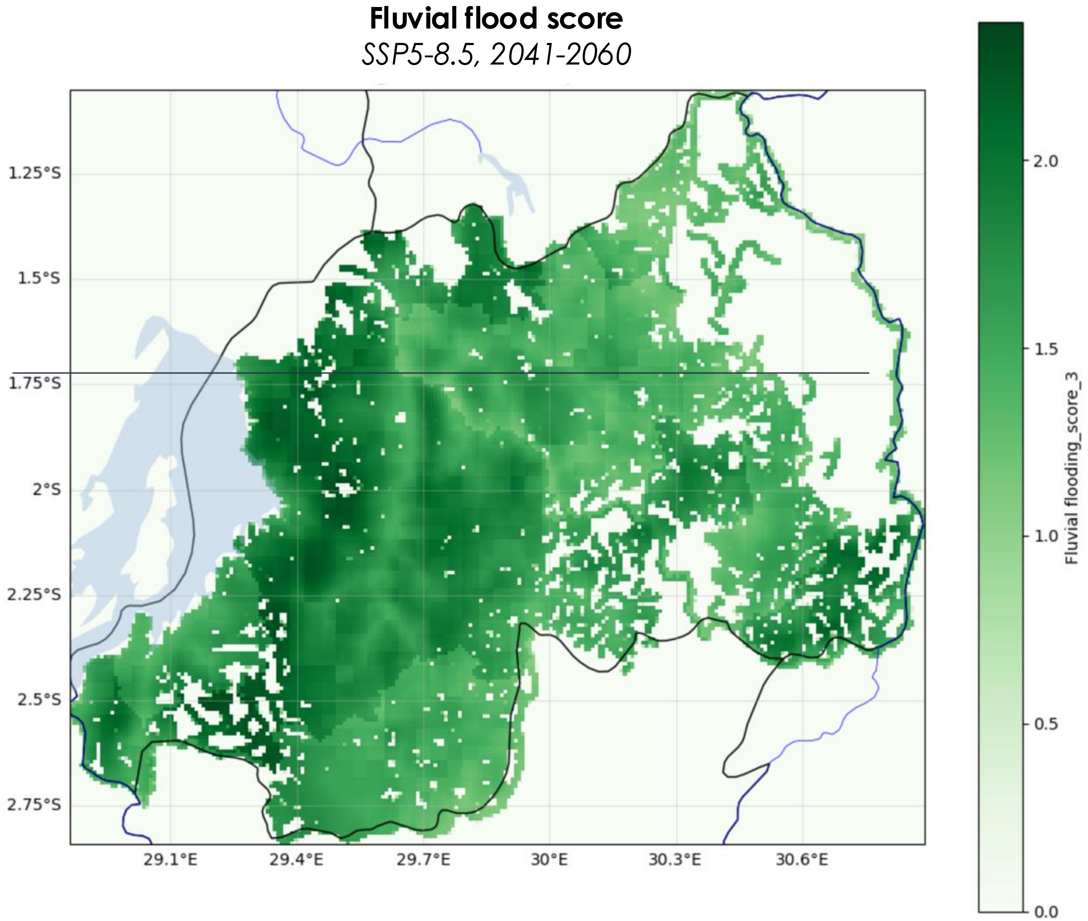


Table of content

Final Score | Storms

Parameters

Indicator	*High winds exposure*
Normalization value for future climate data	-
Normalization value for historic climate data	*Discrete scores normalized between 0 and 1*
Aggravating factor	*Lightening density*
Exposure factor	-

Climate Score calculation method

Future Indicator score

x (1 + Historical indicator score)

x (1 + Aggravating factor score)

Data visualization

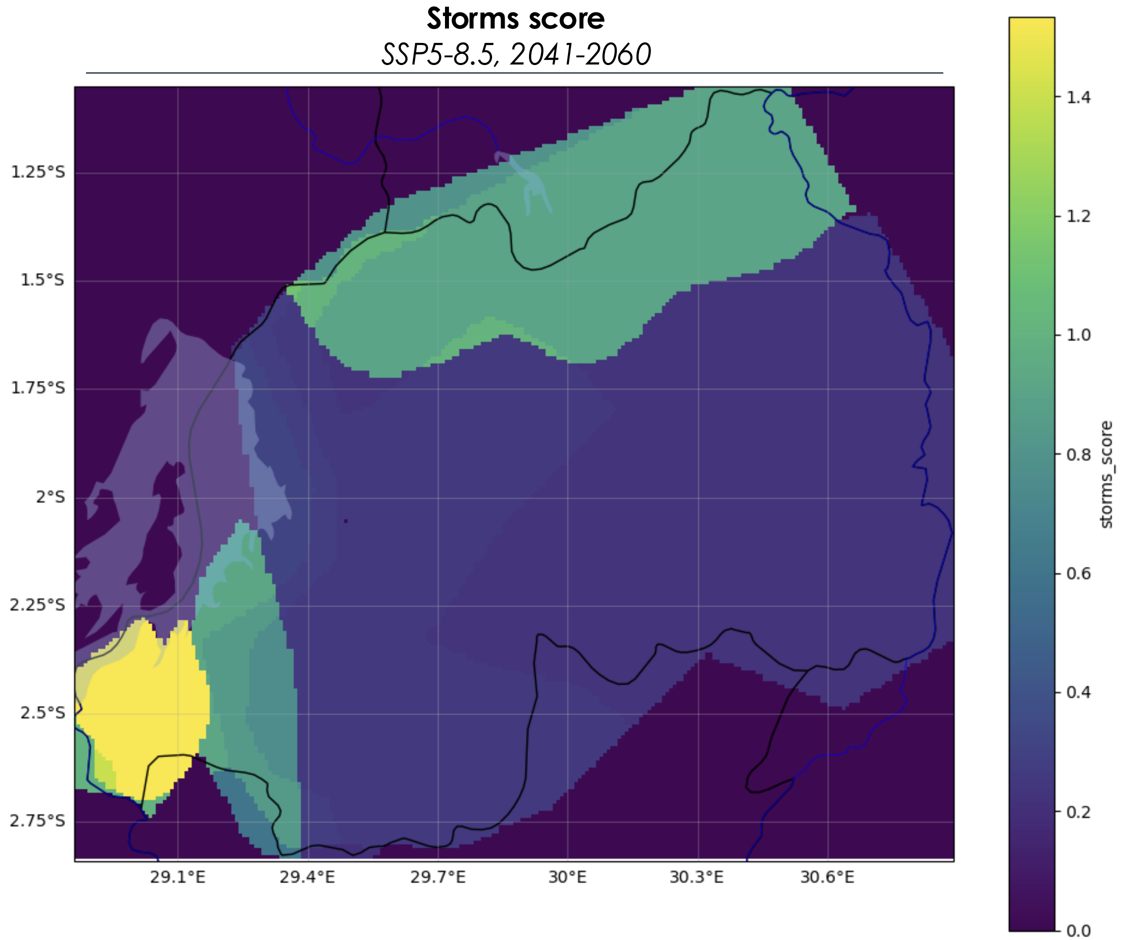
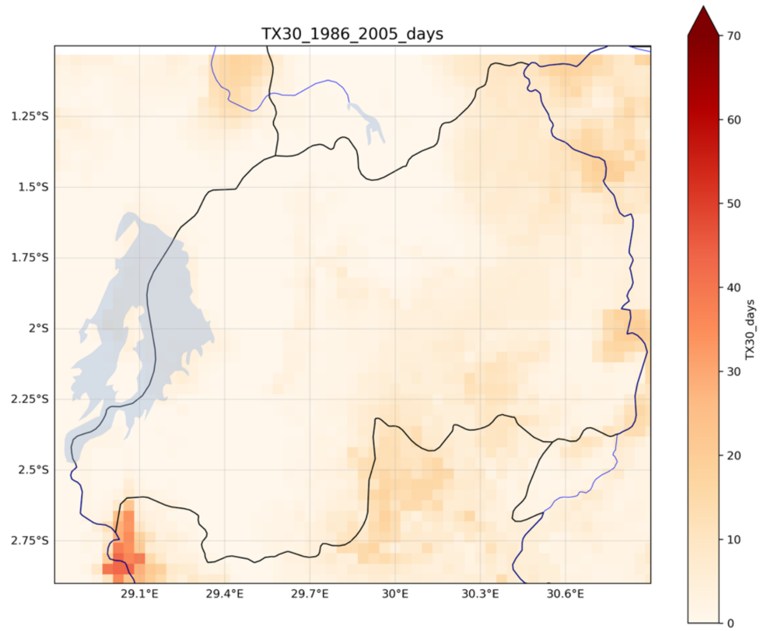


Table of content

Details and tests | Climate data: Number of days above 30°C

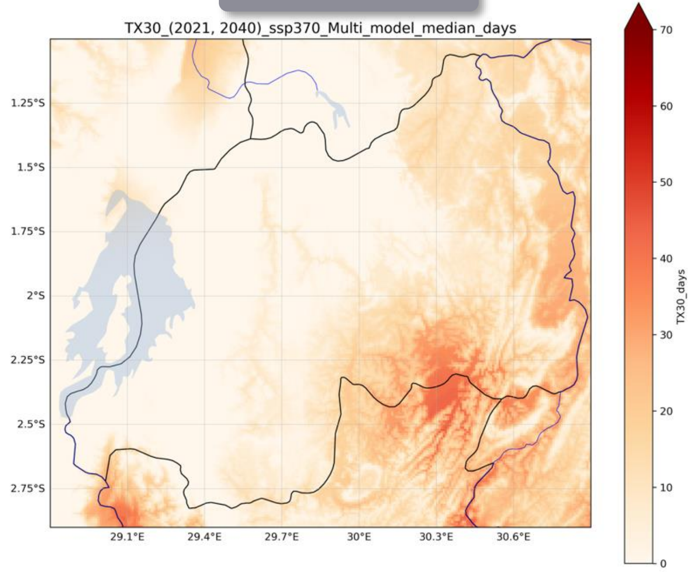
Historical

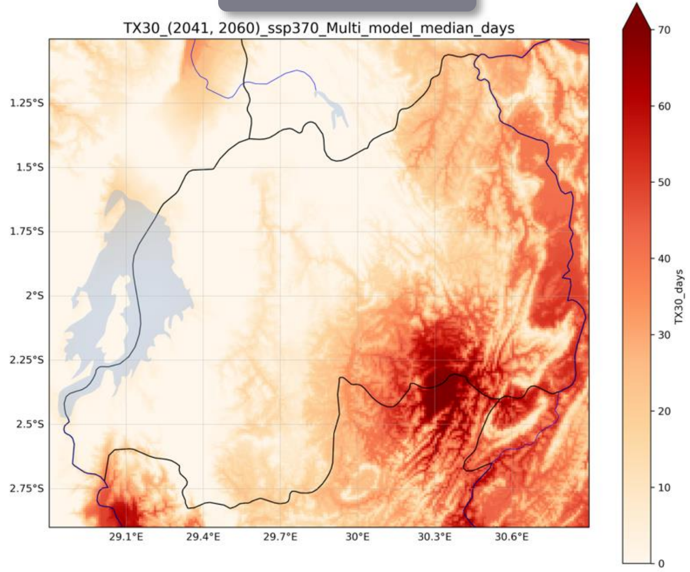


2030

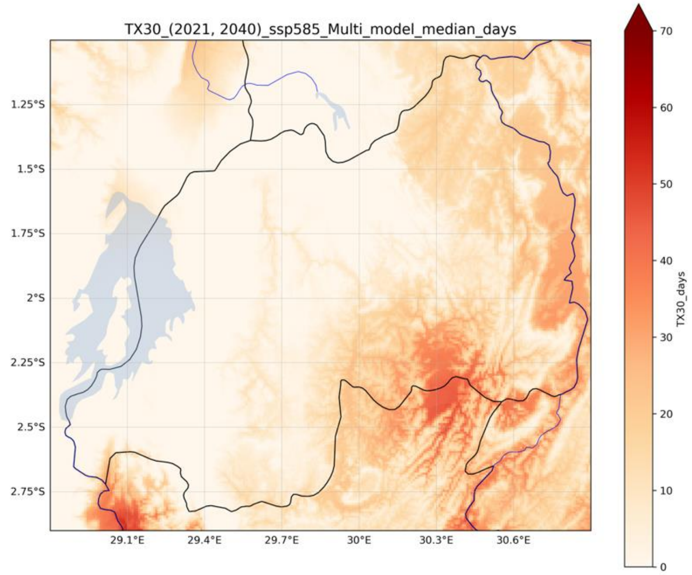
2050

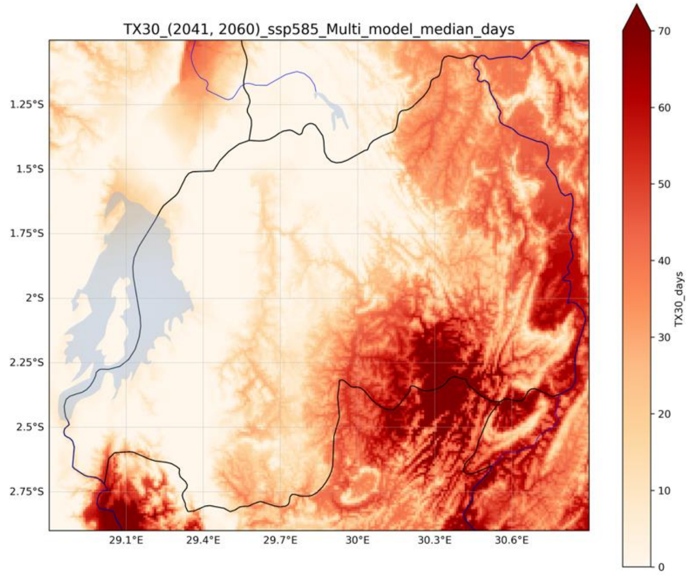
SSP3-7.0



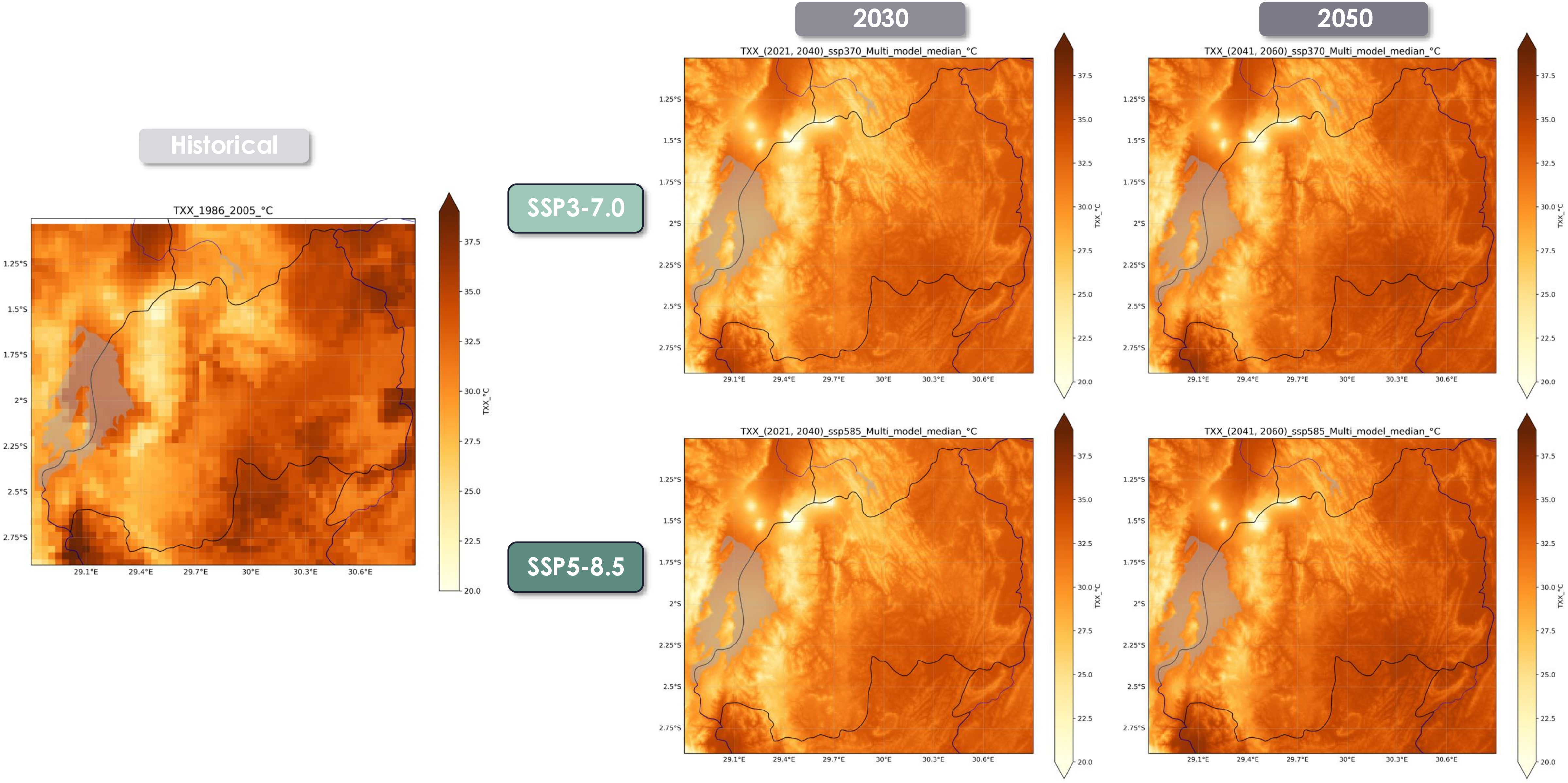


SSP5-8.5





Details and tests | Climate data: Maximum of maximum temperatures

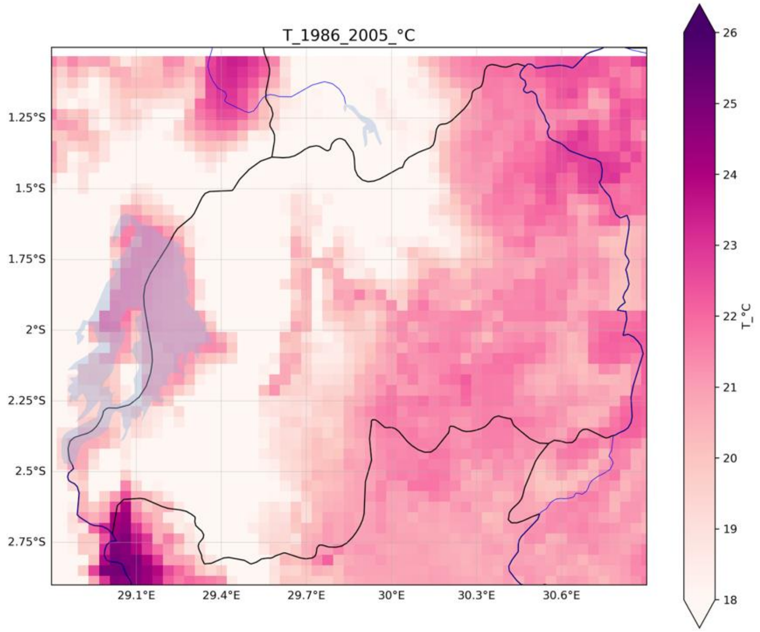


Details and tests | Climate data: Annual Average Temperature

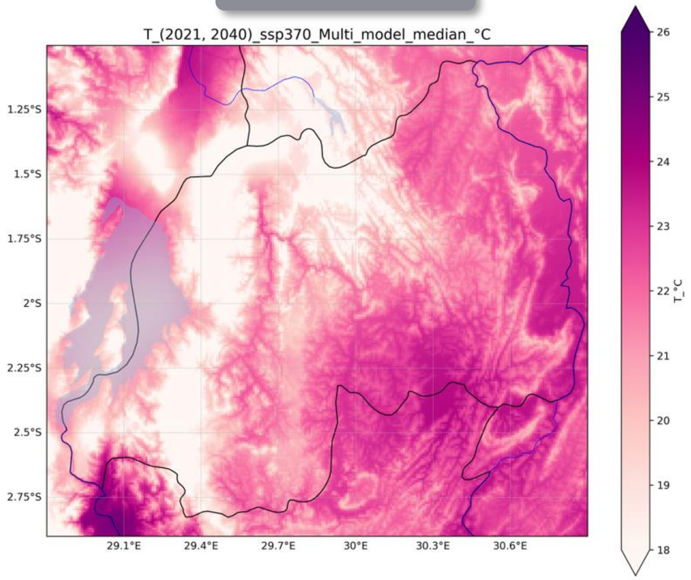
2030

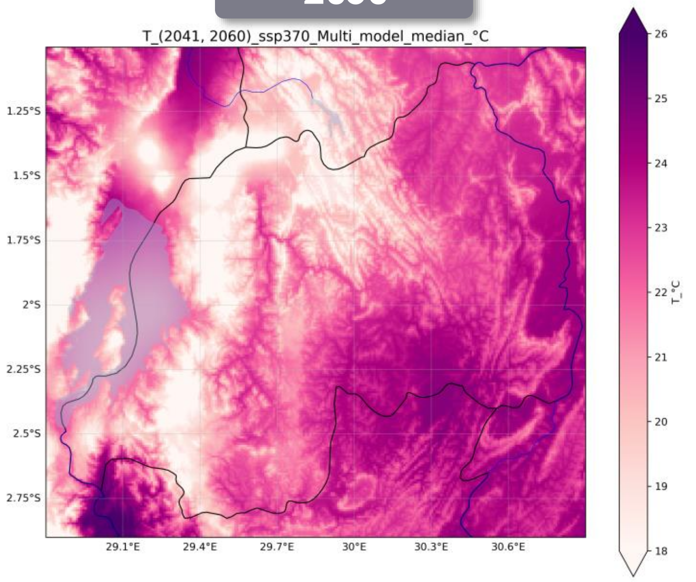
2050

Historical

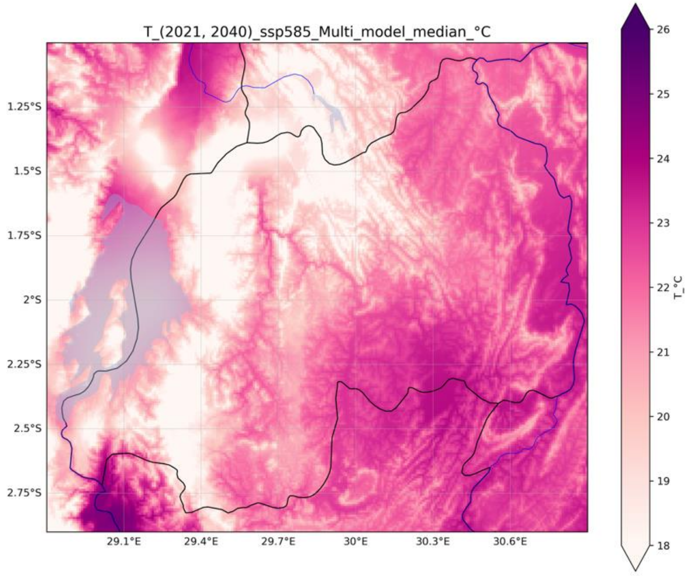


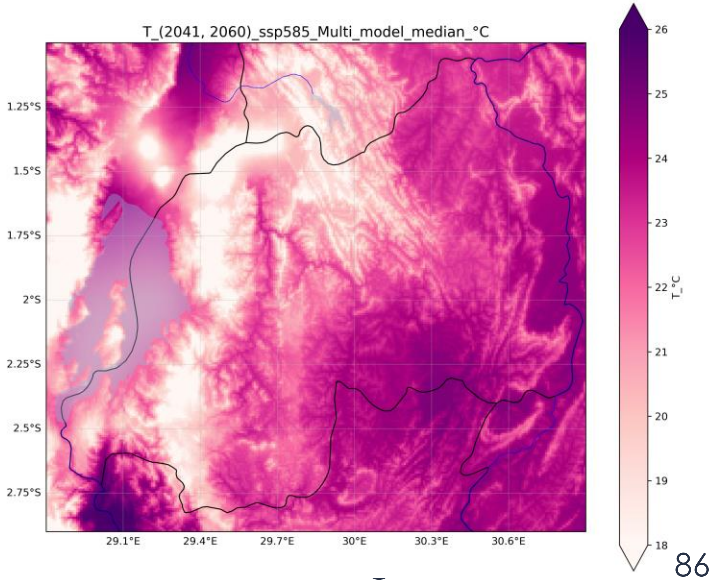
SSP3-7.0



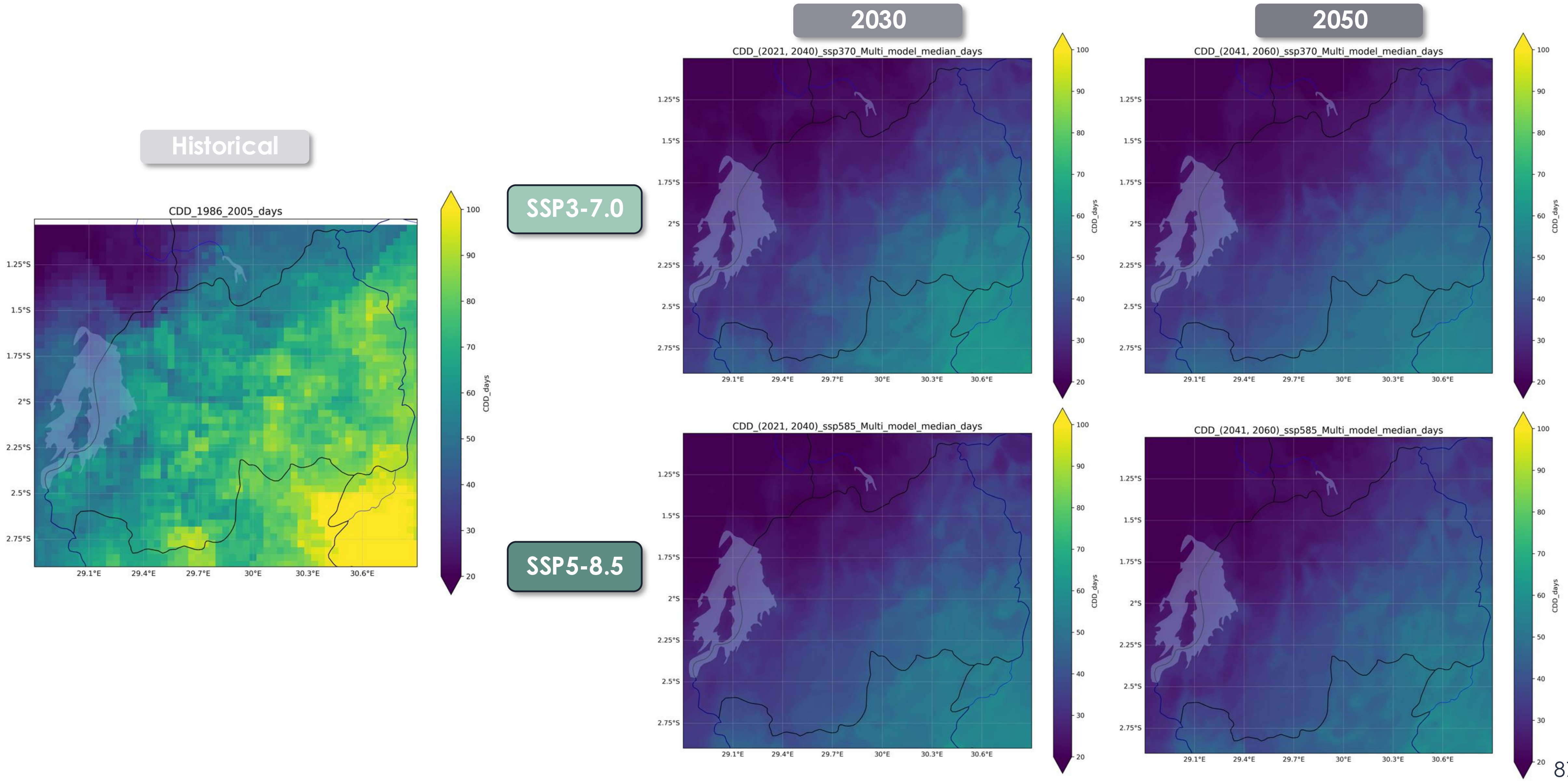


SSP5-8.5



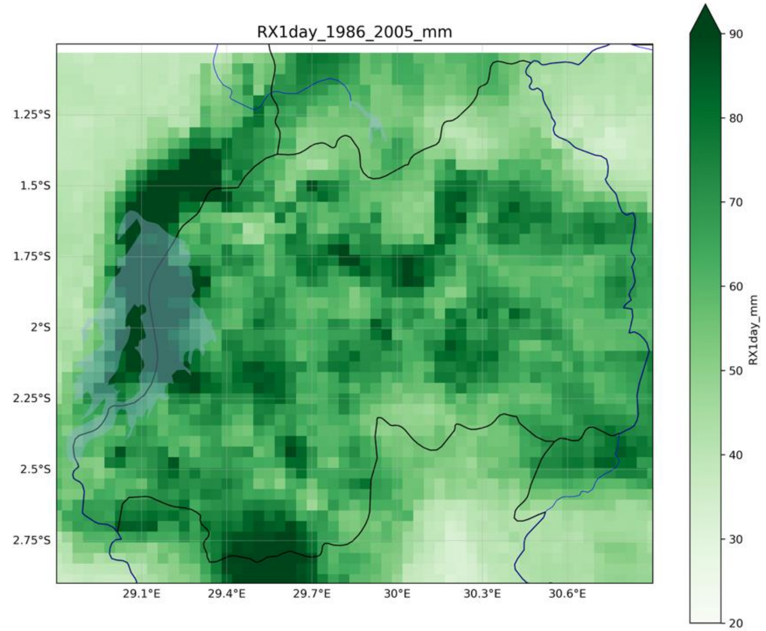


Details and tests | Wildfire - Climate data: Consecutive dry days



Details and tests | Climate data: RX1day – annual maximum daily precipitation

Historical

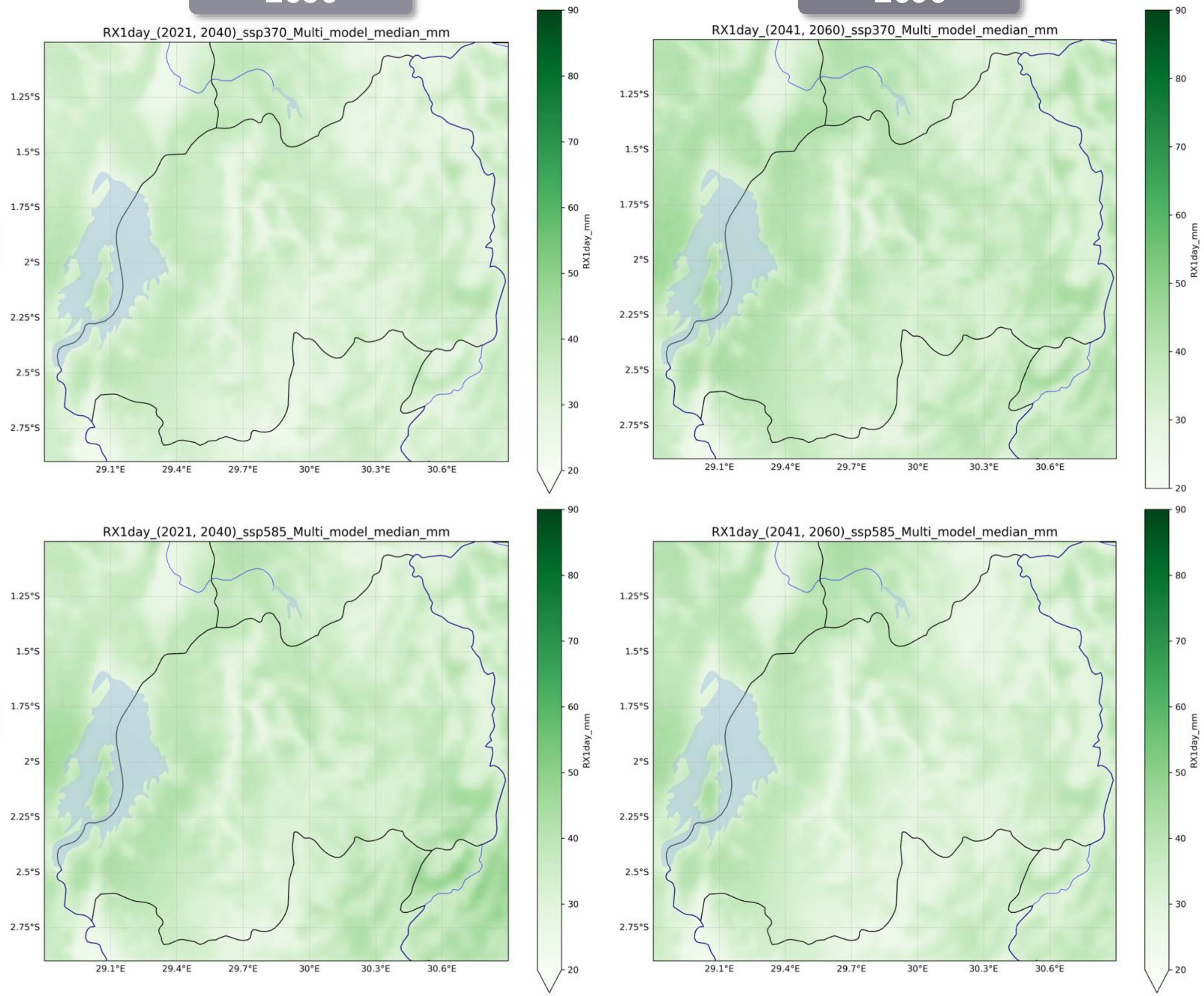


SSP3-7.0

SSP5-8.5

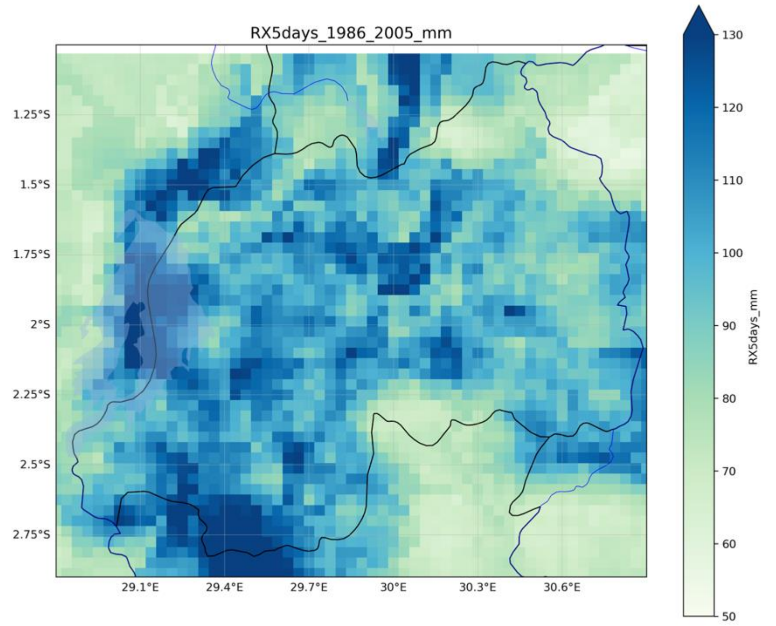
2030

2050



Details and tests | Soil Erosion – Climate data: annual maximum precipitation on 5 consecutive days

Historical

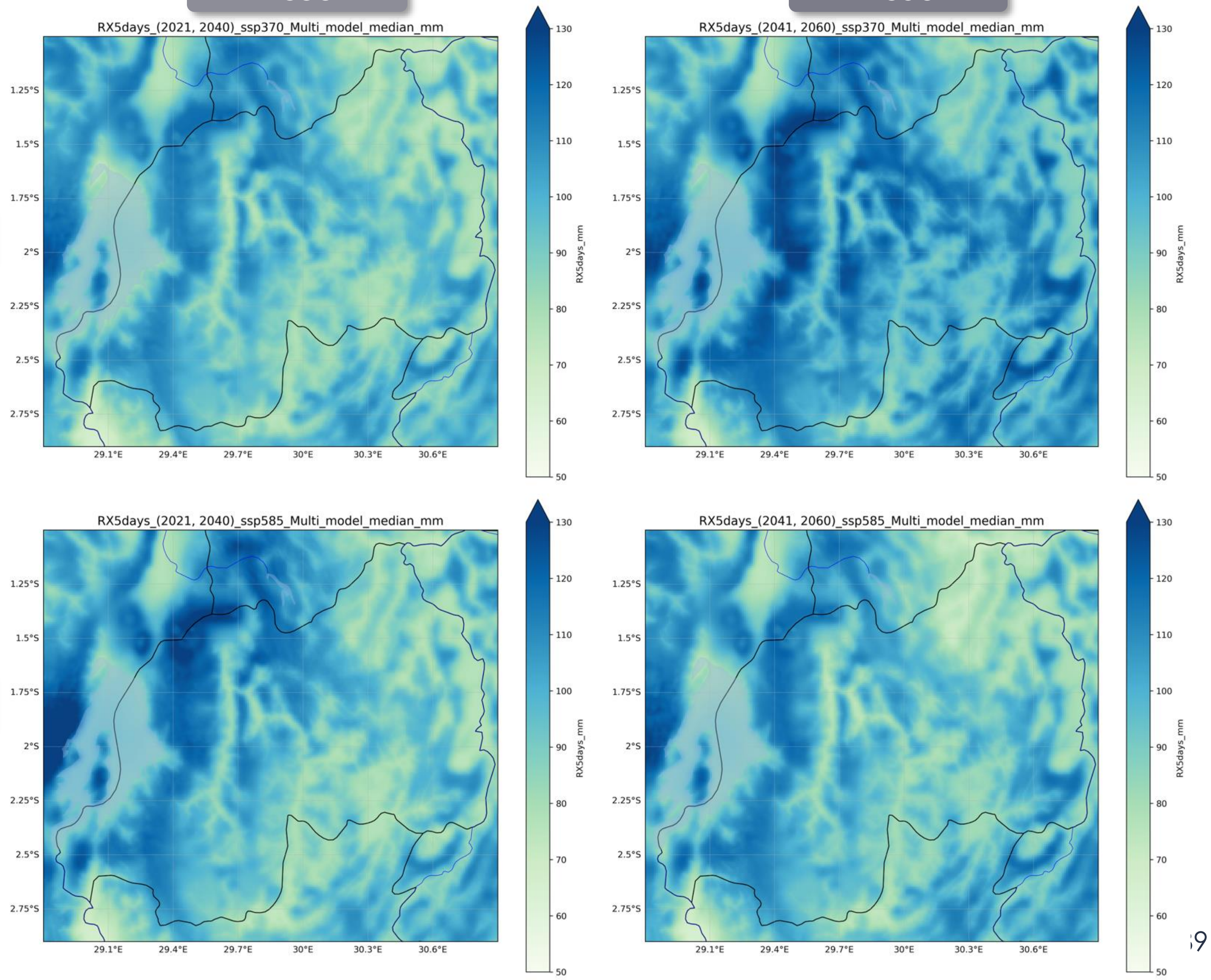


2030

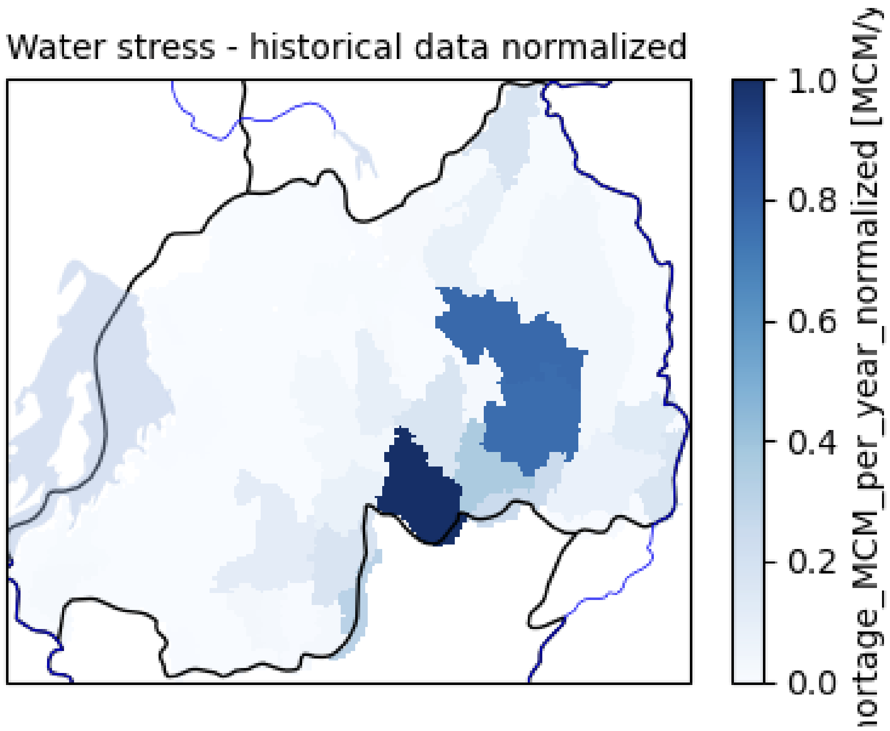
2050

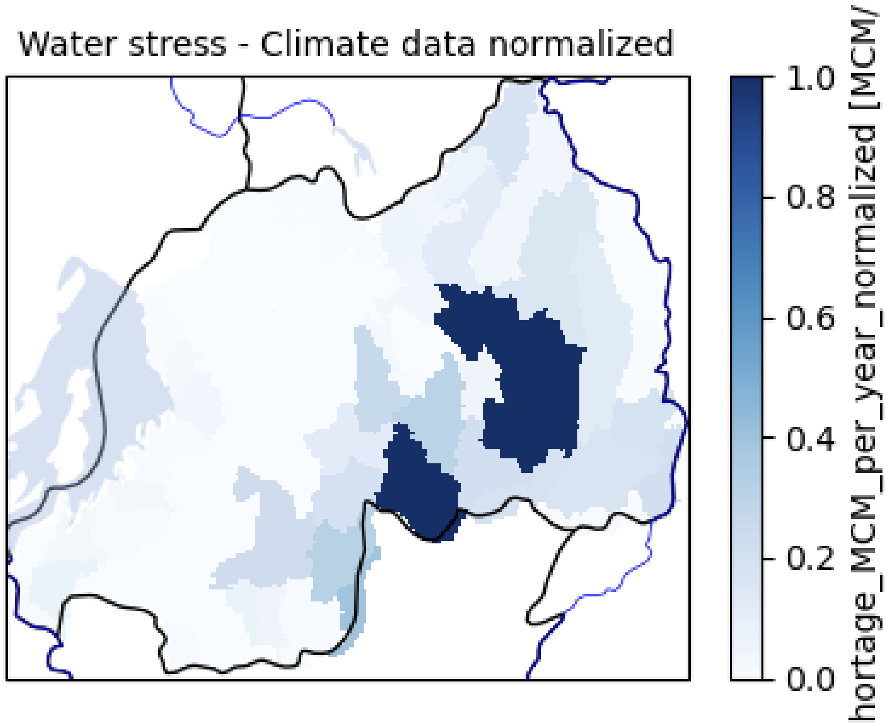
SSP3-7.0

SSP5-8.5

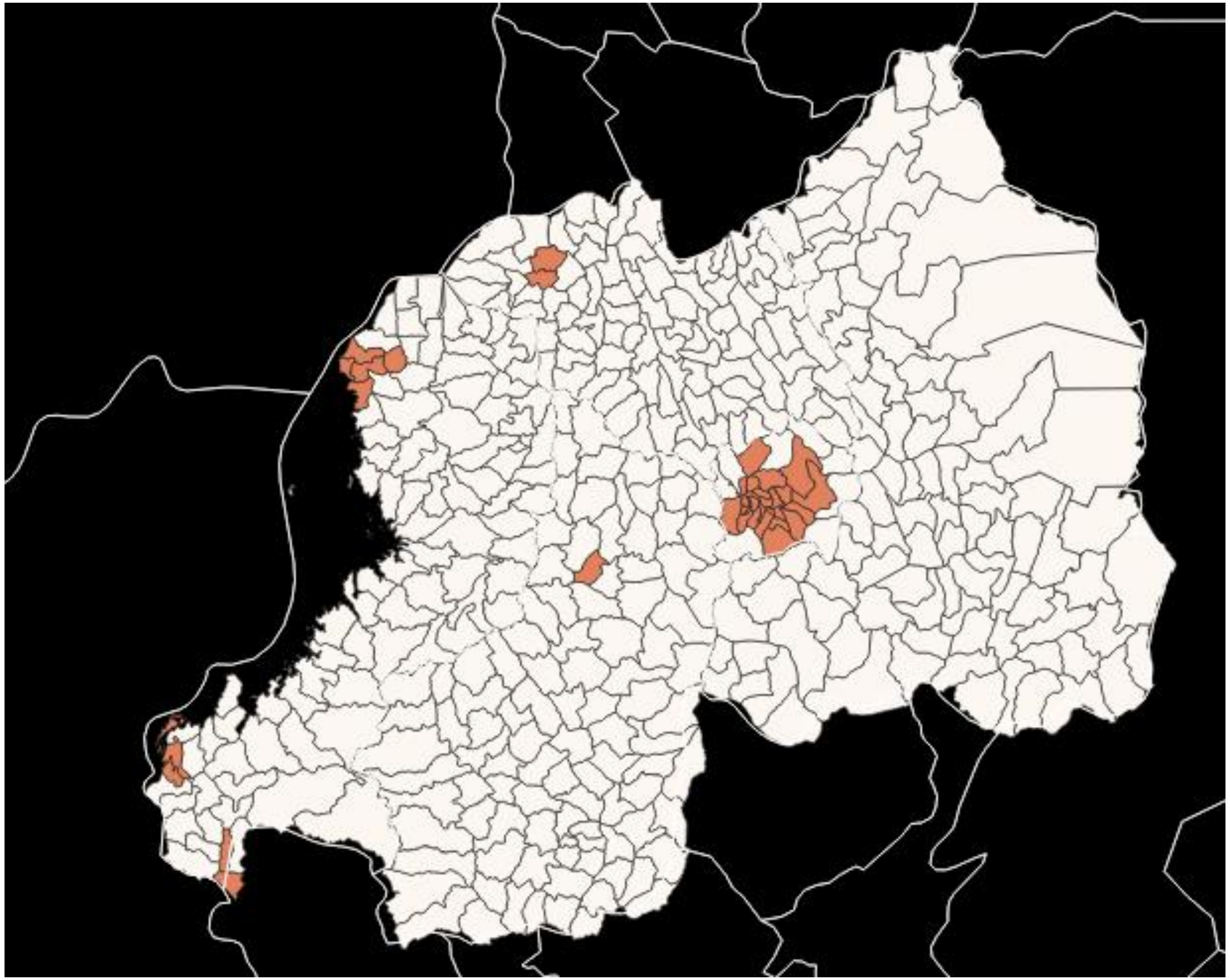


Details and tests | Water stress - Climate data: historical and 2050 water shortage





Details and tests | Aggravating factor: Urban heat island



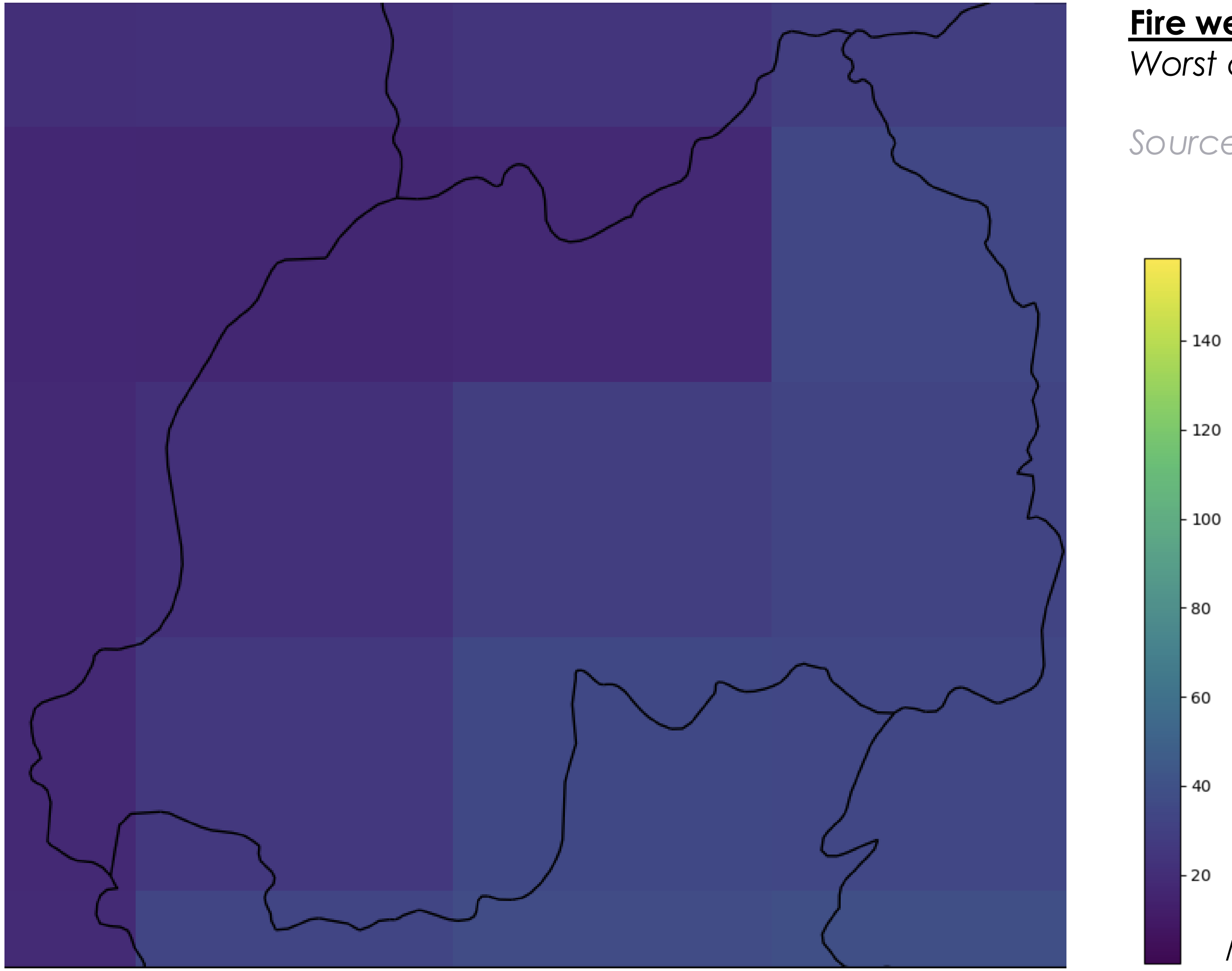
Sectors with high population density (2022)

Source: National Institute of Statistics of Rwanda (NISR)

≥ 1500 hab/km²

< 1500 hab/km²

Details and tests | Wildfire - Fire Weather Index (aggravating factor)



Fire weather index – historical value

Worst average monthly value (1981-2010)

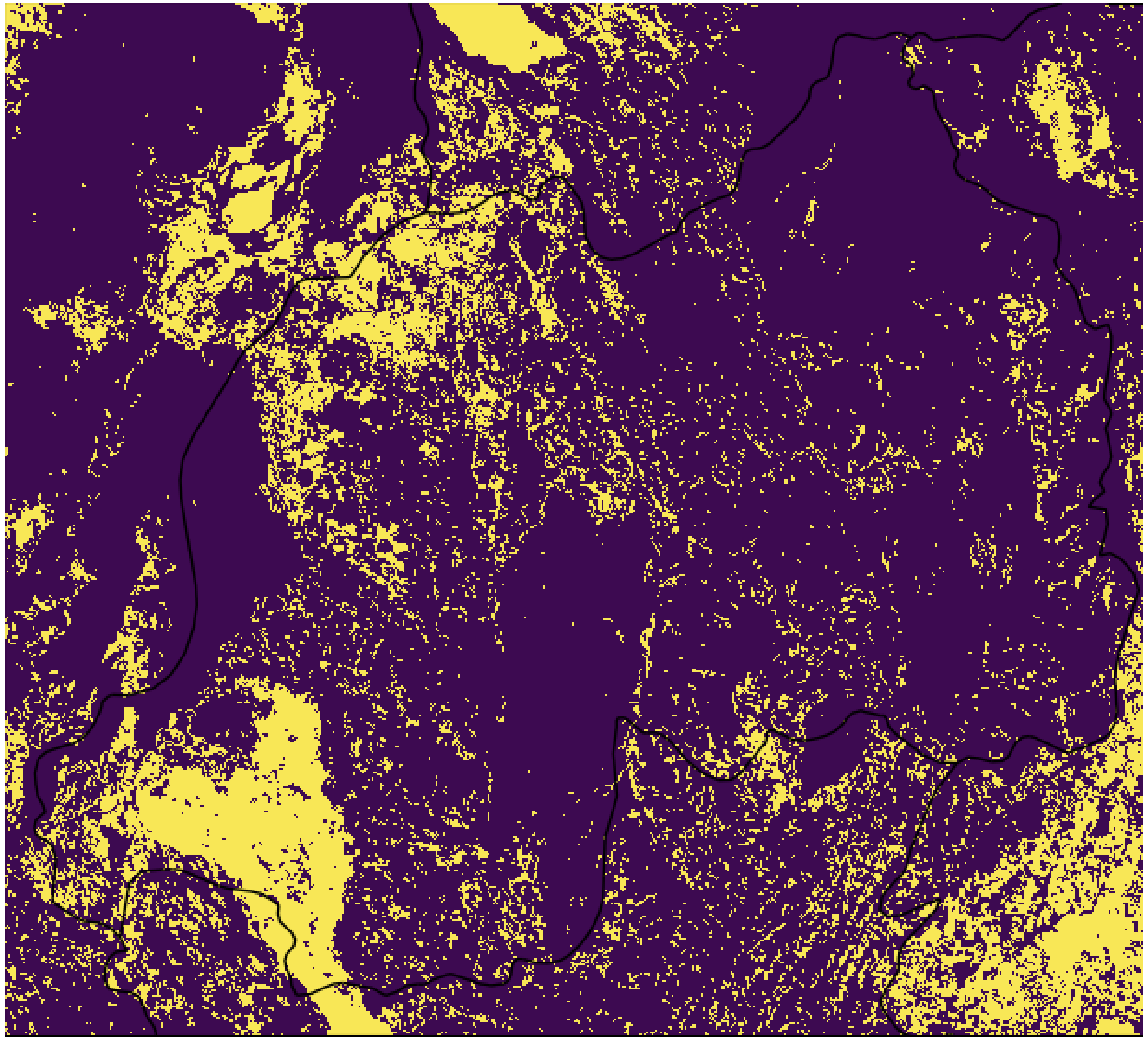
Source: MERRA2 Corrected

- Note:

  The aggravating factor will be set at zero for all Rwanda

Maximum monthly value for Fire Weather Index

Details and tests | Wildfire - Burnable vegetaion map (predisposing context)



Global Landcover map (2016-2020)

Source: Copernicus Climate Change Service (C3S)
Burnable vegetation defined as categories below:

50	Tree cover, broadleaved, evergreen, closed to open (>15%)
60	Tree cover, broadleaved, deciduous, closed (>15%)
70	Tree cover, needleleave, evergreen, closed (>15%)
80	Tree cover, needleleave, deciduous, closed (>15%)
90	Tree cover, mixed leaf (broadleaved and needleleaved)
100	Mosaic tree and shrub (>50%) / herbaceous cover (<50%)
110	Mosaic herbaceous cover (>50%) / tree and shrub (<50%)

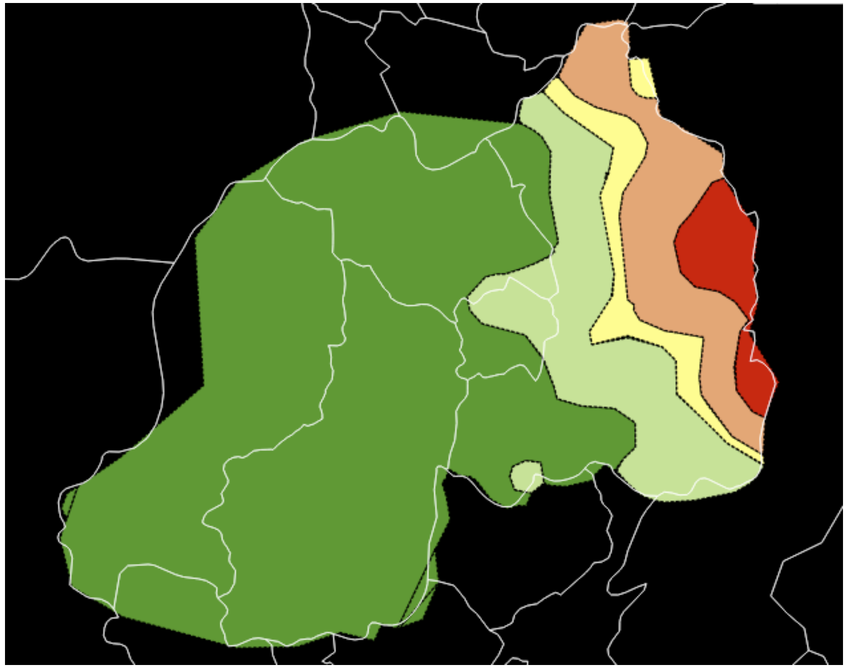
Presence of burnable vegetation

Absence of burnable vegetation

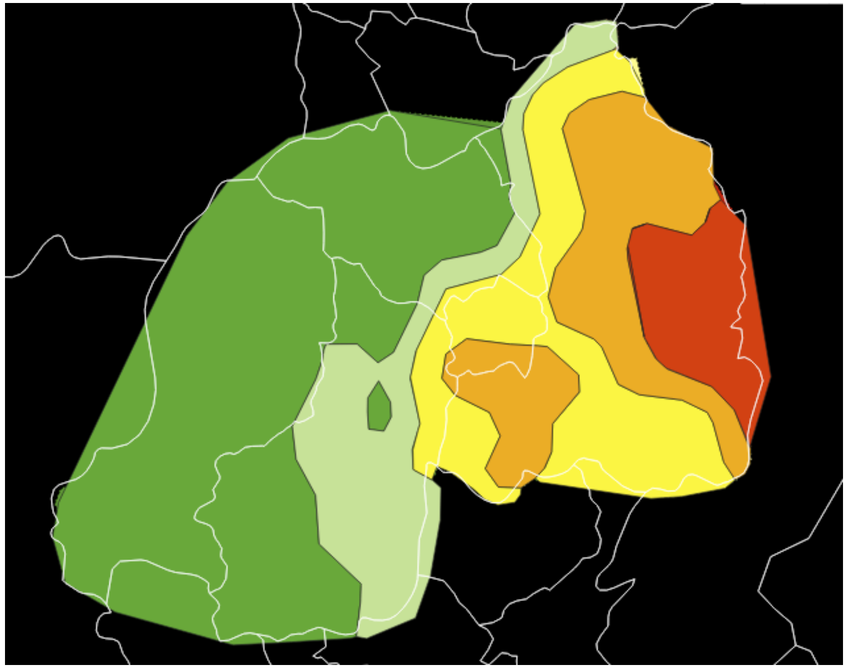
carbone4

Details and tests | Drought – Aggravating factor: Historical drought

Season A



Season B – Chosen as agggravating factor



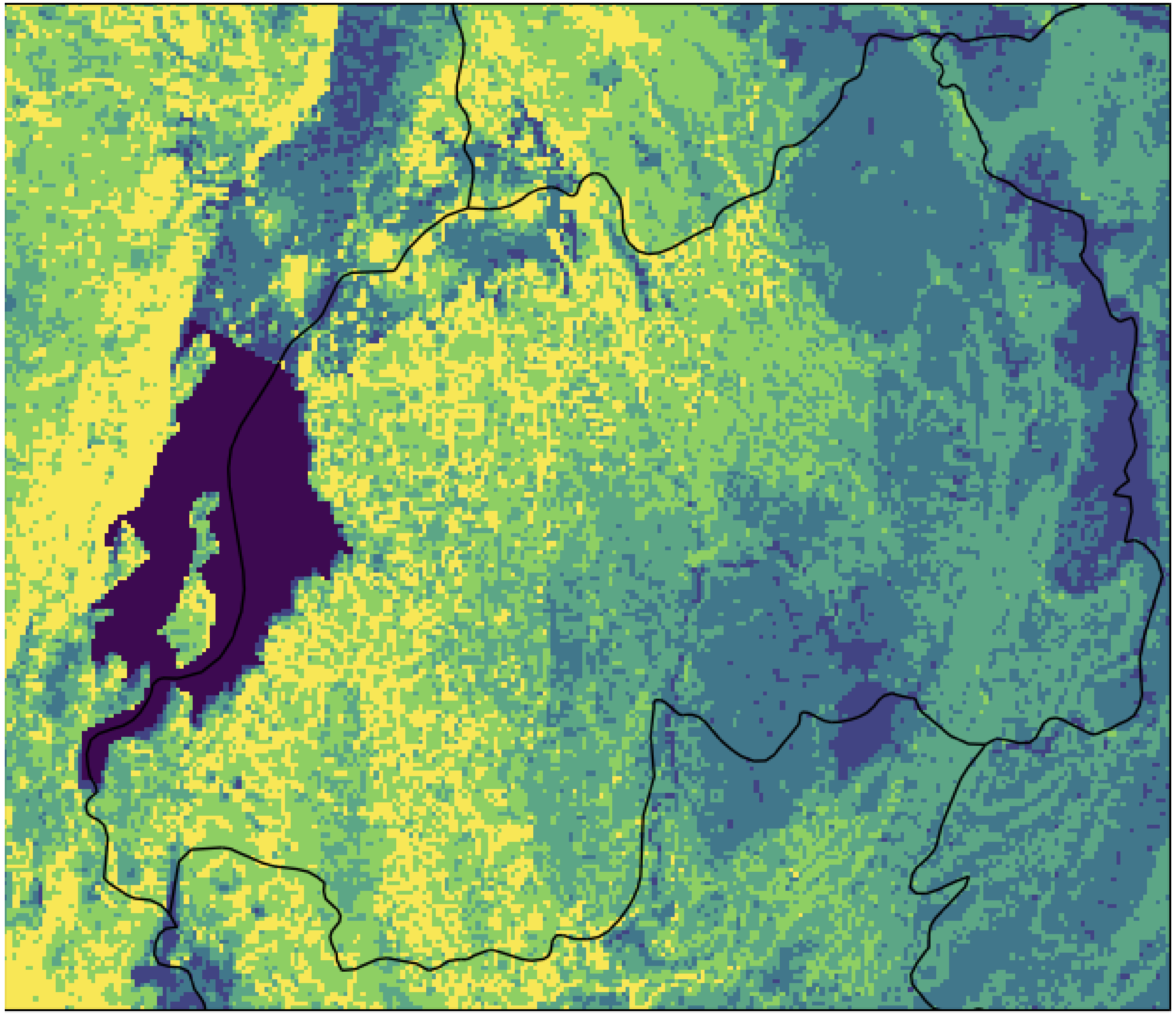
Historical drought

Source: National Risk Atlas of Rwanda– digitilized by Carbone4

Drought susceptibility

- Very high
- High
- Moderate
- Low
- Very low

Details and tests | Landslide – Aggravating factor: Satellite-Based Assessment of Rainfall-triggered Landslide Hazard



Global Landslide susceptibility

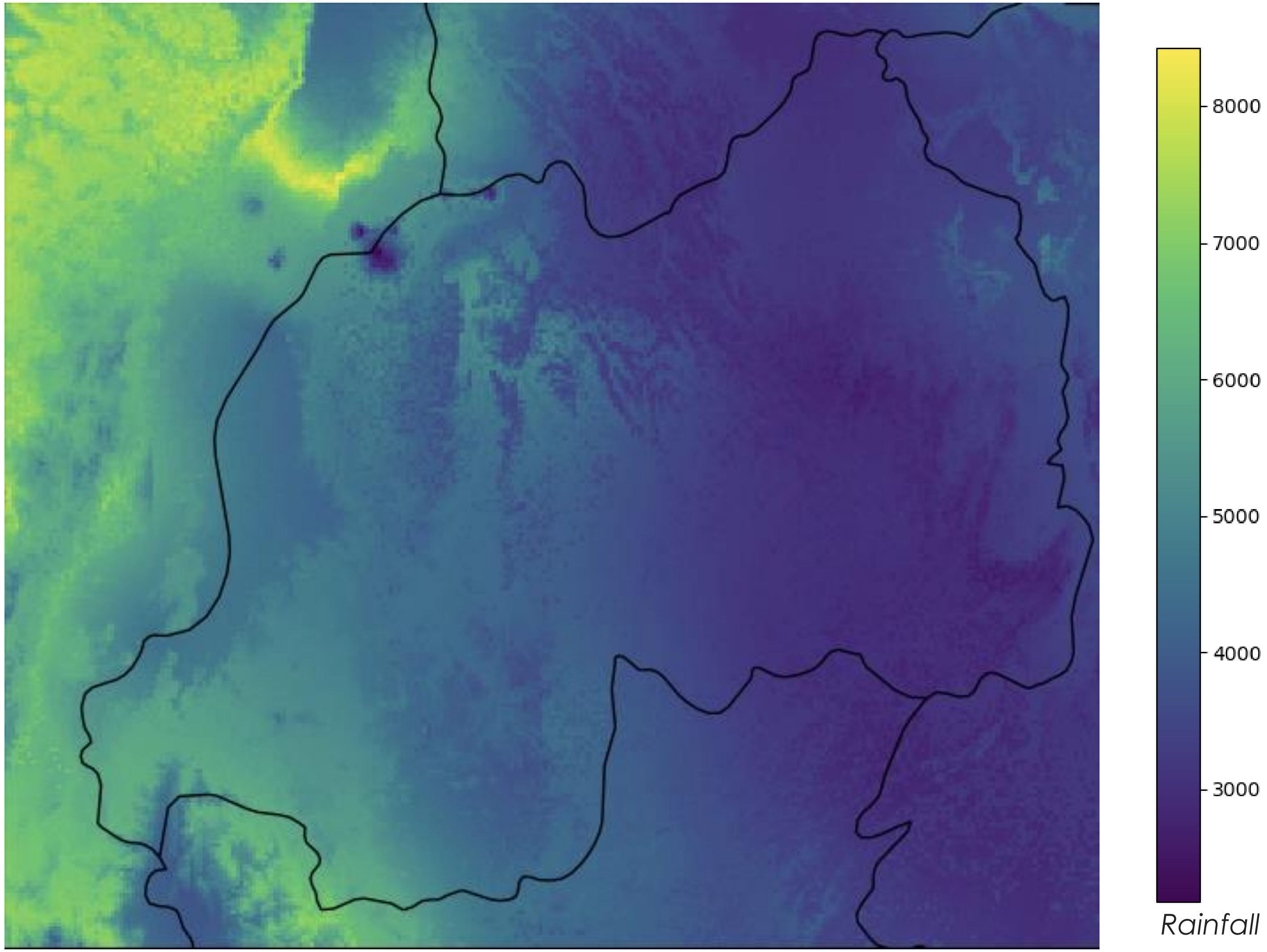
Source: Kirschbaum, D., & Stanley, T. (2018). Satellite-Based Assessment of Rainfall-Triggered Landslide Hazard for Situational Awareness. Earth's Future, 6, 505–523. https://doi.org/10.1002/ 2017EF000715

Landslide susceptibility

- Null
- Very Low
- Moderate
- High
- Very high

carbone4

Details and tests | Soil Erosion – Aggravating factor: Global Rainfall Erosivity

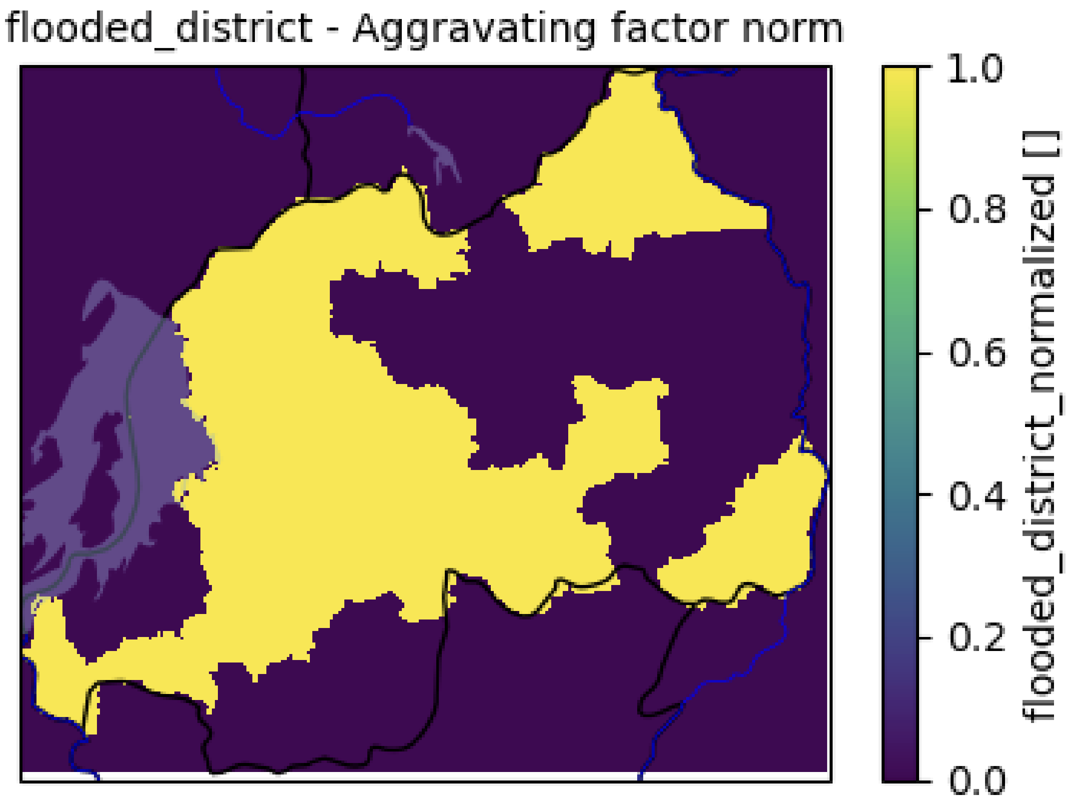


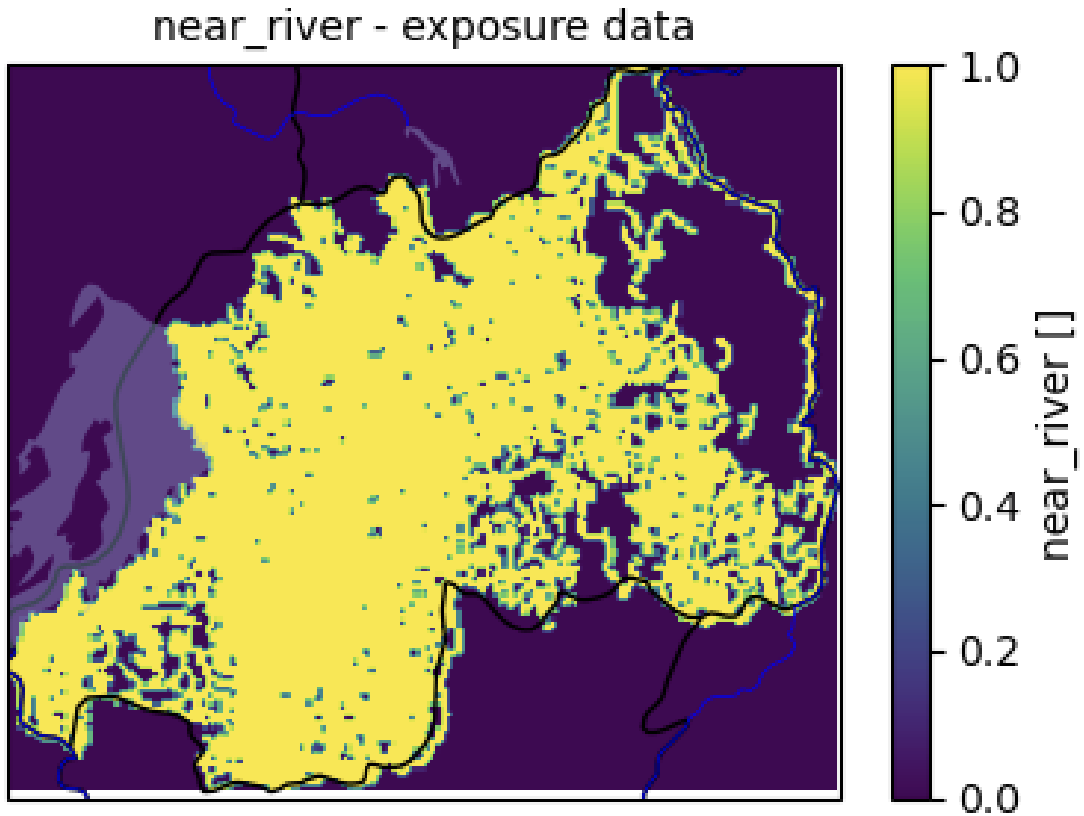
Rainfall erosivity (MJ mm hm^{-2} h^{-1} yr^{-1}) per rainfall unit (mm)

Global Rainfall Erosivity

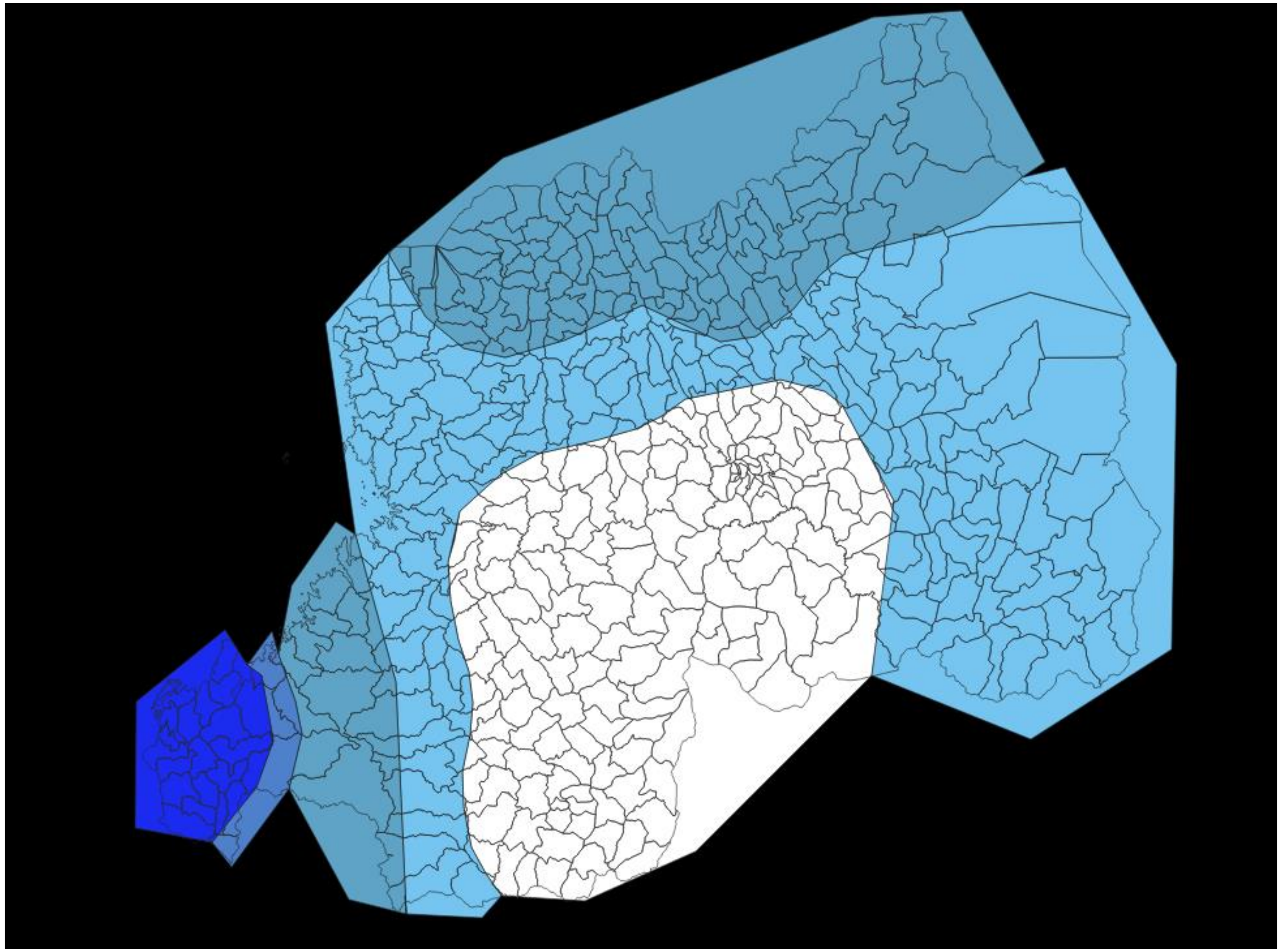
Source: Rainfall erosivity dataset (2017) is one of the input layers when calculating the Revised Universal Soil Loss Equation (RUSLE) model, which is the most frequently used model for soil erosion risk estimation; for the whole World; https://esdac.jrc.ec.europa.eu/content/global-rainfall-erosivity

Details and tests | Fluvial flood





Details and tests | Storms – climate data: historical strong winds

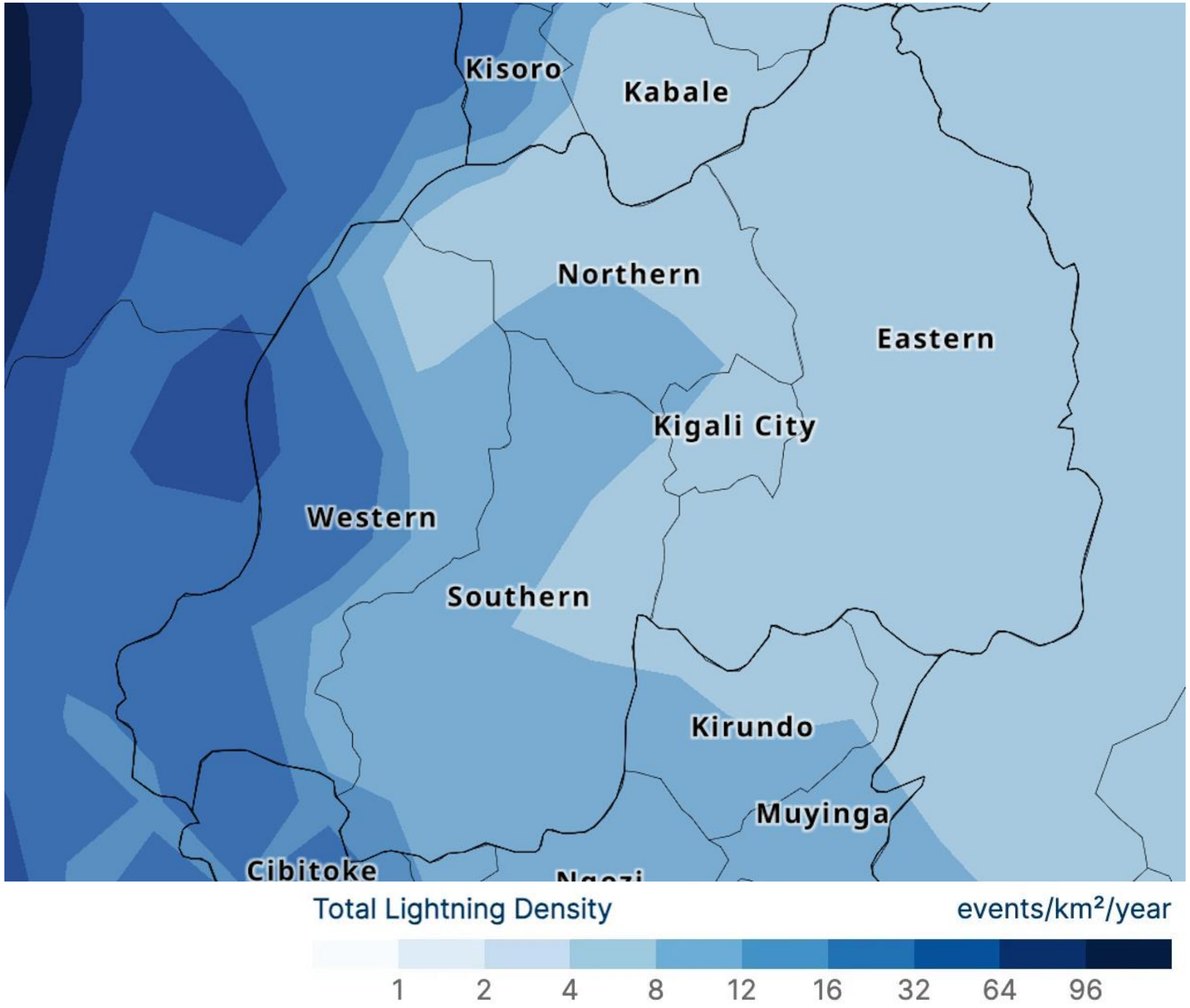


Strong wind hazard map of ten year return period

Source: National Risk Atlas of Rwanda – digitalized by Carbone4

- Strong Gale
- Gale
- Moderate Gale
- Strong Breeze
- Fresh breeze

Details and tests | Storm – Aggravating factor: ligthening



Lightening density (events/km2/year) 2016-2023

Source: Lightning data from 2016 to 2023 collected by Vaisala's NLDN and GLD360 detection networks, which monitor in-cloud and cloud-to-ground lightning 24/7 worldwide.

https://interactive-lightning-map.vaisala.com/

Table of content

Project Sensitivity Profile

- This section explores **sensitivity,** a component of the **project's vulnerability.**
- Sensitivity is subdivided into two main categories:
  - **operational sensitivity** assesses the potential impact of a hazard on the project's operation (e.g.: working conditions, equipment)
  - **structural sensitivity** concerns impacts on the project's buildings and infrastructure.
- **Operational and structural sensitivity scores,** along with their associated impacts,**have been discussed with BRD and defined for each project type and each hazard**, through matrices detailing specific consequences.

4 sectors and 22 types of project are included in the climate risk tool

Sector	Project type	Examples
Agriculture Finance	Rain fed crops	Any rain fed crop
	Irrigated crops	Any irrigated crop
	Livestock farming	Poultry and piggery farming
	Cash crop	Cash crop farming (mostly tea and coffee)
	Horticulture	Horticulture (i.e., Fruits, vegetables, and ornamental plants)
	Food processing	- Fruit and vegetable processing - Milling facilities (i.e., Cereal processing) - Dairy processing - Meat processing - Beverage processing (Excluding strong alcohol) - Financing coffee washing stations various activities
Building and Infrastructure	Real estate and hotels	- Affordable housing - Highend real estate - Hotels
	Health facilities	Health projects involving physical infrastructure (building hospitals, dispensaries, care homes etc.)
	Constructions of public buildings	'- Construction and renovation of schools - Construction and upgrading of modern trading markets - Warehousing facilities and bulk storage centers - Energy Dispatching and control room
	Waste and sanitation	- On-site sanitation project - Community sanitation network extension project - Solid waste management projects - Power generation through waste incineration - Finance for wastewater treatment capacity and potential reuse
	Water	- Drinking water production - Construction/extension of Drinking water networks and work to prevent leaks - Construction/extension of drinking water networks and work to prevent leaks - Integrated water resource management projects
	Transport infrastructures	- Rural tracks and market access - Surface line excluding aviation (road, rail, metro, tram etc.) - Unpaved road infrastructure projects

4 sectors and 22 types of project are included in the climate risk tool

Sector	Project type	Examples
Energy	Energy network infrastructure - overhead	- Overhead network
	Energy network infrastructure - underground	- Urban district heating network - Gas distribution projects - Underground network
	Energy generation - thermal	- Geothermal Power generation - Biomass Power plant - Power generation through waste incineration - Hydrocarbon reserves (e.g., Methane gas and fuel)
	Energy generation - renewable	- PV - Onshore wind electricity generation
	Energy generation - hydro power	- Run-of-river dam - Storage dam
	Off grid energy generation	- Rural off-grid electrification projects
Manufacturing and equipment	Manufacturing plants	- Pharmaceutical manufacturing plants - Construction of ICT gadgets assembly plants - Financing textile and garments - Packaging facilities - Automobile assembling
	Mining	- Financing mining operations (e.g., purchase of mining equipment, and working capital)
	Transport equipment	- Financing transport solutions (i.e., Public transport buses, cargo trucks, auto repairs workshops, aviation projects, Emobility, etc...)
	Equipment	- Clean cooking solutions (e.g., dissemination of improved cooking stoves)

Operational sensitivity is the first component of sensitivity.

- **Vulnerability**
  - **Sensitivity**
    How is the project affected by an occurrence of the hazard
    - **Operational sensitivity**
      Potential impacts of the hazard on the project's operation (working conditions, equipment)
    - **Structural sensitivity**
      Potential impacts of the hazard on the projects structure (buildings)
  - **Adaptability**
    What is already in place to face an occurrence of the hazard
    - **Project adaptability**
      Project's readiness to face climate hazards (assessed through user inputs)
    - **District adaptability**
      District's readiness to face climate hazards (assessed through ASSESSMENT OF CLIMATE CHANGE VULNERABILITY IN RWANDA - 2018)

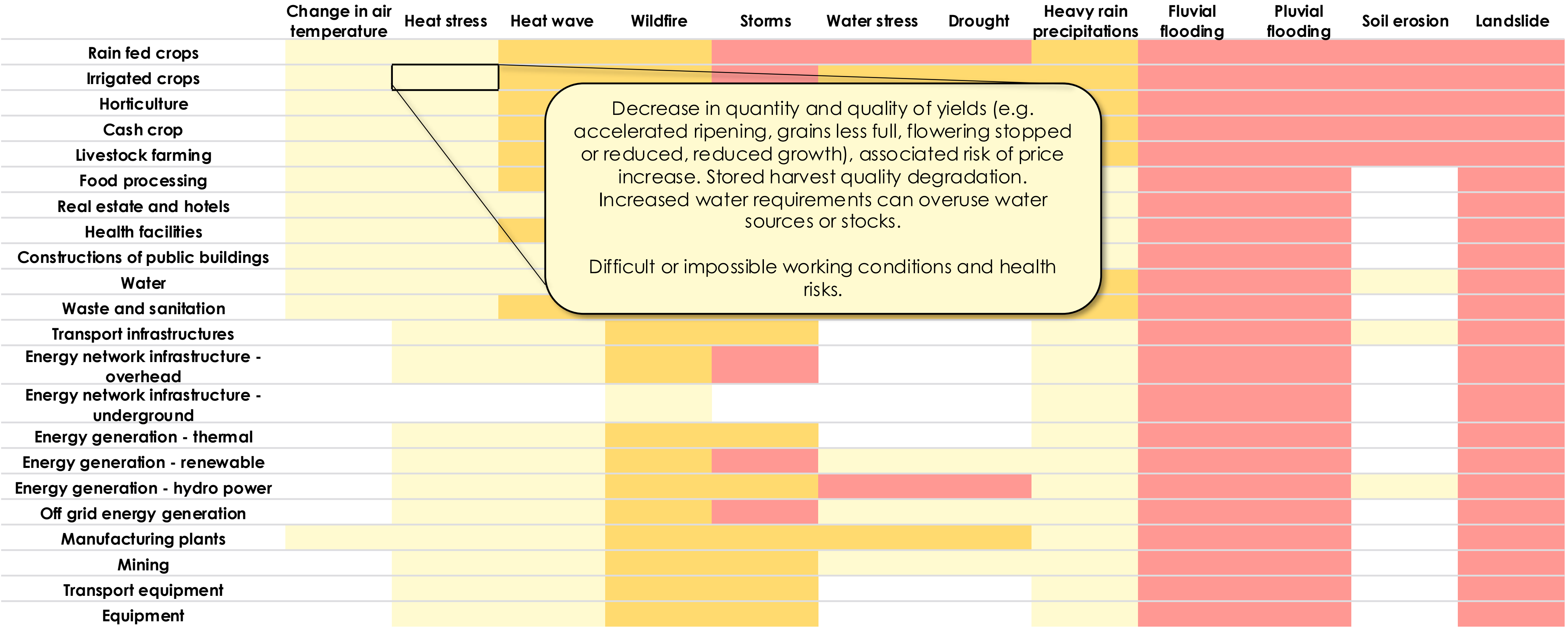
Operational and structural sensitivity are assessed through project matrixes detailing impacts of every kind of hazard on every kind of project and providing a score. District adaptability is already scored by the REMA study, and project adaptability based on user inputs.

Operational sensitivity scores and associated impacts were defined for every project type and every hazard

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms	Water stress	Drought	Heavy rain precipitations	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Rain fed crops	Low	Low	Medium	Medium	High	High	High	Medium	High	High	High	High
Irrigated crops	Low	Low	Medium	Medium	High	Medium	Medium	Medium	High	High	High	High
Horticulture	Low	Low	Medium	Medium	High	High	High	Medium	High	High	High	High
Cash crop	Low	Low	Medium	Medium	High	High	High	Medium	High	High	High	High
Livestock farming	Low	Low	Medium	Medium	High	High	High	Medium	High	High	High	High
Food processing	Low	Low	Medium	Medium	Medium	High	High	Low	High	High	NA	High
Real estate and hotels	Low	Low	Low	Medium	Medium	Low	Low	Low	High	High	NA	High
Health facilities	Low	Low	Medium	Medium	Medium	Low	Low	Low	High	High	NA	High
Constructions of public buildings	Low	Low	Low	Medium	Medium	Low	Low	Low	High	High	NA	High
Water	Low	Low	Low	Medium	Medium	High	High	Medium	High	High	Low	High
Waste and sanitation	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	High	High	NA	High
Transport infrastructures	NA	Low	Low	Medium	Medium	NA	NA	Low	High	High	Low	High
Energy network infrastructure - overhead	NA	Low	Low	Medium	High	NA	NA	Low	High	High	NA	High
Energy network infrastructure - underground	NA	NA	NA	Low	NA	NA	NA	Low	High	High	NA	High
Energy generation - thermal	NA	Low	Low	Medium	Medium	NA	NA	Low	High	High	NA	High
Energy generation - renewable	NA	Low	Low	Medium	High	Low	Low	Low	High	High	NA	High
Energy generation - hydro power	NA	Low	Low	Medium	Medium	High	High	Low	High	High	Low	High
Off grid energy generation	NA	Low	Low	Medium	High	Low	Low	Low	High	High	NA	High
Manufacturing plants	Low	Low	Low	Medium	Medium	Medium	Medium	Low	High	High	NA	High
Mining	NA	Low	Low	Medium	Medium	Low	Low	Low	High	High	NA	High
Transport equipment	NA	Low	Low	Medium	Medium	NA	NA	Low	High	High	NA	High
Equipment	NA	Low	Low	Medium	Medium	NA	NA	Low	High	High	NA	High

Operational sensitivity		
Not concerned	NA	-
Low	0,3	Activity impacted only slightly or for a short period
Medium	0,6	Activity is significantly impacted or for a substantial period
High	0,9	The activity is stopped

Operational sensitivity scores and associated impacts were defined for every project type and every hazard



Operational sensitivity		
Not concerned	NA	-
Low	0,3	Activity impacted only slightly or for a short period
Medium	0,6	Activity is significantly impacted or for a substantial period
High	0,9	The activity is stopped

carbone4

Operational impacts for every project type and every hazard (1/9)

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms (including thunderstorms)	Water stress	Drought	Heavy rain	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Rain fed crops	Evolution (decrease or increase depending on crops types) of yields, qualitiy and prices due to the rise in average annual air temperature. Gradual increase in water requirements. Crop adapted to Rwanda's current climate might not be adapted anymore and reversly.	Decrease in quantity and quality of yields (e.g. accelerated ripening, grains less full, flowering stopped or reduced, reduced growth), associated risk of price increase. Stored harvest quality degradation. Increased water requirements coupled to the lack of irragation can further reduce yields. Difficult or impossible working conditions and health risks.	Decrease in quantity and quality of yields (e.g. accelerated ripening, grains less full, flowering stopped or reduced, reduced growth), associated risk of price increase. Increased water requirements coupled to the lack of irragation can further reduce yields. Difficult or impossible working conditions and health risks.	Areas and crops destroyed and production interrupted. Potential total harvest loss. Working conditions durably degraded or compromised.	Areas and crops destroyed and production interrupted. Potential total harvest loss. Working conditions compromised.	Hydric stress of crops resulting in crop failure: problems with emergence, growth, yellowing, limited nitrogen uptake.	Hydric stress of crops resulting in crop failure: problems with emergence, growth, yellowing, limited nitrogen uptake.	Loss of yield and quality: damaged harvests, yellowing of emerged harvests. Working conditions compromised. Risk of dispersion of stock or agricultural inputs.	Outside areas flooded, temporarily unusable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality.	Outside areas flooded, temporarily unusable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality.	Productive soil washed away. Loss of nutrients and increased use of fertilisers (nitrogen, phosphate) Important yield decrease. Increased risk of flooding. Increased sensitivity for annual crops (soil being metimes completely bare).	Fields inaccessible and potentially uncultivable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff from soil contributing more sediment.
Irrigated crops	Evolution (decrease or increase depending on crops types) of yields, qualitiy and prices due to the rise in average annual air temperature. Gradual increase in water requirements. Crop adapted to Rwanda's current climate might not be adapted anymore and reversly.	Decrease in quantity and quality of yields (e.g. accelerated ripening, grains less full, flowering stopped or reduced, reduced growth), associated risk of price increase. Stored harvest quality degradation. Increased water requirements can overuse water sources or stocks. Difficult or impossible working conditions and health risks.	Decrease in quantity and quality of yields (e.g. accelerated ripening, grains less full, flowering stopped or reduced, reduced growth), associated risk of price increase. Increased water requirements can overuse water sources or stocks. Difficult or impossible working conditions and health risks.	Areas and crops destroyed and production interrupted. Potential total harvest loss. Working conditions durably degraded or compromised.	Areas and crops destroyed and production interrupted. Potential total harvest loss. Working conditions compromised.	Hydric stress of crops resulting in crop failure: problems with emergence, growth, yellowing, limited nitrogen uptake. The drying of wells or watercourses can cause disturbances requiring maintenance work. Risk of resource depletion. Greater need for treatment to ensure recovery.	Hydric stress of crops resulting in crop failure: problems with emergence, growth, yellowing, limited nitrogen uptake. The drying of wells or watercourses can cause disturbances requiring maintenance work. Risk of resource depletion. Greater need for treatment to ensure recovery.	Loss of yield and quality: damaged harvests, yellowing of emerged harvests. Working conditions compromised. Risk of dispersion of stock or agricultural inputs.	Outside areas flooded, temporarily unusable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality. The level of water treatment required may be affected by floods and high levels of turbidity. Channels will need to be dredged in the event of debris.	Outside areas flooded, temporarily unusable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality. The level of water treatment required may be affected by floods and high levels of turbidity. Channels will need to be dredged in the event of debris.	Productive soil washed away. Loss of nutrients and increased use of fertilisers (nitrogen, phosphate) Important yield decrease. Increased risk of flooding. Increased sensitivity for annual crops (soil being metimes completely bare).	Fields inaccessible and potentially uncultivable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality. The level of water treatment required may be affected by floods and high levels of turbidity. Channels will need to be dredged in the event of debris.

Operational impacts for every project type and every hazard (2/9)

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms (including thunderstorms)	Water stress	Drought	Heavy rain	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Horticulture	Evolution (decrease or increase depending on crops types) of yields, qualitiy and prices due to the rise in average annual air temperature. Gradual increase in water requirements. Crop adapted to Rwanda's current climate might not be adapted anymore and reversly.	Decrease in quantity and quality of yields (e.g. accelerated ripening, grains less full, flowering stopped or reduced, reduced growth), associated risk of price increase. Stored harvest quality degradation. Increased water requirements can overuse water sources or stocks. Difficult or impossible working conditions and health risks.	Decrease in quantity and quality of yields (e.g. accelerated ripening, grains less full, flowering stopped or reduced, reduced growth), associated risk of price increase. Increased water requirements can overuse water sources or stocks. Difficult or impossible working conditions and health risks.	Areas destroyed and production interrupted. Potential total harvest loss. Working conditions durably degraded or compromised.	Areas and crops destroyed and production interrupted. Potential total harvest loss. Working conditions compromised.	Hydric stress of crops resulting in crop failure: problems with emergence, growth, yellowing, limited nitrogen uptake. If irrigated, the drying of wells or watercourses can cause disturbances requiring maintenance work. Risk of resource depletion. Greater need for treatment to ensure recovery.	Hydric stress of crops resulting in crop failure: problems with emergence, growth, yellowing, limited nitrogen uptake. If irrigated, the drying of wells or watercourses can cause disturbances requiring maintenance work. Risk of resource depletion. Greater need for treatment to ensure recovery.	Loss of yield and quality: damaged harvests, yellowing of emerged harvests. Working conditions compromised. Risk of dispersion of stock or agricultural inputs.	Outside areas flooded, temporarily unusable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality. If irrigated, the level of water treatment required may be affected by floods and high levels of turbidity. Channels will need to be dredged in the event of debris.	Outside areas flooded, temporarily unusable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality. If irrigated, the level of water treatment required may be affected by floods and high levels of turbidity. Channels will need to be dredged in the event of debris.	Productive soil washed away. Loss of nutrients and increased use of fertilisers (nitrogen, phosphate) Important yield decrease. Increased risk of flooding. Increased sensitivity for annual crops (soil being metimes completely bare).	Fields inaccessible and potentially uncultivable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality. The level of water treatment required may be affected by floods and high levels of turbidity. Channels will need to be dredged in the event of debris.
Cash crop	Evolution (decrease or increase depending on crops types) of yields, qualitiy and prices due to the rise in average annual air temperature. Gradual increase in water requirements. Crop adapted to Rwanda's current climate might not be adapted anymore and reversly.	Decrease in quantity and quality of yields (e.g. accelerated ripening, grains less full, flowering stopped or reduced, reduced growth), associated risk of price increase. Stored harvest quality degradation. Increased water requirements can overuse water sources or stocks. Difficult or impossible working conditions and health risks.	Decrease in quantity and quality of yields (e.g. accelerated ripening, grains less full, flowering stopped or reduced, reduced growth), associated risk of price increase. Difficult working conditions and health risks. Increased water requirements can overuse water sources or stocks. Difficult or impossible working conditions and health risks.	Areas destroyed and production interrupted. Potential total harvest loss. Working conditions durably degraded or compromised.	Areas and crops destroyed and production interrupted. Potential total harvest loss. Working conditions compromised.	Hydric stress of crops resulting in crop failure: problems with emergence, growth, yellowing, limited nitrogen uptake.	Hydric stress of crops resulting in crop failure: problems with emergence, growth, yellowing, limited nitrogen uptake. If irrigated, the drying of wells or watercourses can cause disturbances requiring maintenance work. Risk of resource depletion. Greater need for treatment to ensure recovery.	Loss of yield and quality: damaged harvests, yellowing of emerged harvests. Working conditions compromised. Risk of dispersion of stock or agricultural inputs.	Outside areas flooded, temporarily unusable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality. If irrigated, the level of water treatment required may be affected by floods and high levels of turbidity. Channels will need to be dredged in the event of debris.	Outside areas flooded, temporarily unusable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality. If irrigated, the level of water treatment required may be affected by floods and high levels of turbidity. Channels will need to be dredged in the event of debris.	Productive soil washed away. Important yield decrease. Increased risk of flooding.	Fields inaccessible and potentially uncultivable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality. The level of water treatment required may be affected by floods and high levels of turbidity. Channels will need to be dredged in the event of debris.

Operational impacts for every project type and every hazard (3/9)

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms (including thunderstorms)	Water stress	Drought	Heavy rain	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Livestock farming	Gradual increase in water requirements, reduction in livestock yields, reduction in the average comfort level of animals.	Discomfort or even suffering of animals, dehydration. Reduced fertility. Fresh feed quality degradation. Decrease in productivity. Increased water requirements can overuse water sources or stocks. Difficult or impossible working conditions and health risks.	Discomfort or even suffering of animals, dehydration. Reduced fertility. Fresh feed quality degradation. Decrease in productivity. Increased water requirements can overuse water sources or stocks. Difficult or impossible working conditions and health risks.	Areas destroyed and production interrupted. Animals asphyxiated, livestock dispersed or wiped out. Working conditions durably degraded or compromised.	Areas destroyed and production interrupted. Injured, stressed livestock. Working conditions compromised	Reduction in water availability, animal suffering. Decrease in quality and quantity of production. Yield reduction for fodder.	Reduction in water availability, animal suffering. Decrease in quality and quantity of production. Yield reduction for fodder.	Deterioration in living conditions for animals, flooding of buildings, less fresh feed. Working conditions compromised. Risk of dispersion of stock or agricultural inputs.	Outside areas flooded, temporarily unusable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality. If irrigated, the level of water treatment required may be affected by floods and high levels of turbidity. Channels will need to be dredged in the event of debris.	Outside areas flooded, temporarily unusable. Loss of harvest, disrupted sowing and/or harvesting. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality. If irrigated, the level of water treatment required may be affected by floods and high levels of turbidity. Channels will need to be dredged in the event of debris.	Productive soil washed away. Important yield decrease. Increased risk of flooding.	Fields inaccessible and potentially uncultivable. Animals killed, injured or stressed. Working conditions compromised. Risk of dispersion of stock or agricultural inputs. Runoff of surface soil, downgrading soil quality. The level of water treatment required may be affected by floods and high levels of turbidity. Channels will need to be dredged in the event of debris.
Food processing	Gradual increase in cooling and air conditioning requirements for fresh food conservation. Risk of degradation of stored fresh products.	Increased air-conditioning requirements, risk of cold chain breakdown and degradation or loss of stock and products. Increased energy consumption to maintain adequate storage conditions. Overheating and discomfort for indoor workers.	Increased air-conditioning requirements, risk of cold chain breakdown and degradation or loss of stock and products. Increased energy consumption to maintain adequate storage conditions. Overheating and discomfort for indoor workers.	Risk of partial to total destruction. Production and working conditions permanently disrupted in the event of destruction of buildings. Risk of power outage.	Risk of large-scale, long-lasting dispersal of products stored outside into the environment. Potential impossibility of indoor production for safety reasons (risk of tearing, breakage). Potential damage to equipment, especially outdoor.	Reduction in water availability. Potentiel interruption of water demanding processes and consequently of all production.	Reduction in water availability. Potentiel interruption of water demanding processes and consequently of all production.	Runoff on company site, flooding due to undersized drainage systems. Risk of stock damage and water infiltration.	Risk of damage to buildings, loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.	Risk of loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.		Risk of loss of stock. Production and working conditions permanently disrupted in the event of destruction of buildings. Risk of power outage.

Operational impacts for every project type and every hazard (4/9)

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms (including thunderstorms)	Water stress	Drought	Heavy rain	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Real estate and hotels	Gradual increase in air conditioning requirements.	Overheating, deformation, damage to materials. Overheating and discomfort for inhabitants and workers, increased air-conditioning requirements and risk of cooling systems breakdowns.	Overheating, deformation, damage to materials. Overheating and discomfort for inhabitants and workers, increased air-conditioning requirements and risk of cooling systems breakdowns.	Risk of partial to total destruction. Living and working conditions permanently disrupted in the event of destruction of buildings. Risk of power outage.	Hostile outdoor environment. Deteriorated or even disrupted working conditions if the site is destroyed or damaged. Risk of power outage.	Reduction in water availability.	Reduction in water availability.	Runoff on site, flooding due to undersized drainage systems. Risk of stock damage and water infiltration.	Risk of damage to buildings, loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.	Risk of loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.		Mudslides destructing or rendering buildings inaccessible and damaging exteriors. Risk of power outage.
Health facilities	Gradual increase in air conditioning requirements.	Overheating, deformation, damage to materials. Overheating and discomfort for patients and workers, increased air-conditioning requirements and risk of cooling systems breakdowns. Risk of increased disease spreading and danger to health.	Overheating, deformation, damage to materials. Overheating and discomfort for patients and workers, increased air-conditioning requirements and risk of cooling systems breakdowns. Risk of increased disease spreading and danger to health.	Risk of partial to total destruction. Production and working conditions permanently disrupted in the event of destruction of buildings. Risk of power outage.	Hostile outdoor environment. Deteriorated or even disrupted working conditions if the site is destroyed or damaged. Risk of power outage.	Reduction in water availability.	Reduction in water availability.	Runoff on site, flooding due to undersized drainage systems. Risk of stock damage and water infiltration.	Risk of damage to buildings, loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.	Risk of loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.		Mudslides destructing or rendering buildings inaccessible and damaging exteriors. Risk of power outage.
Constructions of public buildings	Gradual increase in air conditioning requirements.	Overheating, deformation, damage to materials. Overheating and discomfort for workers.	Overheating, deformation, damage to materials. Overheating and discomfort for workers.	Risk of partial to total destruction. Production and working conditions permanently disrupted in the event of destruction of buildings or works. Risk of power outage.	Hostile outdoor environment. Risk of destruction and dispersion of stocks and works. Working conditions compromised , interruption of works. Risk of power outage.	Reduction in water availability.	Reduction in water availability.	Runoff on site, flooding due to undersized drainage systems. Risk of stock damage and water infiltration. Working conditions compromised , interruption of works.	Risk of damage to buildings, loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.	Risk of loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.		Mudslides destructing or rendering buildings inaccessible and damaging exteriors.

Operational impacts for every project type and every hazard (5/9)

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms (including thunderstorms)	Water stress	Drought	Heavy rain	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Water	Gradual decrease of water quality (drop in oxygen concentration, increase in eutrophication, development of cyanobacteria) and quantity (increase in evaporation, decrease in water availability (all else being equal), increase in consumption, increase in prices	Decrease of water quality (drop in oxygen concentration, increase in temperature, eutrophication, development of cyanobacteria) and quantity (increase in evaporation, decrease in water availability (all else being equal), increase in consumption, increase in prices) Deterioration of structures, envelopes and plumbing networks, leading to leaks - Increased water requirements and use, higher water prices, risk of power cuts to collection pumps.	Decrease of water quality (drop in oxygen concentration, increase in temperature, eutrophication, development of cyanobacteria) and quantity (increase in evaporation, decrease in water availability (all else being equal), increase in consumption, increase in prices) Deterioration of structures, envelopes and plumbing networks, leading to leaks - Increased water requirements and use, higher water prices, risk of power cuts to collection pumps.	Risk of total destruction of equipment. Risk of contamination of network water by ashes or particles from large-scale forest fires.	Potential damage to equipment.	Higher treatment requirements to meet concentration limits. Reduction in quantity of water available, restrictions on use, possible disruption of service.	Higher treatment requirements to meet concentration limits. Reduction in quantity of water available, restrictions on use, possible disruption of service.	Increase in water tubidity, decrease in water quality. Risk of operational failure (breakdown), obstruction of water supplies (overloaded). Risk of water contamination.	Increase in water tubidity, decrease in water quality. Risk of network saturation and flooding. Risk of power failure on pumping installations, leading to temporary shutdown of pumping/purification stations. Risk of operational breakdown and permanent disuse. Increased treatment requirements, risk of contamination.	Increase in water tubidity, decrease in water quality. Risk of network saturation and flooding. Risk of power failure on pumping installations, leading to temporary shutdown of pumping/purification stations. Risk of operational breakdown and permanent disuse. Increased treatment requirements, risk of contamination.	Increase in turbity, decrease in water quality.	Increase in water tubidity, decrease in water quality. Risk of operational breakdown and permanent disuse. Risk of power failure on pumping installations, leading to temporary shutdown of pumping/purification stations. Increased treatment requirements, risk of contamination.
Waste and sanitation	Gradual increase in evaporation of certain wastes. Gradual increase in air conditioning requirements. Gradual increase in water requirements, equipment sizing to be reviewed. Gradual decrease of water quality (drop in oxygen concentration, increase in eutrophication, development of cyanobacteria) and quantity (increase in evaporation, decrease in water availability (all else being equal), increase in consumption, increase in prices	Risk of change in state of waste, increased risk of evaporation, explosion, fire. Higher energy consumption for cooling buildings Decrease of water quality (drop in oxygen concentration, increase in temperature, eutrophication, development of cyanobacteria) and quantity (increase in evaporation, decrease in water availability (all else being equal), increase in consumption, increase in prices. Deterioration of structures, envelopes and plumbing networks, leading to leaks. Increased water requirements and use, higher water prices, risk of power cuts to collection pumps.	Risk of change in state of waste, increased risk of evaporation, explosion, fire. Higher energy consumption for cooling buildings Decrease of water quality (drop in oxygen concentration, increase in temperature, eutrophication, development of cyanobacteria) and quantity (increase in evaporation, decrease in water availability (all else being equal), increase in consumption, increase in prices. Deterioration of structures, envelopes and plumbing networks, leading to leaks - Increased water requirements and use, higher water prices, risk of power cuts to collection pumps.	Risk of widespread and lasting dispersion of waste in the environment (toxic fumes, breach of containment). Risk of explosion. Risk of total destruction of equipment.	Risk of widespread and lasting dispersion of waste in the environment (toxic fumes, breach of containment). Risk of damage to equipment.	Higher treatment requirements to meet concentration limits. Reduction in quantity of water available, restrictions on use, possible disruption of service.	Higher treatment requirements to meet concentration limits. Reduction in quantity of water available, restrictions on use, possible disruption of service.	Risk of containment failure and waste dispersal into the environment. Risk of water infiltration, operational failure (breakdown), obstruction of water supplies (overloaded).	Risk of widespread and long-lasting dispersion in the environment. Increased drainage requirements, risk of flooding and increased humidity. Risk of water infiltration and operational breakdown. Increased treatment requirements, risk of contamination. Risk of power failure leading to temporary shutdown of pumping/purification stations.	Risk of widespread and long-lasting dispersion in the environment. Increased drainage requirements, risk of flooding and increased humidity. Risk of water infiltration and operational breakdown. Increased treatment requirements, risk of contamination. Risk of power failure leading to temporary shutdown of pumping/purification stations.		Risk of widespread and long-lasting dispersion in the environment. Risk of operational breakdown and permanent disuse. Risk of power failure leading to temporary shutdown of purification stations. Increased treatment requirements, risk of contamination.

Operational impacts for every project type and every hazard (6/9)

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms (including thunderstorms)	Water stress	Drought	Heavy rain	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Transport infrastructures		Road: Overheating of roads (softening of asphalt). Increased road maintenance. Rail: buckling effect (bowing of rails under thermal constraint). Aviation: Softening asphalt and less dense air, making take-offs more difficult. Slower activity. Longer take-off distances, loss of carrying capacity. Aircraft unable to operate when temperatures exceed certification levels.	Road: Overheating of roads (softening of asphalt). Increased road maintenance. Rail: buckling effect (bowing of rails under thermal constraint). Aviation: Softening asphalt and less dense air, making take-offs more difficult. Slower activity. Longer take-off distances, loss of carrying capacity. Aircraft unable to operate when temperatures exceed certification levels.	Risk of infratructures being rendered unusable and traffic being permanently interrupted.	Risk of infratructures being rendered unusable and traffic being degraded and dangerous.			Risk of infratructures being rendered unusable and traffic being degraded and dangerous.	Risk of infrastructures being damaged and rendered unusable and lasting interruption to traffic. Air traffic disrupted or interrupted.	Risk of infrastructures being damaged and rendered unusable and lasting interruption to traffic. Air traffic disrupted or interrupted.	Gradual degradation of roads (especially unpaved).	Slope or embankment failure, risk of infrastructures being destroyed and rendered unusable.
Energy network infrastructure - overhead		Risk of load shedding or unintentional interruption of service: cable sagging, impact on measuring equipment, circuit breakers tripped, reduction in the amount of current allowed on the line.	Risk of load shedding or unintentional interruption of service: cable sagging, impact on measuring equipment, circuit breakers tripped, reduction in the amount of current allowed on the line.	Risk of destruction of wooden pylons, damage or destruction of metal pylons. Cable sagging in hot weather may bring cables closer to fires or accelerate forest fires.	Risk of failure of a portion of the network (cable breaks, falling pylons).			Risk of failure of a portion of the network (cable breaks, falling pylons).	Risk of failure of a portion of the network (cable breaks, falling pylons).	Risk of failure of a portion of the network (cable breaks, falling pylons).		Risk of failure of a portion of the network (cable breaks, falling pylons).
Energy network infrastructure - underground				Cables and enclosures damaged, risk of containment rupture leading to leakage.				Damage to the pipeline and corrosion may occur. Potential damage to network electrical equipment (compressors), possible interruption of service if damage also affects backup generation systems.	Potential rise of buried structures. Damage to the pipeline and corrosion may occur. Potential damage to network electrical equipment (compressors), possible interruption of service if damage also affects backup generation systems.	Potential rise of buried structures. Damage to the pipeline and corrosion may occur. Potential damage to network electrical equipment (compressors), possible interruption of service if damage also affects backup generation systems.		Potential rise of buried structures. Damage or destruction of the infrastructure.

Operational impacts for every project type and every hazard (7/9)

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms (including thunderstorms)	Water stress	Drought	Heavy rain	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Energy generation - thermal		Reduced efficiency of thermal power plants, reduced cooling capacity.	Reduced efficiency of thermal power plants, reduced cooling capacity.	Risk of containment failure leading to leakage.	Potential leaks of stored liquid or solid energy source.			Potential damage to equipment. Potential leaks of stored liquid or solid energy source.	Potential rise of buried structures. Potential damage to equipment. Potential leaks of stored liquid or solid energy source.	Potential rise of buried structures. Potential damage to equipment. Potential leaks of stored liquid or solid energy source.		Potential rise of buried structures. Potential damage to equipment. Potential leaks of stored liquid or solid energy source.
Energy generation - renewable		Risk of load shedding or unintentional interruption of service: cable sagging, impact on measuring equipment, circuit breakers tripped, reduction in the amount of current allowed on the line.	Risk of load shedding or unintentional interruption of service: cable sagging, impact on measuring equipment, circuit breakers tripped, reduction in the amount of current allowed on the line.	Risk of destruction of wooden pylons, damage or destruction of metal pylons. Cable sagging in hot weather may bring cables closer to fires or accelerate forest fires.	Risk of damage to high infrastructure (wind turbines) and fall of branches/objects on ground infrastructure (solar panels). Risk of failure of a portion of the network (cable breaks, falling pylons).	Unability to clean solar panels, leading to production reduction.	Unability to clean solar panels, leading to production reduction.	Potential damage to equipment especially electric equipment.	Potential rise of buried structures. Potential damage to equipment especially electric equipment.	Potential rise of buried structures. Potential damage to equipment especially electric equipment.		Potential rise of buried structures. Damage or destruction of the infrastructure.
Energy generation - hydro power		Decrease in water quantity (increase in evaporation, decrease in water availability (all else being equal), increase in consumption, increase in prices). Risk of load shedding or unintentional interruption of service: cable sagging, impact on measuring equipment, circuit breakers tripped, reduction in the amount of current allowed on the line.	Decrease in water quantity (increase in evaporation, decrease in water availability (all else being equal), increase in consumption, increase in prices. Risk of load shedding or unintentional interruption of service: cable sagging, impact on measuring equipment, circuit breakers tripped, reduction in the amount of current allowed on the line.	Risk of destruction of wooden pylons, damage or destruction of metal pylons. Cable sagging in hot weather may bring cables closer to fires or accelerate forest fires.	Risk of failure of a portion of the network (cable breaks, falling pylons).	Decrease of water supply. Reduction of energy production.	Decrease of water supply. Reduction of energy production.	Risk of overloading leading to damage of the infrastructure. Rising need for drainage system maintenance.	Risk of overloading leading to damage of the infrastructure. Rising need for drainage system maintenance.	Risk of overloading leading to damage of the infrastructure. Rising need for drainage system maintenance.	Soil erosion may affect hydropower generation through sediments that may affect turbines.	Potential rise of buried structures. Damage or destruction of the infrastructure.

Operational impacts for every project type and every hazard (8/9)

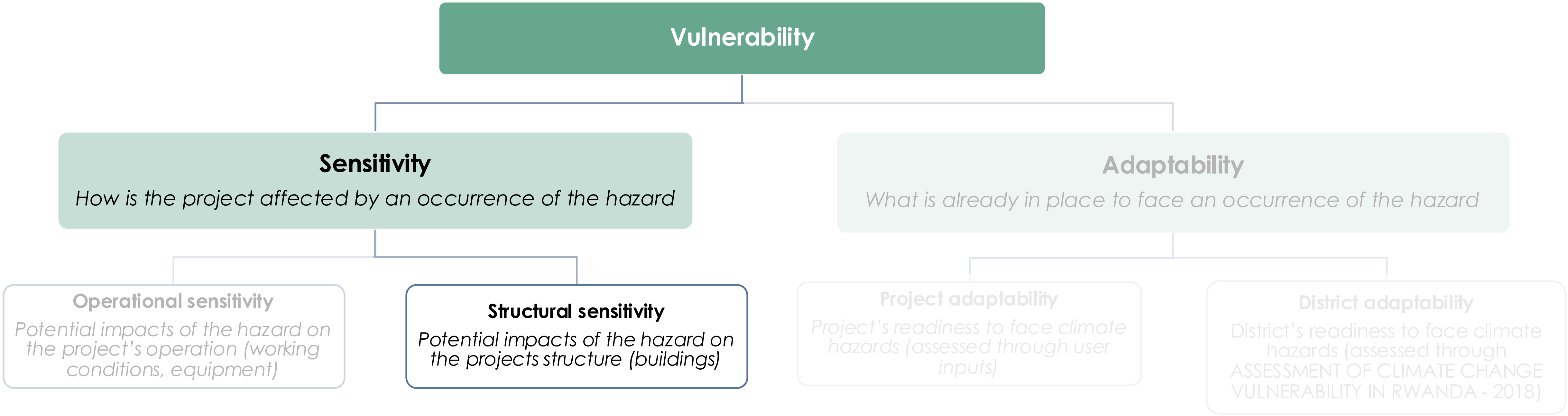
	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms (including thunderstorms)	Water stress	Drought	Heavy rain	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Off grid energy generation		Failure of solar panels (heat-sensitive inverters), temporary interruption of electricity production. Risk of failure of electrical equipment, temporary interruption of supply. Increased need for cooling, which could limit production (particularly if thermal generation is used).	Failure of solar panels (heat-sensitive inverters), temporary interruption of electricity production. Risk of failure of electrical equipment, temporary interruption of supply. Increased need for cooling, which could limit production (particularly if thermal generation is used).	Risk of destruction of equipment. Cables and enclosures damaged, risk of containment rupture leading to leakage. Risk of electricity transmission failure between production and consumption.	Risk of damage and failure. Reduction of production for solar panels (dust, dirt on the panel). Risk of electricity transmission failure between production and consumption.	Unability to clean solar panels, leading to production reduction.	Unability to clean solar panels, leading to production reduction.	Risk of damage and failure. Risk of electricity transmission failure between production and consumption.	Risk of damage and failure. Risk of electricity transmission failure between production and consumption.	Risk of damage and failure. Risk of electricity transmission failure between production and consumption.		Risk of damage and failure. Risk of electricity transmission failure between production and consumption.
Manufacturing plants	Gradual increase in air conditioning requirements for processes with a controlled atmosphere.	Increased energy consumption for building cooling. Non-compliance with thermal production conditions (standards). Significant heat inside buildings (employee discomfort, impact on quality of work) and outside, possible impossible working conditions leading to production interruption. Risk of overheating or breakdown of machines requiring cooling. Risk of supply disruption.	Increased energy consumption for building cooling. Non-compliance with thermal production conditions (standards). Significant heat inside buildings (employee discomfort, impact on quality of work) and outside, possible impossible working conditions leading to production interruption. Risk of overheating or breakdown of machines requiring cooling. Risk of supply disruption.	Risk of partial to total destruction. Production and working conditions permanently disrupted in the event of destruction of buildings. Risk of power outage.	Indoor production potentially impossible for safety reasons (risk of snatching, breakage). Risk of structural damage to infrastructure especially for high elements (chimneys etc.)	Reduction in water availability. Potentiel interruption of water demanding processes and consequently of all production.	Reduction in water availability. Potentiel interruption of water demanding processes and consequently of all production.	Risk of damage to buildings, loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.	Risk of damage to buildings, loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.	Risk of damage to buildings, loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.		Mudslides destructing or rendering buildings inaccessible and damaging exteriors.
Mining		Working conditions compromised, reduction of work quality, possible impossible working conditions leading to production interruption.	Working conditions compromised, reduction of work quality, possible impossible working conditions leading to production interruption.	Risk of partial to total destruction. Production and working conditions permanently disrupted in the event of destruction of buildings. Risk of power outage.	Hostile outdoor environment, deteriorated production and working conditions / interrupted production.	Reduction in water availability. Potentiel interruption of water demanding processes and consequently of all production.	Reduction in water availability. Potentiel interruption of water demanding processes and consequently of all production.	Runoff on company site, flooding due to undersized drainage systems. Working conditions compromised, workers endangered.	Risk of flooding, mine unusable. Material and human losses.	Risk of flooding, mine unusable. Material and human losses.		Mudslides rendering company and buildings inaccessible and damaging exteriors. Mine unusable, loss of structure. Human and material losses.

carbone4

Operational impacts for every project type and every hazard (9/9)

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms (including thunderstorms)	Water stress	Drought	Heavy rain	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Transport equipment		Overheated vehicle, burst tires, battery failure. Increased energy requirements for refrigerated vehicles, leading to higher transport costs and risk of breaking the cold chain.	Overheated vehicle, burst tires, battery failure. Increased energy requirements for refrigerated vehicles, leading to higher transport costs and risk of breaking the cold chain.	Risk of partial to total destruction. Impossibility of usage of the transport equipment.	Risk of partial to total destruction. Impossibility of usage of the transport equipment.			Impossibility of usage of the transport equipment.	Risk of partial to total destruction. Impossibility of usage of the transport equipment.	Risk of partial to total destruction. Impossibility of usage of the transport equipment.		Risk of partial to total destruction. Impossibility of usage of the transport equipment.
Equipment		Overheating of equipments, risk of failure, risk of wildfire. Increased energy requirements for cooling.	Overheating of equipments, risk of failure, risk of wildfire. Increased energy requirements for cooling.	Risk of partial to total destruction.	Risk of partial to total destruction.			Risk of water infiltration and damage.	Risk of water infiltration and damage. Risk of partial to total destruction.	Risk of water infiltration and damage. Risk of partial to total destruction.		Risk of partial to total destruction.

Structural sensitivity is the second component of sensitivity.



Operational and structural sensitivity are assessed through project matrixes detailing impacts of every kind of hazard on every kind of project and providing a score. District adaptability is already scored by the REMA study, and project adaptability based on user inputs.

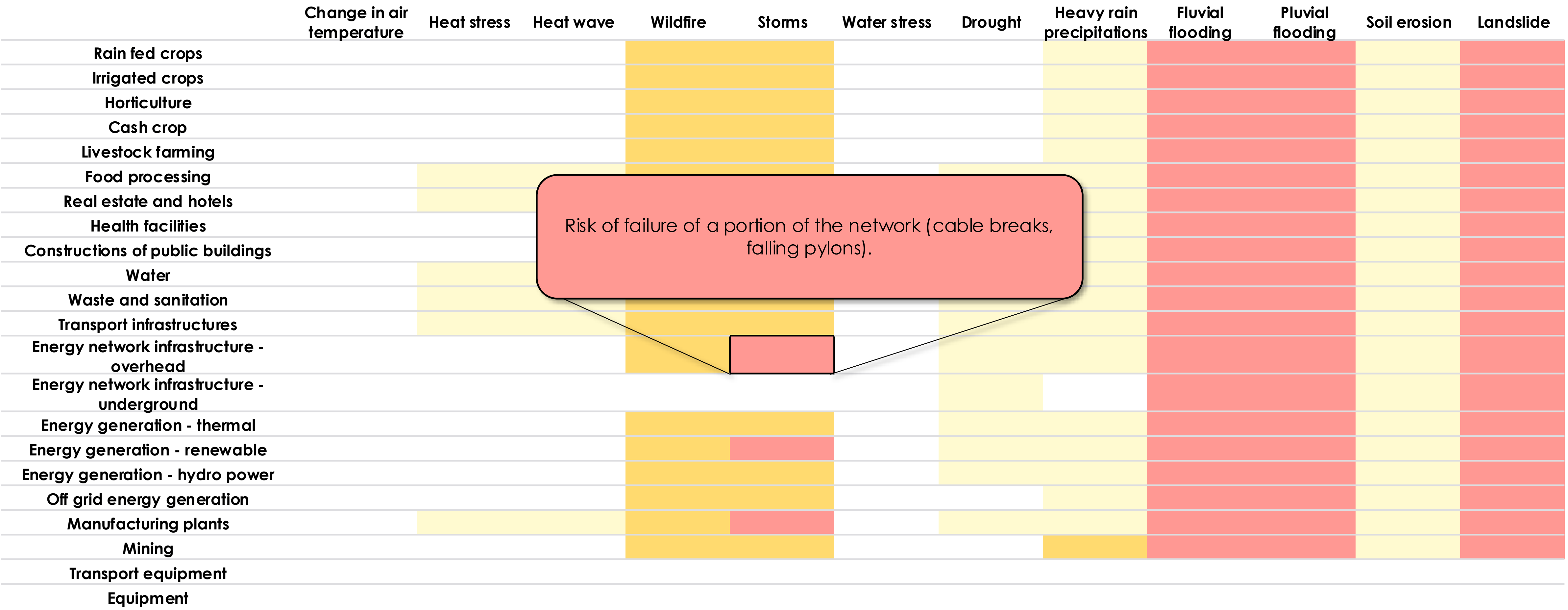
Structural sensitivity scores and associated impacts were defined for every project type and every hazard

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms	Water stress	Drought	Heavy rain precipitations	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Rain fed crops				Medium	Medium			Low	High	High	Low	High
Irrigated crops				Medium	Medium			Low	High	High	Low	High
Horticulture				Medium	Medium			Low	High	High	Low	High
Cash crop				Medium	Medium			Low	High	High	Low	High
Livestock farming				Medium	Medium			Low	High	High	Low	High
Food processing		Low	Low	Medium	Medium		Low	Low	High	High	Low	High
Real estate and hotels		Low	Low	Medium	Medium		Low	Low	High	High	Low	High
Health facilities				Medium	Medium		Low	Low	High	High	Low	High
Constructions of public buildings				Medium	Medium		Low	Low	High	High	Low	High
Water		Low	Low	Medium	Medium		Low	Low	High	High	Low	High
Waste and sanitation		Low	Low	Medium	Medium		Low	Low	High	High	Low	High
Transport infrastructures		Low	Low	Medium	Medium		Low	Low	High	High	Low	High
Energy network infrastructure - overhead				Medium	High		Low	Low	High	High	Low	High
Energy network infrastructure - underground							Low		High	High	Low	High
Energy generation - thermal				Medium	Medium		Low	Low	High	High	Low	High
Energy generation - renewable				Medium	High		Low	Low	High	High	Low	High
Energy generation - hydro power				Medium	Medium		Low	Low	High	High	Low	High
Off grid energy generation				Medium	Medium			Low	High	High	Low	High
Manufacturing plants		Low	Low	Medium	High		Low	Low	High	High	Low	High
Mining				Medium	Medium			Medium	High	High	Low	High
Transport equipment												
Equipment												

Structural sensitivity		
Not concerned	NA	-
Low	0,3	Low level of investments required (e.g. light repair work)
Medium	0,6	Major investments are necessary (requiring a partial shutdown of the business, for example)
High	0,9	100% of fixed assets are lost

carbone4

Structural sensitivity scores and associated impacts were defined for every project type and every hazard



Structural sensitivity		
Not concerned	NA	-
Low	0,3	Low level of investments required (e.g. light repair work)
Medium	0,6	Major investments are necessary (requiring a partial shutdown of the business, for example)
High	0,9	100% of fixed assets are lost

carbone4

Structural impacts for every project type and every hazard (1/4)

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms (including thunderstorms)	Water stress	Drought	Heavy rain	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Rain fed crops				Partial to total destruction of on-site infrastructures.	Damage to on-site infrastructures and buildings.			Damage to on-site infrastructures and buildings.	Damage of on-site infrastructure.	Damage of on-site infrastructure.	Gradual destabilization of infrastructures	Destruction of on-site infrastructures and land definitiviley uncultivable.
Irrigated crops				Partial to total destruction of on-site infrastructures.	Damage to on-site infrastructures and buildings.			Damage to on-site infrastructures and buildings.	Damage of on-site infrastructure.	Damage of on-site infrastructure.	Gradual destabilization of infrastructures	Destruction of on-site infrastructures and land definitiviley uncultivable.
Horticulture				Partial to total destruction of on-site infrastructures.	Damage to on-site infrastructures and buildings.			Damage to on-site infrastructures and buildings.	Damage of on-site infrastructure.	Damage of on-site infrastructure.	Gradual destabilization of infrastructures	Destruction of on-site infrastructures and land definitiviley uncultivable.
Cash crop				Partial to total destruction of on-site infrastructures.	Damage to on-site infrastructures and buildings.			Damage to on-site infrastructures and buildings.	Damage of on-site infrastructure.	Damage of on-site infrastructure.	Gradual destabilization of infrastructures	Destruction of on-site infrastructures and land definitiviley uncultivable.
Livestock farming				Partial to total destruction of on-site infrastructures.	Damage to on-site infrastructures and buildings.			Damage to on-site infrastructures and buildings.	Damage of on-site infrastructure.	Damage of on-site infrastructure.	Gradual destabilization of infrastructures	Destruction of on-site infrastructures and buildings.
Food processing		Overheating, deformation, damage to materials (equipements and buildings with metal structures) above 35°C	Overheating, deformation, damage to materials (equipements and buildings with metal structures) above 35°C	Partial to total destruction of buildings.	Potential damage to infrastructures and buildings, especially high elements (chimneys, poles etc.)		Clay shrink-swell leading to cracks in concrete and structural damage.	Damage to on-site infrastructures and buildings.	Damage of on-site infrastructures and buildings.	Damage of on-site infrastructures and buildings.	Gradual destabilization of infrastructures	Partial to total destruction of infrastructures and buildings.
Real estate and hotels		Overheating, deformation, damage to materials (equipements and buildings with metal structures) above 35°C	Overheating, deformation, damage to materials (equipements and buildings with metal structures) above 35°C	Partial to total destruction of buildings.	Potential damage to infrastructures and buildings, especially high elements (chimneys, poles etc.)		Clay shrink-swell leading to cracks in concrete and structural damage.	Damage to on-site infrastructures and buildings.	Damage of on-site infrastructures and buildings.	Damage of on-site infrastructures and buildings.	Gradual destabilization of infrastructures	Partial to total destruction of infrastructures and buildings.

Structural impacts for every project type and every hazard (2/4)

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms (including thunderstorms)	Water stress	Drought	Heavy rain	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Health facilities				Partial to total destruction of buildings.	Potential damage to infrastructures and buildings, especially high elements (chimneys, poles etc.)		Clay shrink-swell leading to cracks in concrete and structural damage.	Damage to on-site infrastructures and buildings.	Damage of on-site infrastructures and buildings.	Damage of on-site infrastructures and buildings.	Gradual destabilization of infrastructures	Partial to total destruction of infrastructures and buildings.
Constructions of public buildings				Partial to total destruction of buildings.	Potential damage to infrastructures and buildings, especially high elements (chimneys, poles etc.)		Clay shrink-swell leading to cracks in concrete and structural damage.	Damage to on-site infrastructures and buildings.	Damage of on-site infrastructures and buildings.	Damage of on-site infrastructures and buildings.	Gradual destabilization of infrastructures	Partial to total destruction of infrastructures and buildings.
Water		Deterioration of structures, envelopes and plumbing networks, leading to leaks	Deterioration of structures, envelopes and plumbing networks, leading to leaks	Partial to total destruction of infrastructures.	Potential damage to infrastructures and buildings, especially high elements (chimneys, poles etc.)		Clay shrink-swell leading to cracks in concrete and structural damage.	Damage to on-site infrastructures and buildings.	Damage of on-site infrastructures and buildings.	Damage of on-site infrastructures and buildings.	Gradual destabilization of infrastructures	Partial to total destruction of infrastructures, inlcuding burried structures.
Waste and sanitation		Deterioration of structures, envelopes and plumbing networks, leading to leaks	Deterioration of structures, envelopes and plumbing networks, leading to leaks	Partial to total destruction of infrastructures.	Potential damage to infrastructures and buildings, especially high elements (chimneys, poles etc.)		Clay shrink-swell leading to cracks in concrete and structural damage.	Damage to on-site infrastructures and buildings.	Damage of on-site infrastructures and buildings.	Damage of on-site infrastructures and buildings.	Gradual destabilization of infrastructures	Partial to total destruction of infrastructures, inlcuding burried structures.
Transport infrastructures		Overheating of roads (softening of asphalt). Increased road maintenance.	Overheating of roads (softening of asphalt). Increased road maintenance.	Partial to total destruction of infrastructures.	Potential damage to infrastructures and buildings, especially high elements (chimneys, poles etc.)		Clay shrink-swell leading to cracks in concrete and structural damage.	Damage to on-site infrastructures and buildings.	Risk of infrastructures being damaged and rendered unusable.	Risk of infrastructures being damaged and rendered unusable.	Gradual degradation of roads (especially unpaved).	Partial to total destruction of infrastructures.
Energy network infrastructure - overhead				Risk of destruction of wooden pylons, damage or destruction of metal pylons.	Risk of failure of a portion of the network (cable breaks, falling pylons).		Clay shrink-swell leading to cracks in concrete and structural damage.	Damage to on-site infrastructures and buildings.	Risk of temporary failure of a portion of the network (cable breaks, falling pylons).	Risk of temporary failure of a portion of the network (cable breaks, falling pylons).	Gradual destabilization of infrastructures	Partial to total destruction of infrastructures.

Structural impacts for every project type and every hazard (3/4)

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms (including thunderstorms)	Water stress	Drought	Heavy rain	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Energy network infrastructure - underground							Clay shrink-swell leading to cracks in concrete and structural damage.		Potential rise of buried structures.	Potential rise of buried structures.	Potential rise of buried structures.	Partial to total destruction of infrastructures, inlcuding burried structures.
Energy generation - thermal				Partial to total destruction of infrastructures.	Potential damage to infrastructures and buildings, especially high elements (chimneys, poles etc.)		Clay shrink-swell leading to cracks in concrete and structural damage.	Damage to on-site infrastructures and buildings.	Potential rise of buried structures. Damage of on-site infrastructures and buildings.	Potential rise of buried structures. Damage of on-site infrastructures and buildings.	Gradual destabilization of infrastructures	Partial to total destruction of infrastructures, inlcuding burried structures.
Energy generation - renewable				Risk of destruction of wooden pylons, damage or destruction of metal pylons. Partial to total destruction of infrastructures.	Risk of damage to high infrastructure (wind turbines) and fall of branches/objects on ground infrastructure (solar panels). Risk of failure of a portion of the network (cable breaks, falling pylons).		Clay shrink-swell leading to cracks in concrete and structural damage.	Damage to on-site infrastructures and buildings.	Potential rise of buried structures. Damage of on-site infrastructures and buildings.	Potential rise of buried structures. Damage of on-site infrastructures and buildings.	Gradual destabilization of infrastructures	Partial to total destruction of infrastructures, inlcuding burried structures.
Energy generation - hydro power				Risk of destruction of wooden pylons, damage or destruction of metal pylons. Partial to total destruction of infrastructures.	Risk of failure of a portion of the network (cable breaks, falling pylons).		Clay shrink-swell leading to cracks in concrete and structural damage.	Damage to on-site infrastructures and buildings.	Damage of on-site infrastructures and buildings. Risk of overload leading to structural damage.	Damage of on-site infrastructures and buildings. Risk of overload leading to structural damage.	Gradual destabilization of infrastructures	Partial to total destruction of infrastructures, inlcuding burried structures.
Off grid energy generation				Cables and enclosures damaged. Partial to total destruction of infrastructures.	Potential damage to infrastructures and buildings, especially high elements (chimneys, poles etc.)			Damage to on-site infrastructures and buildings.	Risk of damage and failure.	Risk of damage and failure.	Gradual destabilization of infrastructures	Partial to total destruction of infrastructures.

Structural impacts for every project type and every hazard (4/4)

	Change in air temperature	Heat stress	Heat wave	Wildfire	Storms (including thunderstorms)	Water stress	Drought	Heavy rain	Fluvial flooding	Pluvial flooding	Soil erosion	Landslide
Manufacturing plants		Overheating, deformation, damage to materials (equipements and buildings with metal structures).	Overheating, deformation, damage to materials (equipements and buildings with metal structures).	Partial to total destruction of infrastructures.	Risk of structural damage to infrastructure especially for high elements (chimneys etc.)		Clay shrink-swell leading to cracks in concrete and structural damage.	Damage to on-site infrastructures and buildings.	Risk of damage to buildings, loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.	Risk of damage to buildings, loss of stock, increased drainage requirements, risk of flooding and increased humidity. Risk of degradation of water quality. Working conditions compromised.	Gradual destabilization of infrastructures	Partial to total destruction of infrastructures and buildings.
Mining				Partial to total destruction of infrastructures.	Risk of structural damage to infrastructure especially for high elements (chimneys etc.)			Collapse of minning tunnels.	Risk of flooding, mine unusable. Material and human losses.	Risk of flooding, mine unusable. Material and human losses.	Gradual destabilization of infrastructures	Partial to total destruction of infrastructures and buildings.
Transport equipment												
Equipment												

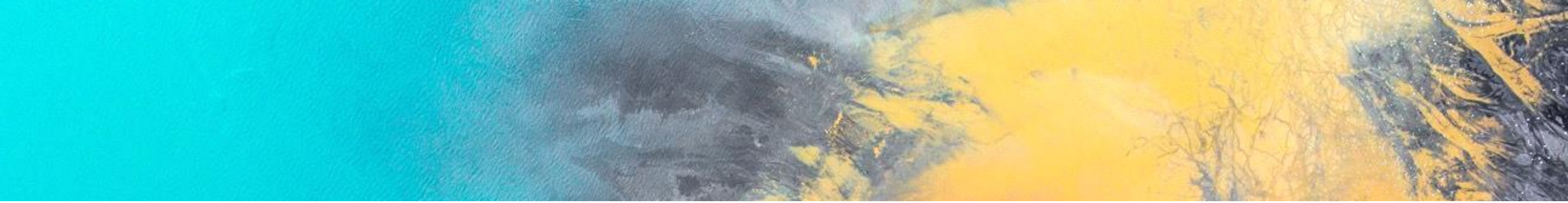


Table of content

Adaptation Capacities

- This section focuses on the **adaptability** aspect of vulnerability, evaluating what is already in place to cope with climate hazards.
- It distinguishes the **project adaptability, which is assessed through four questions asked to the tool's user**, measuring the project's readiness to face climate risks.
- Concurrently, the **district adaptability is directly extracted from the "Assessment of Climate Change Vulnerability in Rwanda - 2018"** study by the Rwanda Environment Management Authority (REMA), providing a score of each district's adaptation capacity based on a series of indicators.

Project adaptability is the first component of adaptability.

- **Vulnerability**
  - **Sensitivity**
    How is the project affected by an occurrence of the hazard
    - **Operational sensitivity**
      Potential impacts of the hazard on the project's operation (working conditions, equipment)
    - **Structural sensitivity**
      Potential impacts of the hazard on the projects structure (buildings)
  - **Adaptability**
    What is already in place to face an occurrence of the hazard
    - **Project adaptability**
      Project's readiness to face climate hazards (assessed through user inputs)
    - **District adaptability**
      District's readiness to face climate hazards (assessed through ASSESSMENT OF CLIMATE CHANGE VULNERABILITY IN RWANDA - 2018)

Operational and structural sensitivity are assessed through project matrixes detailing impacts of every kind of hazard on every kind of project and providing a score. District adaptability is already scored by the REMA study, and project adaptability based on user inputs.

The project adaptability score is assessed through four questions asked to the tool’s user

User’s input on the project’s adaptation capacity :

The state of knowledge about the impacts of climate in this sector is good	**Yes or No = 1 or 0**
Natural or climatic risk assessment studies are underway	**Yes or No = 1 or 0**
Adaptation measures are already included in the project	**Yes or No = 1 or 0**
The subject has already been clearly identified by the project coordinator, who wishes to make the project resilient	**Yes or No = 1 or 0**

Score = Sum /4

Project adaptability is the second component of adaptability.

Vulnerability

Sensitivity

How is the project affected by an occurrence of the hazard

Operational sensitivity

Potential impacts of the hazard on the project's operation (working conditions, equipment)

Structural sensitivity

Potential impacts of the hazard on the projects structure (buildings)

Adaptability

What is already in place to face an occurrence of the hazard

Project adaptability

Project's readiness to face climate hazards (assessed through user inputs)

District adaptability

District's readiness to face climate hazards (assessed through ASSESSMENT OF CLIMATE CHANGE VULNERABILITY IN RWANDA - 2018)

Operational and structural sensitivity are assessed through project matrixes detailing impacts of every kind of hazard on every kind of project and providing a score. District adaptability is already scored by the REMA study, and project adaptability based on user inputs.

District adaptability

- District adaptability is directly extracted from the *"Assessment of climate change vulnerability in Rwanda - 2018", Rwanda Environment Management Authority, Kigali, 2019*
- REMA has scored the adaptive capacity of every district based on a series of indicators. The resulting score is used as district adaptability score.

Index of Vulnerability for Rwanda, 2018
Exposure (E), Sensitivity (S), Impact (I), Adaptive Capacity (AC) and Vulnerability (V)
Low numbers = low E, S, I, AC and V

District/Province	E	S	I	AC	V
Nyarugenge	0.312	0.294	0.303	0.353	0.475
Gasabo	0.319	0.348	0.333	0.446	0.444
Kicukiro	0.326	0.331	0.329	0.374	0.478
CITY of KIGALI	0.319	0.324	0.322	0.391	0.465
Nyanza	0.425	0.405	0.415	0.365	0.525
Gisagara	0.430	0.430	0.430	0.357	0.537
Nyaruguru	0.388	0.385	0.387	0.333	0.527
Huye	0.394	0.451	0.423	0.290	0.566
Nyamagabe	0.380	0.368	0.374	0.334	0.520
Ruhango	0.412	0.388	0.400	0.327	0.536
Muhanga	0.388	0.369	0.378	0.434	0.472
Kamonyi	0.413	0.382	0.398	0.393	0.502
SOUTHERN PROVINCE	0.404	0.397	0.400	0.354	0.523
Karongi	0.449	0.468	0.459	0.372	0.543
Rutsiro	0.404	0.417	0.410	0.414	0.498
Rubavu	0.351	0.415	0.383	0.382	0.500
Nyabihu	0.432	0.412	0.422	0.418	0.502
Ngororero	0.452	0.421	0.437	0.431	0.503
Rusizi	0.426	0.378	0.402	0.428	0.487
Nyamasheke	0.450	0.443	0.447	0.418	0.514
WESTERN PROVINCE	0.423	0.422	0.423	0.409	0.507
Rulindo	0.350	0.414	0.382	0.480	0.451
Gakenke	0.390	0.397	0.393	0.489	0.452
Musanze	0.378	0.364	0.371	0.464	0.454
Burera	0.403	0.391	0.397	0.455	0.471
Gicumbi	0.424	0.407	0.415	0.470	0.472
NORTHERN PROVINCE	0.389	0.394	0.392	0.472	0.460
Rwamagana	0.336	0.345	0.341	0.372	0.484
Nyagatare	0.336	0.412	0.374	0.348	0.513
Gatsibo	0.311	0.337	0.324	0.406	0.459
Kayonza	0.392	0.395	0.394	0.393	0.500
Kirehe	0.397	0.388	0.392	0.419	0.487
Ngoma	0.411	0.366	0.389	0.393	0.498
Bugesera	0.395	0.356	0.376	0.387	0.494
EASTERN PROVINCE	0.368	0.371	0.370	0.388	0.491

Table of content

Recommendations

- This section presents the **climate adaptation recommendations** generated by the tool for each project type.
- It highlights specific directives aimed at **integrating climate change adaptation and resilience** into project design and operation.
- **Recommendations are structured around key actions, such as identifying climatic variables and non-climatic risk factors,** studying observed and projected climate changes, reviewing current engineering designs, prioritizing adaptation options, and developing training for project stakeholders.
- For certain sectors, specific challenges and concrete adaptation options are also detailed.

Recommendations are issued at the end of the tool for every project type (1/7)

Project	Adaptation directives
Rain fed crops	The challenge of adapting to climate change is twofold: - Modifying production and farming practices to make them more resilient to climate risks; - Ensuring that these changes are accompanied by socio-economic and institutional measures to guarantee their success. It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the project's lifespan, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders. Possible adaptation options include modifying the agricultural calendar, choosing crop varieties, diversifying crop species, adopting cultivation methods (agro-ecology, agro-forestry) to better retain soil moisture and limit soil erosion, modifying phytosanitary treatments, resizing the irrigation or drainage network, seeking additional water resources, etc.
Irrigated crops	The challenge of adapting to climate change is twofold: - Modifying production and farming practices to make them more resilient to climate risks; - Ensuring that these changes are accompanied by socio-economic and institutional measures to guarantee their success. It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the project's lifespan, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders. Possible adaptation options include modifying the agricultural calendar, choosing crop varieties, diversifying crop species, adopting cultivation methods (agro-ecology, agro-forestry) to better retain soil moisture and limit soil erosion, modifying phytosanitary treatments, resizing the irrigation or drainage network, seeking additional water resources, etc.
Horticulture	The challenge of adapting to climate change is twofold: - Modifying production and farming practices to make them more resilient to climate risks; - Ensuring that these changes are accompanied by socio-economic and institutional measures to guarantee their success. It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the project's lifespan, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders. Possible adaptation options include modifying the agricultural calendar, choosing crop varieties, diversifying crop species, adopting cultivation methods (agro-ecology, agro-forestry) to better retain soil moisture and limit soil erosion, modifying phytosanitary treatments, resizing the irrigation or drainage network, seeking additional water resources, etc.

Recommendations are issued at the end of the tool for every project type (2/7)

Project	Adaptation directives
Cash crop	The challenge of adapting to climate change is twofold: - Modifying production and farming practices to make them more resilient to climate risks; - Ensuring that these changes are accompanied by socio-economic and institutional measures to guarantee their success. It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the project's lifespan, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders. Possible adaptation options include modifying the agricultural calendar, choosing crop varieties, diversifying crop species, adopting cultivation methods (agro-ecology, agro-forestry) to better retain soil moisture and limit soil erosion, modifying phytosanitary treatments, resizing the irrigation or drainage network, seeking additional water resources, etc.
Livestock farming	The challenge of adapting to climate change is twofold: - Modifying production and farming practices to make them more resilient to climate risks; - Ensuring that these changes are accompanied by socio-economic and institutional measures to guarantee their success. It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the project's lifespan, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate changein the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders. Possible adaptation options include modifying the agricultural calendar, choosing crop varieties, diversifying crop species,adopting cultivation methods (agro-ecology, agro-forestry) to better retain soil moisture and limit soil erosion, modifying phytosanitary treatments, resizing the irrigation or drainage network,seeking additional water resources, etc.
Food processing	It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the life of the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders.

Recommendations are issued at the end of the tool for every project type (3/7)

Project	Adaptation directives
Real estate and hotels	The challenge of adapting to climate change is twofold: - Protecting housing and urban development projects from the effects of climate change; - To ensure that these projects do not increase the vulnerability of surrounding areas to the effects of climate change. It is recommended to integrate climate change adaptation and resilience into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the project's lifespan, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders. Possible adaptation options include, for example, formulating urban planning recommendations to mitigate urban vulnerabilities identified according to their exposure to risks, delineating green spaces and wetlands to be protected or even developed to increase the project's resilience to climate change, identify infrastructure and investment requirements to protect real estate assets, prescribe building regulations that take account of local climatic specificities and anticipate expected changes, issue recommendations concerning the preparedness of institutions to manage the long-term impacts of climate change and the emergency management of natural disasters, etc.
Health facilities	It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the lifeof the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate changein the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders.
Constructions of public buildings	The challenge of adapting to climate change is twofold: - Protecting housing and urban development projects from the effects of climate change; - To ensure that these projects do not increase the vulnerability of surrounding areas to the effects of climate change. It is recommended to integrate climate change adaptation and resilience into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the project's lifespan, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders. Possible adaptation options include, for example, formulating urban planning recommendations to mitigate urban vulnerabilities identified according to their exposure to risks, delineating green spaces and wetlands to be protected or even developed to increase the project's resilience to climate change, identify infrastructure and investment requirements to protect real estate assets, prescribe building regulations that take account of local climatic specificities and anticipate expected changes, issue recommendations concerning the preparedness of institutions to manage the long-term impacts of climate change and the emergency management of natural disasters, etc.

Recommendations are issued at the end of the tool for every project type (4/7)

Project	Adaptation directives
Water	The main challenge is to maintain the population's drinking water supply, against a backdrop of climate change that could reduce seasonal and annual rainfall volumes and increase drought episodes. It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the life of the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders. Possible adaptation options include, for example, integrating improved network efficiency by reducing losses, but also a possible need for alternative supply sources (e.g. seawater desalination), and network renovation and/or resizing requirements. Proposals should also be made to control water consumption.
Waste and sanitation	It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the lifeof the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate changein the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders.
Transport infrastructures	The challenge of adapting to climate change is twofold: - Protecting infrastructures from the effects of climate change; - Ensuring that infrastructures do not increase the vulnerability of surrounding areas to the effects of climate change. It is recommended to integrate climate change adaptation and resilience into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the life of the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders.

Recommendations are issued at the end of the tool for every project type (5/7)

Project	Adaptation directives
Energy network infrastructure - overhead	The main challenge of adapting to climate change concerns maintaining electricity distribution in a context of increasing frequency of exceptional climatic events. It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the life of the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders. Possible adaptation options include modification of the layout, improved tower anchoring, network redundancy, etc.
Energy network infrastructure - underground	The main challenge of adapting to climate change concerns maintaining electricity distribution in a context of increasing frequency of exceptional climatic events. It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the lifeof the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate changein the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders. Possible adaptation options include modification of the layout, improved tower anchoring, network redundancy, etc.
Energy generation - thermal	It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the lifeof the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate changein the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders.
Energy generation - renewable	It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the life of the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders.

Recommendations are issued at the end of the tool for every project type (6/7)

Project	Adaptation directives
Energy generation - hydro power	The challenge of adaptation and resilience to climate change is twofold: - The main challenge lies in the location and sizing of the structure, in a context of climate change that could modify seasonal and annual rainfall volumes, and therefore reservoir filling levels. - The other challenge goes beyond the investment project itself. Most major dam-reservoir projects are strategic development aid infrastructures. However, global warming is leading to a general increase in water consumption. The impact of climate change on water and energy demand in the area served should therefore also be examined. It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the life of the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders. Possible adaptation options include modifying reservoir capacity, controlling land use in the watershed, diversifying energy sources (in the case of hydroelectric projects), reservoir management methods, etc. Proposals should also be made to control water demand.
Off grid energy generation	It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the lifeof the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate changein the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders.
Manufacturing plants	It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the life of the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders.
Mining	It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the life of the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders.

Recommendations are issued at the end of the tool for every project type (7/7)

Project	Adaptation directives
Transport equipment	It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the life of the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders.
Equipment	It is recommended that climate change adaptation and resilience be integrated into this type of project through the implementation of the following actions: 1. Identify the climatic variables that have the greatest impact and the non-climatic risk factors that make the area vulnerable. 2. Study climate changes already observed in the project area, and climate projections for a horizon consistent with the life of the project, then assess the effects of climate change on the project. 3. Prepare a climate change vulnerability map for the project, in order to integrate risks and improve project design. 4. Review the sustainability and capacity of current engineering designs, standards and guidelines to address climate change in the context of the project. 5. Identify and prioritize current and additional adaptation options (cost-benefit analysis), including technical and/or non-technical adjustments. 6. Set up or develop training courses on climate risk protection for project stakeholders.