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VALIDATED LOCAL RISK ACTIONABLE DATA FOR ADAPTATION



D4.6

Final definition and description of climate risks indicators implementation

TERRANIS

WP4 - Development of data manipulation tools

The project has received funding from the Horizon Europe Framework Programme under grant agreement No 101112837

DELIVERABLE REPORT

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Deliverable name	**Final definition and description of climate risks indicators implementation**

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Preamble

This deliverable presents the final version of the tools developed for calculating and visualising the values of the indicators selected for each demonstrator region. The definition of these indicators is provided by WP1 (Task 1.2, Deliverable D 2.1 "Selected climate risk indicators with detailed computing metrics").

This calculation process includes access and use of local databases, climate projections and appropriate information extracted from Earth Observation and Land use data, as defined in Task 1.2. Both tools are used in the demonstrators' contexts to evaluate the risks faced by the regions against key challenges (flooding, drought, heatwaves, forest fires, soil degradation, coastal erosion, etc.) and aim at replicability for other regions in view of "scaling up" risk assessment performances in other regional contexts.

The selected indicators have been generated using the datasets provided by local demonstrators and are accessible on the VALORADA platform. For some indicators where local data was unavailable, data from other sources (e.g. the Climate Data Store or Copernicus Land Monitoring) have been used, albeit with less accuracy.

It is important to note that the results achieved — both in terms of calculated indicators and visualisation tools — remain strongly dependent on the local context of each demonstrator and the data available. Consequently, the implemented indicators may differ somewhat from the original list established in D2.1, and the visualisations may vary from one demonstrator to another.

1. Introduction

1.1 About VALORADA

The EU aims to transform 150 European regions into sustainable and climate resilient regions by 2030. VALORADA contributes to addressing this challenge by co-developing tested FAIR customisable data-manipulation tools to access available climate datasets and to enable the sharing, community validation and use of local socioeconomic, demographic and Earth-Observation data. With a rigorous transdisciplinary approach, the respective risks of climate change are analysed with the local actors in five demonstrators in Europe. Data required for the analysis are compiled from the various already existing repositories (e.g., Copernicus Climate Change Climate Data Store) and locally sourced non-climate data catalogues processed by local communities and regions. The project will co-develop and make available prototype climate data and non-climate data manipulation tools to support and improve existing data portals and platforms and to enable user-oriented multi-data integration.

VALORADA aims to achieve Technology Readiness Levels (TRL) 7 and above. VALORADA's tools will enable the acquisition of different useful climate and non-climate data and make them "interoperable" in terms of metadata, as well as tools able to harmonise the geographical and time references chosen for the data. The "Analyst toolbox" will be composed of software tools able to combine different kinds of data all relevant for assessing climate risks and to calculate resulting indicators. VALORADA will contribute to scaling up to 150 regions through the implementation of dedicated scalability and replicability activities with at least 10 European regions and through strong collaboration with other Horizon projects. Additional activities include capacity-building schemes for end users as well as providers of climate services. VALORADA will explore and assess the options to facilitate the connection of the VALORADA data tools to the Copernicus Atmosphere Data Store.

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VALORADA's vision statement: VALORADA wants to empower European regions and cities to steer the upcoming societal transformation towards sustainable and climate-resilient development through their own actions.
VALORADA's mission statement: VALORADA will enable the integration of diverse datasets that enable merging local knowledge with climate and non-climate datasets by means of co-developed data-manipulation tools and climate data.

1.2 Objectives of WP4

• Define and develop multi-source data manipulation tools and make them available and customised to the service providers in charge of the regional demonstrators.
• Define together with WP1, WP2 and with the service providers of WP3, the climate service data which needs specific geographic downscaling, and perform the needed downscaling for the benefit of each service provider of WP3.
• Develop tools for generating a set of indicators combining climate, EO-based and non-climate data for assessing the vulnerability and risks mitigation benefits of the regions
• Assess the maturity level for operationalization with full compliance of the FAIR principles
• Assess the potential integration of the relevant tools into the Climate and Atmosphere Data Store (CADS) and/or other C3S related activities and Climate-ADAPT.

All the tools developed in this WP4 will comply with findability, accessibility, interoperability and reusability as described within the FAIR data principles.

1.3 Objectives of Task 4.1

Definition of task 4.1: Implement ingestion, manipulation, and integration tools for multi-source non-climate data;

The purpose of this task is to make available a set of services and software tools for manipulating locally sourced socio-economic, demographic and EO data (previously identified with the demonstrators 'local stakeholders) relevant to locally contextualising climate data. This task includes:

• "Populating" the various local datasets into GeoNetwork catalogues, as well as the EO data and Copernicus services available and being of interest for building indicators to inform about climate risks, as identified in the impact climate chains built in WP1. This task involves all the local service providers participating in the demonstrators.

• Making available a set of tools able to handle (in a global approach or in separate steps) the following functions:

- "data ingestion" to get access to the data registered in the metadata catalogues. These tools will allow to ingest the data and images necessary for the relevant areas of interest into a "GeoServer" dedicated to the local area, with a common geographic and time reference, in order to allow easy further manipulation of these different data (optimising data access and data extraction on the time and spatial axis, resampling data).
- "data normalisation" to express the different data (local datasets, EO images and land use maps) into common geographical units (hexagonal grids or local administrative units) allowing further merging and alignment of these data with different spatio-temporal resolutions.
- "data analysis and manipulation" in order to generate indicators values, corresponding to the risks identified by the local stakeholders and described in the climate impact chains, and to the indicators definition issued from WP2.

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- "visualization" of these indicators values in a way which can be both easily understood by non technical decision makers and also compared with other situations of the same area (past configurations or scenario models defined by the end users by changing the set of input data).

These tools are made available by TerraNIS (as WP coordinator) or by the different service providers participating to WP4, either as software suite able to be integrated into the local services providers platforms, or as a "Software as a Service" (SaaS) mode running in the TerraNIS cloud environment.

This chaining of tools is depicted in Figure 1.

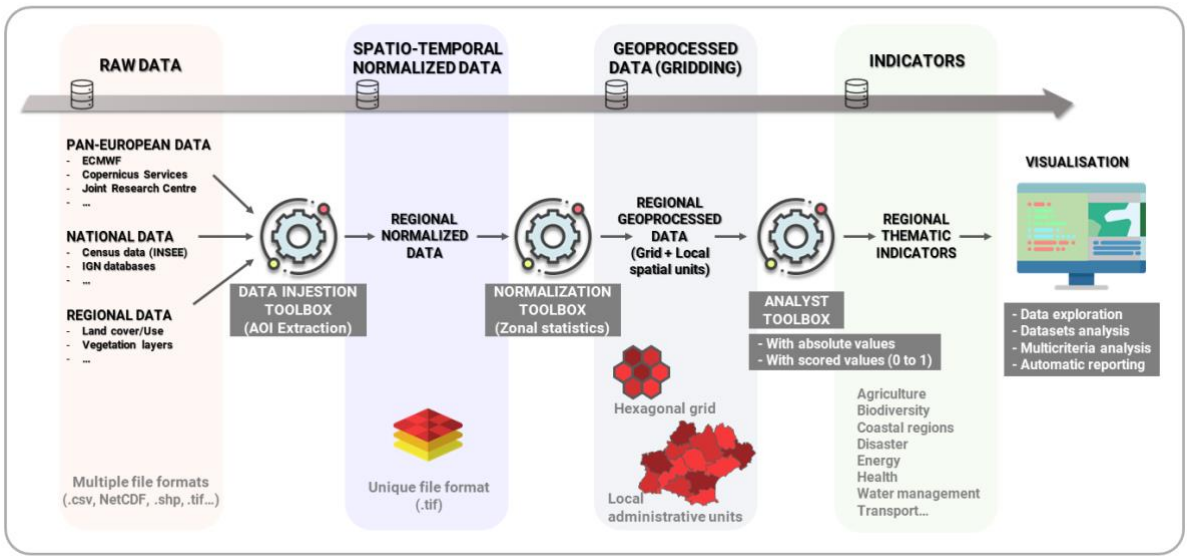


Figure 1 : Overall chaining of tools made available to handle the necessary functions

The software tools used in this overall process (**described in the deliverable D4.2 "Final non-climate data manipulation and visualisation tools description")** have been made available either by TerraNIS (as WP coordinator) or by the Partners from Greece (TerraSpatium and the University of Thessaloniki for the indicators relevant for Central Greece) as a "Software as a Service" (SaaS) mode running in the TerraNIS or in the TerraSpatium cloud environment. The exact list of tools used for each indicator is given in the following sections.

For the visualization exercise it has been decided to use the "dashboards" facility provided by the ArcGIS suite of ESRI, since all users communities involved in the demonstrators are using this software suite as a normal operating tool. The customization of the dashboards has been handled by TerraNIS, by using the ArGIS capabilities and some software scripts used in the company.

2. Main steps of the processing chain

2.1 Overall processing chain

The overall processing chain performed during this task is schematized in Figure 2. A more detailed diagrams is given in ANNEX 1.

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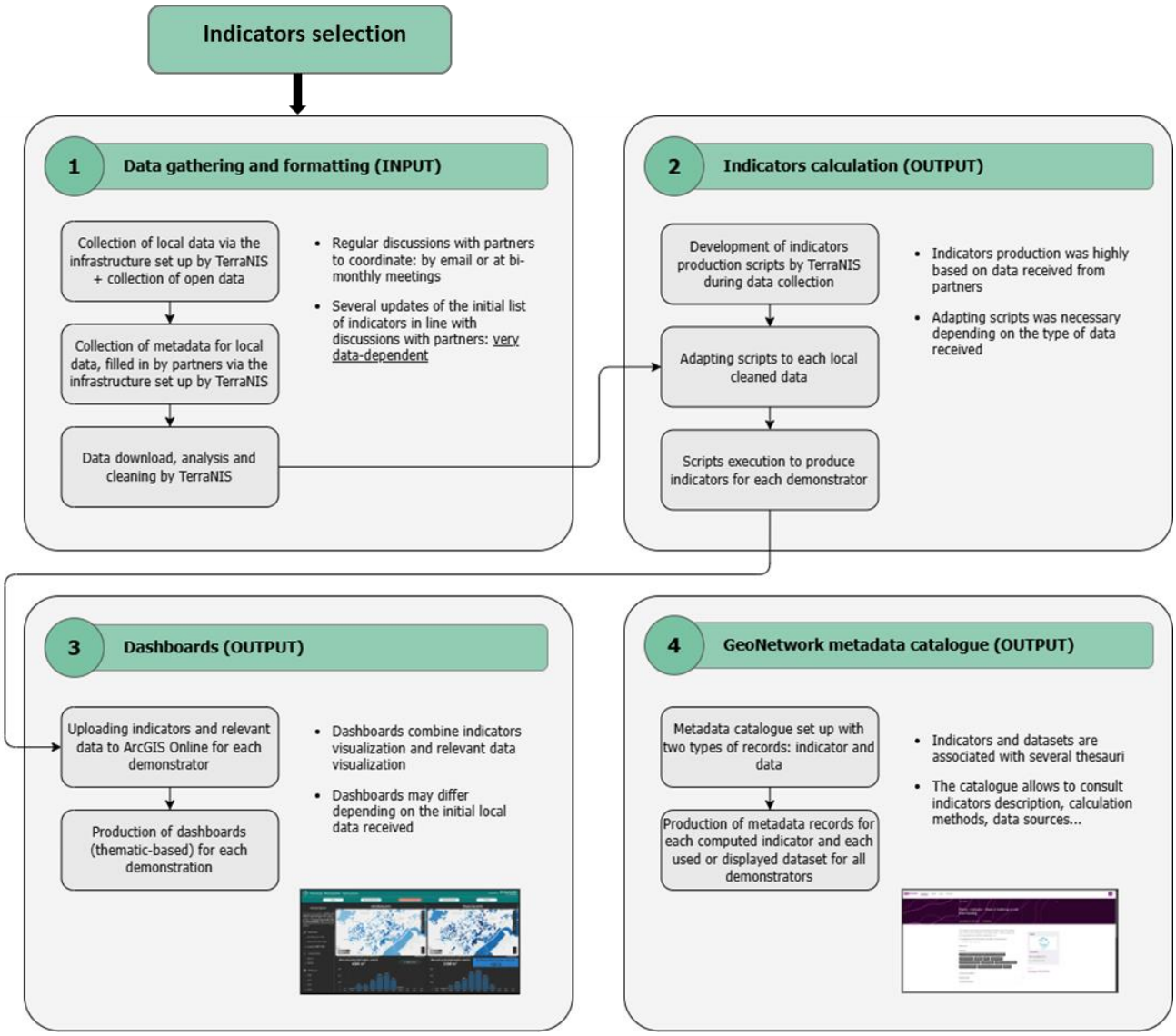


Figure 2 : Main steps of the implementation process: indicators selection, data gathering and formatting, indicators calculation, dashboards production and metadata catalogue filling.

Each step is detailed in the following parts of this document .

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2.2 Indicators selection

The selection of the different indicators to be calculated in all demonstrators has been done during the first year of the project, led by WP1 with the involvement of WP3 and WP4 actors, with two different phases:

- Phase 1: based on the discussions on the climate impacts chains held with the various stakeholders, a first list of indicators has been produced, with the objective of characterizing and quantifying the exposure of the territories to these climate risks. This selection included also the exact definition of these indicators, the computation methods, and more importantly the types of input data necessary to approach and calculate them. The list of these indicators, together with the types of input data needed, is given in Annex 2 of this document.
- Phase 2: based on these generic indicators list, long discussions have been set up with the different stakeholders in all demonstrators, in order:
    - To select the indicators which were felt relevant and important for the territories,
    - To find the local data which could be made available for their calculation. This search for local data sets has taken much more time than expected.
      When local data sets were not found, it has been proposed to use Copernicus data issued from the Land or Emergency services, when available, but with a spatial resolution not always at the expected level.

These two phases have led to a list of indicators per demonstrator, associated with input data, as shown in the following section. As already mentioned in the preamble, this final list of indicators remains strongly dependent on the local context of each demonstrator and the data available. Consequently, the implemented indicators may differ somewhat from the phase 1 list.

2.3 Data gathering and formatting

2.3.1 Non climate data gathering and formatting

Once the data sources had been identified by the local partners, the data were ingested into the VALORADA processing servers: the TerraSpatium server for the Central Greece indicators, which required the operational involvement of specialised personnel to run specific tools (coastal line monitoring and soil degradation analysis), and the TerraNIS server for all other indicators and regions.

In parallel with data ingestion, the associated metadata — **where available** — were similarly ingested into the servers. These metadata were subsequently used to populate the GeoNetwork metadata catalogue.

Together with the data ingestion, reformatting operations were carried out using the open-source QGIS software, with specific scripts developed where necessary. Dedicated storage spaces, one per region, were set up on the server to host all local datasets, as illustrated in the figure below.

Several important points are worth highlighting regarding the data sources used:

- All European datasets are open and free to use, as they originate from Copernicus services (Sentinel-2 imagery, Land and Emergency Management services), with the exception of SPOT images ordered for the Bulgarian area. These were required to produce the vegetation index for certain indicators, as the necessary spatial accuracy could not be achieved with Sentinel-2 data.
- Regarding local datasets, most are openly accessible (once the data source has been identified), however many did not include INSPIRE-compliant metadata descriptions, which required additional manual processing and sometimes created a lack of understanding.
- All reformatting tasks needed to ingest the various datasets (in raster, vector or tabular formats) into the Geographic Information System can be performed manually using the

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facilities available in open-source QGIS software. While this requires some operational effort, it remains manageable for GIS operators.

The restricted access data used for the generation of the indicators are listed in *Table 1*, which identifies also some "back up" potential open solutions which have been used when the restricted access data had not been made available.

Table 1 : List of restricted access data used for the generation of the indicators and details on sources, ingestion mean, "back up" potential Open solutions, main characteristics and indicators impacted.

Restricted access Input Data used	Characteristics and Source	Ingestion means	Back up open data	Characteristics	Indicators impacted
Spot Image data	Airbus/ 4m spatial resolution	Airbus One Atlas platform	Sentinel 2	10 m spatial resolution	
LPIS (Land Parcel identification)	Generally open but can be limited to farmers organizations in some countries	QGIS or other GIS	NO	NA	All indicators related to agriculture
Crops classification per year	Limited access in some countries. CAP payment agency	QGIS or other GIS	Could be done with Sentinel services with automatic crop recognition	Until 50% of mistakes	Sensitivity of the crops to lack of water
Pluviometry data	O (from CDS) Or restricted access when from local meteo station for current data status	Scripts for ingestion	Climate data store	Difficult to assess	All indicators related to water availability, flooding and drought
Evapotranspiration of soils	O (from CDS) or restricted specific soils data sets for currents status	Scripts for ingestion	Climate data store	Difficult to assess	All indicators related to water availability, flooding and drought
crop specific evapotranspiration data	Terranis with Pixagri tool using Sentinel 2 data	Calculation of estimated Kc and Scripts for ingestion	No	Allows to set up some alternative scenario for crop selection	Indicators linked to crop behaviours against drought
Pleiades images and Surface elevation models for Local Cimate Zone identification	Terranis with Landia tool and Pleiades data	Specific algorithms owned by Cerema and IGN	No	Better accuracy	Indicators for well being in urban areas

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Flood prone areas	Limited access in some countries.	QGIS or other GIS Scripts for ingestion	Copernicus Emergency Management Service	Historically calibrated modeling	All indicators related to flooding
Forest areas with tree composition	Often available	QGIS or other GIS Scripts for ingestion	Corine Land Cover	Tree composition can be hard to interpret (mlxed forest)	Forest related indicators
Demographic data, population with age…	Often available for the population only. Other demographic characteristics can be hard to find	QGIS or other GIS Scripts for ingestion	Global Human Settlement Layer EUROSTAT	NA	Indicators related to flooding, urban vegetation.. with a vulnerability to people
Soil degradation, erosion or desertification	Limited access in some countries	QGIS or other GIS Scripts for ingestion	JRC Land Degradation in Europe	A wide variety of data types	Indicators related the soil degradation and erosion
Municipalities infrastructures (critical or not)	Often available	QGIS or other GIS Scripts for ingestion	Not in GIS format	A wide variety of data	Indicators related to flooding or urban climatology
Urban green area	Limited access in some countries and limited quality	QGIS or other GIS Scripts for ingestion	Sentinel 2 but with less accuracy	Difficult to assess with a good quality	Indicators related to urban vegetation

2.3.2 Climate data gathering and formatting

For climate data, the baseline approach consisted in selecting variables of relevance to the indicators chosen by each demonstrator region from the Copernicus Climate Data Store (CDS, https://cds.climate.copernicus.eu/). The dataset retained to feed the tools is the "Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections", which provides ERA5 reanalysis data for the historical period and CORDEX projection data for future periods.

Once retrieved via the CDS API into a local environment, the data are processed through a series of scripts and formatted into a database in the server for visualisation purposes. This processing pipeline includes a set of statistical operations applied to the data, such as multi-model ensemble handling, temporal aggregations, and deviation calculations.

The full processing chain — from CDS data retrieval to formatting — is illustrated schematically in Figure 3 : process used for ingesting the Climate Data Store data into the server and to use it either for indicators calculation or for display.. Annex 3 also provides the complete list of variables selected for the tools.

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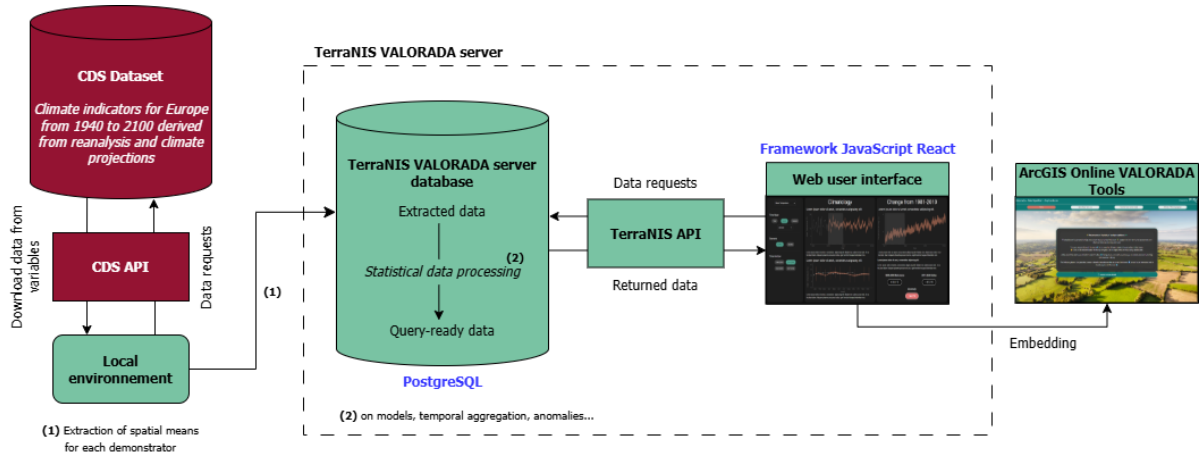


Figure 3 : process used for ingesting the Climate Data Store data into the server and to use it either for indicators calculation or for display.

The climate data can ultimately serve two distinct purposes: they can either be displayed on a dedicated climate dashboard, or be directly integrated into the computation of specific indicators — as is the case for the crop water requirements indicator.

2.4 Indicators calculation

Once the input data have been ingested and formatted, the indicators values are calculated by using basic or more sophisticated tools as detailed in Annex 4. As shown in the following table, most of the indicator's values are resulting from basic functions performed by a set of basic scripts running on open GIS like QGIS.

Four dedicated analytic tools made available by some project partners have been used for the calculation of certain indicators. They are:

- Pixagri "territory" made available by TerraNIS for calculating indicators linked to water stress of the crops and irrigation water needs over the territory.
- Greencity/Landia, also made available by TerraNIS, to calculate the "Local Climate Zones" in an urban environment, and to better estimate the indicators linked to people vulnerability against the heat waves effects in an urban environment,
- Terracoast, made available by TerraSpatium, for assessing the evolution of the coastal line over the time, as result of the climate change effect,
- Soil degradation monitoring tool, made available by Aristoteles University of Thessaloniki, to assess the soil degradation impact of wildfires. This particular case was not reflected as an indicator as such but displayed as a specific graphic datasets.

In addition, project-specific tools have been developed to compute indicators related to the following thematic areas: flooding, forests, protected areas, and, in some cases, agriculture.

A comprehensive description of the tools is provided in Deliverable D4.2.

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2.5 Dashboards development

The development of the thematic dashboards, illustrating the indicators values, has been made by TerraNIS and by TerraSpatium by using the ArcGIS pro software suite: for each indicator, a dedicated script has been developed for managing the display of this indicator value.

The full set of available dashboards can be seen in the following links:
https://experience.arcgis.com/experience/e7da888927ed4495816540e48886f826/

Examples of these thematic dashboards are shown in Figure 4, Figure 5 and Figure 6.

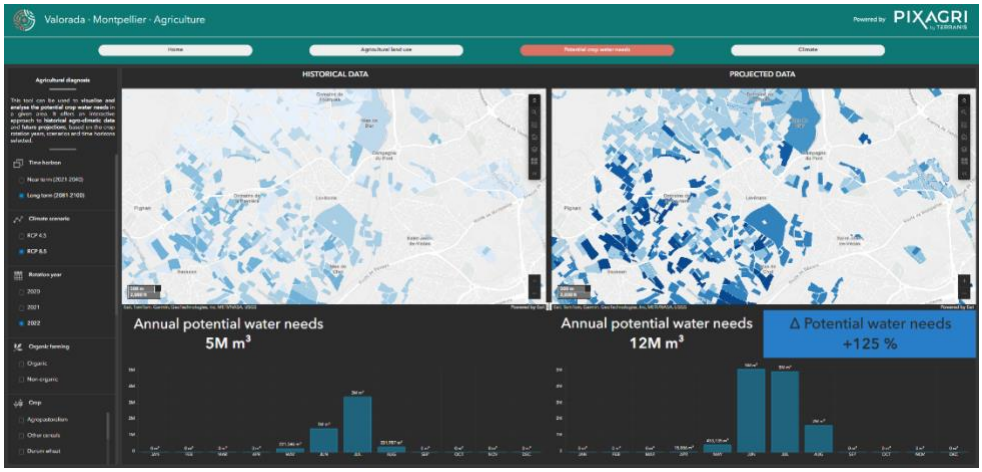


Figure 4 : Agriculture dashboard in Montpellier

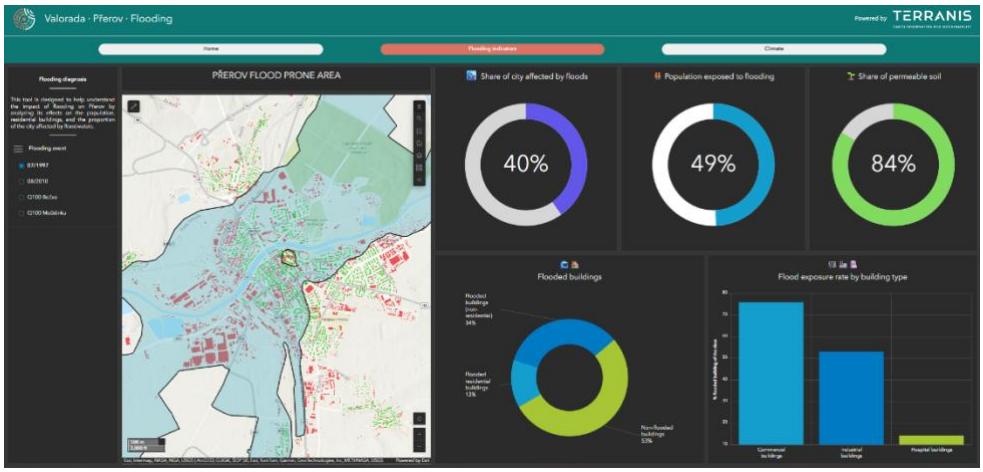


Figure 5: Flooding dashboard in Prerov

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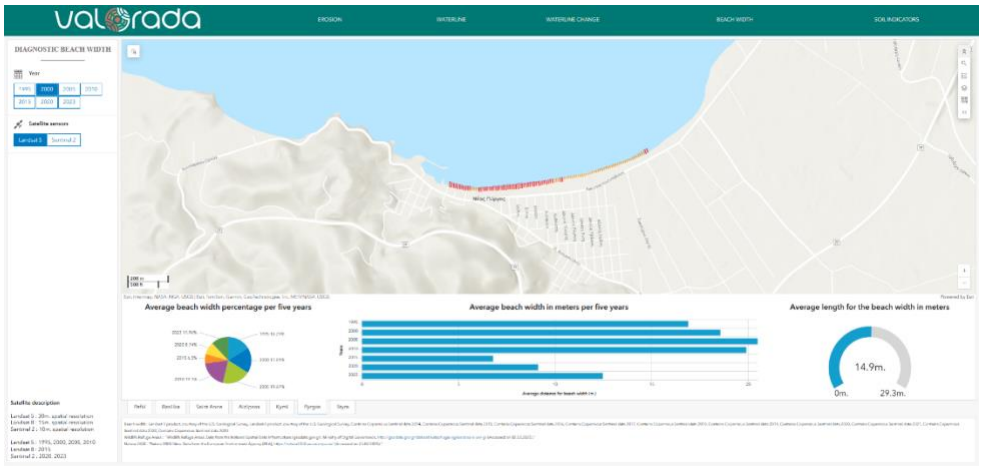


Figure 6: Beach width dashboard in Central Greece

All thematic dashboards share a common structure, organised around four main components:

- A top navigation bar providing access to a home page that summarises the key challenges of the thematic area and explains how the dashboard works, followed by access to the indicator dashboards themselves. At the end of the navigation bar, the dedicated climate data platform is accessible from any thematic dashboard. For each thematic area, recommendations are provided regarding the climate variables to be consulted as a priority.
- A lateral selection panel allowing users to filter the displayed data and update the indicators accordingly — for instance, by selecting a specific year or a specific municipality.
- A cartographic section displaying either contextual data to support the interpretation of the indicators, or a direct cartographic visualisation of the indicators themselves.
- Finally, the indicators are displayed in various formats — charts, gauges, text, or numerical values — and are dynamically updated based on the current selection.

The climate data platform was developed by TerraNIS using an external solution, as ArcGIS alone proved insufficient in terms of data formatting capabilities. The platform was tailored for each of the demonstrator regions and relies on an API connecting the underlying database — which stores the climate data — to a JavaScript React front-end. This front-end is then embedded within the ArcGIS environment via a web link (see Figure 3).

Figure 7provides an example of this climate data platform for the Molise demonstrator and or the mean temperature variable.

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Figure 7: View of the Climate platform for the Molise demonstrator. Mean temperature is displayed on this example.

The climate platform is structured around several key components:

- A lateral selection panel enabling users to choose the climate variable of interest, a time span (yearly, seasonal or monthly), a climate scenario, and a projection time horizon.
- A central "Evolution and Climatology" panel providing two complementary visualisations: first, the temporal evolution of both reanalysis and projection data on a year-by-year basis, updated according to the current selection; second, a monthly climatology visualisation to analyse the intra-annual distribution of the variable, again displaying both reanalysis and projected data based on the selected parameters.
- A central "Projections vs Reference Period (1981–2010)" panel offering two views: a year-by-year visualisation of the deviation from the reference period based on the selected time—span, scenario and horizon, alongside a more synthetic summary view designed to support end-users in interpreting the projected changes.

2.6 GeoNetwork catalog set-up

Another important task in the project was to progressively build up a Geonetwork metadata catalogue describing all the metadata corresponding to each input data used for the generation of the indicators or for the indicators themselves.

This rather demanding task has been shared between TerraNIS and some local partners using a form as provided by TerraNIS, and an example of which is shown Table 2. The completeness of the data in this file is key to calculating relevant indicators, as it allows us to understand the data in terms of both format and meaning.

A comprehensive description of the catalogue is provided in Deliverable D4.2.

The catalogue is complete with respect to both the computed indicators and the data displayed and/or used in the indicator calculations. However, the level of detail regarding data sources varies considerably, as it depends on the collaborative workflow described earlier in this section, whereby each partner was expected to provide comprehensive metadata alongside their local data.

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Table 2 : Example of form provided by TerraNIS to local partners in order to describe each input data used for the generation of the indicators.

Dataset ID		Online resource					Metadata									
Dataset_Name	**Date of deposit**	**Metadata available ?**	**Metadata Link**	**Online dataset resource ?**	**Dataset Link**	**Genealogy**	**Title**	**Theme**	**Abstract**	**Demonstrator**	**Data producer**	**Individual name**	**Email**	**Date of creation**	**Projection system**	
Name of the file dropped on the Terranis server. If this is a shapefile, just write the name of the "file.shp"	*Date of deposit on the Terranis server*	*Does the dataset already have metadata ?*	*If the dataset already have a metadata, provide the link here please.*	*Is the dataset already online ?*	*If the dataset is available online, provide the link here please.*	If the dataset comes from different datasets or has been modified/cleaned, please provide the link and the dataset name. Example: The dataset "Europe_forestry_surface" has been filtered to create "France_forestry_surface." In the Genealogy field, I paste the link to the "Europe_forestry_surface" dataset.	*Name of the dataset*	*Click on the cell, then click on the down arrow to choose a theme that fits the dataset. The theme should correspond to the folder where the dataset resides.*	*Summarize or describe the dataset and its purpose.*	*Click on the cell, then click on the down arrow to choose a demonstrator name.*	*Name of the organization that produced the data*	*Name of the person reponsible for the data*	*Data producer or individual email*	*Date when the dataset was created.*	*Projection system of the dataset : Number of EPSG.*	*The fi only c that attribu Vecti*
forest.shp	12/02/2025	Yes		Yes		ZABAGED	forest	Forest	The dataset contains areas of prerov forest.	CZ-Prerov	???	???	???	2023	5514	
garden_parks.shp	12/02/2025	Yes		Yes		ZABAGED	garden_parks	Urban-vegetation	The dataset contains Prerov gardens parks	CZ-Prerov	???	???	???	2023	5514	
dmr_5G_MB.tif		Yes	https://geoportal.cuzk.cz/(S(pr0a23dqpseamb0km4mb1chn))/Default.aspx?lng=EN&mode=TextMeta&metadataID=CZ-CUZK-DMR5G-V&metadataXSL=Full&side=vyskopis	Yes	https://ags.cuzk.cz/geoprohlizec/#en	ZABAGED - Altimetry - DMR 5G	dmr_5G_MB	Other	The dataset contains Mlada Boleslav´s digital terrain model	CZ-Mlada_Boleslav	ČÚZK					
DMP1G.shp		Yes	https://geoportal.cuzk.cz/(S(pr0a23dqpseamb0km4mb1chn))/Default.aspx?mode=TextMeta&metadataID=CZ-CUZK	Yes	https://ags.cuzk.cz/geoprohlizec/#en	ZABAGED - Altimetry - DMP 1G	DMP1G	Other	The dataset contains Mlada Boleslav´s digital surface model in points	CZ-Mlada_Boleslav	ČÚZK					
Ortofoto.tif		Yes	https://geoportal.cuzk.cz/(S(pr0a23dqpseamb0km4mb1chn))/Default.aspx?mode=TextMeta&metadataID=CZ-CUZK-ORTOFOTO-R&metadataXSL=Full&side=ortofoto	Yes	https://ags.cuzk.cz/geoprohlizec/#en	Ortophoto CR	Ortofoto	Other	The dataset contains Mlada Boleslav´s ortophoto	CZ-Mlada_Boleslav	ČÚZK					
			https://geoportal.cuzk.cz/(S(pr0a23dqpseamb0km4mb1ch													

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3. Main achievements

Climate dashboards are available for all demonstrators (see again Annex 3 for the complete list of variables displayed in the tools).

Table 3 provides a summary of the indicators computed for each thematic area across all demonstrator regions. As previously noted, the set of implemented indicators may differ from the original list established in D2.1 for two main reasons: the evolution of user needs throughout the project, and most importantly data availability constraints. Indeed, each indicator was adapted to the local data available, which generally offered the best spatial resolution for the region concerned.

Table 3 : Synthesis of main achievements for each demonstrator: all computed indicators for each thematic.

Burgas	Vegetation
	Share of green area
	Share of canopy area
	Share of low vegetation area
	Green area per capita
	Canopy area per capita
	Low vegetation area per capita
	Flooding
	Share of flood risk area
	Share of people living in flood-prone area
	Share of healthcare facilities at risk from flooding
Gabrovo	Vegetation
	Share of green area
	Share of canopy area
	Share of low vegetation area
	Green area per capita
	Canopy area per capita
	Forest
	Share of forested area (2 data sources)
	Tree composition of forests (2 data sources)
	Low vegetation area per capita
Mladá Boleslav	Urban vegetation
	Share of green area
	Breakdown of types of green areas
	Green area per capita
	Share of public green area
	Public green area per capita
	Accessibility to public green area
	Forest

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	Share of forested area (2 data sources)
	Tree composition of forests (2 data sources)
	Agriculture
	Agricultural land use: · Total agricultural area · Breakdown of crop types
	Potential crop water needs
	Land erosion: · Share of each erosion level · Erosion levels evolution
	Flooding
	Share of flood risk area
	Share of people living in flood-prone area
	Share of buildings at risk from flooding
	Share of permeable soil
Přerov	Urban vegetation
	Share of green area
	Breakdown of types of green areas
	Green area per capita
	Share of public green area
	Public green area per capita
	Accessibility to public green area
	Forest
	Share of forested area (2 data sources)
	Tree composition of forests (2 data sources)
	Agriculture
	Agricultural land use: · Total agricultural area · Breakdown of crop types
	Potential crop water needs
	Land erosion: · Share of each erosion level · Erosion levels evolution
	Flooding
	Share of flood risk area
	Share of people living in flood-prone area
	Share of buildings at risk from flooding
	Share of permeable soil
	Flood exposure rate by building type
Molise	Climate action and resilience
	Development of tools, guides, and policies to support action on climate risks
	Agriculture
	Land degradation
	Forest
	Share of forested area (2 data sources)

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	Tree composition of forests (2 data sources)
	Protected area
	Share of protected area
	Share of protected area type
	Flooding
	Share of flood risk area
	Share of people living in flood-prone area: · Percentage of the total population residing within areas identified as flood-prone · Percentage of households residing within areas identified as flood-prone
	Share of buildings at risk from flooding: · General buildings · Businesses · Cultural heritage
	Share of critical infrastructures at risk from flooding: · Share of roads at risk from flooding · Share of railway network at risk from flooding · Lenght of emergency roads at risk from flooding · Status of emergency areas · Share of strategic buildings at risk from flooding
Montpellier	Urban vegetation
	Share of green area
	Share of canopy area
	Share of herbaceous area
	Green area per capita
	Canopy area per capita
	Urban climatology
	Share of vulnerable population
	Poverty rate
	Vulnerability of populations linked to the age of residents (/5)
	Vulnerability of populations linked to the economic situation of residents (/5)
	Vulnerability of populations linked to accessibility to cooling areas (/5)
	Vulnerability of populations linked to the typomorphology of UMUs (/5)
	Synthetic indicator of population vulnerability to heat waves aggravated by the ICU effect (/5)
	Temperature gradient
	Agriculture
	Agricultural land use: · Total agricultural area · Total organic farming area · Breakdown of crop types · Number of farms within M3M · Irrigable area within M3M
	Potential crop water needs

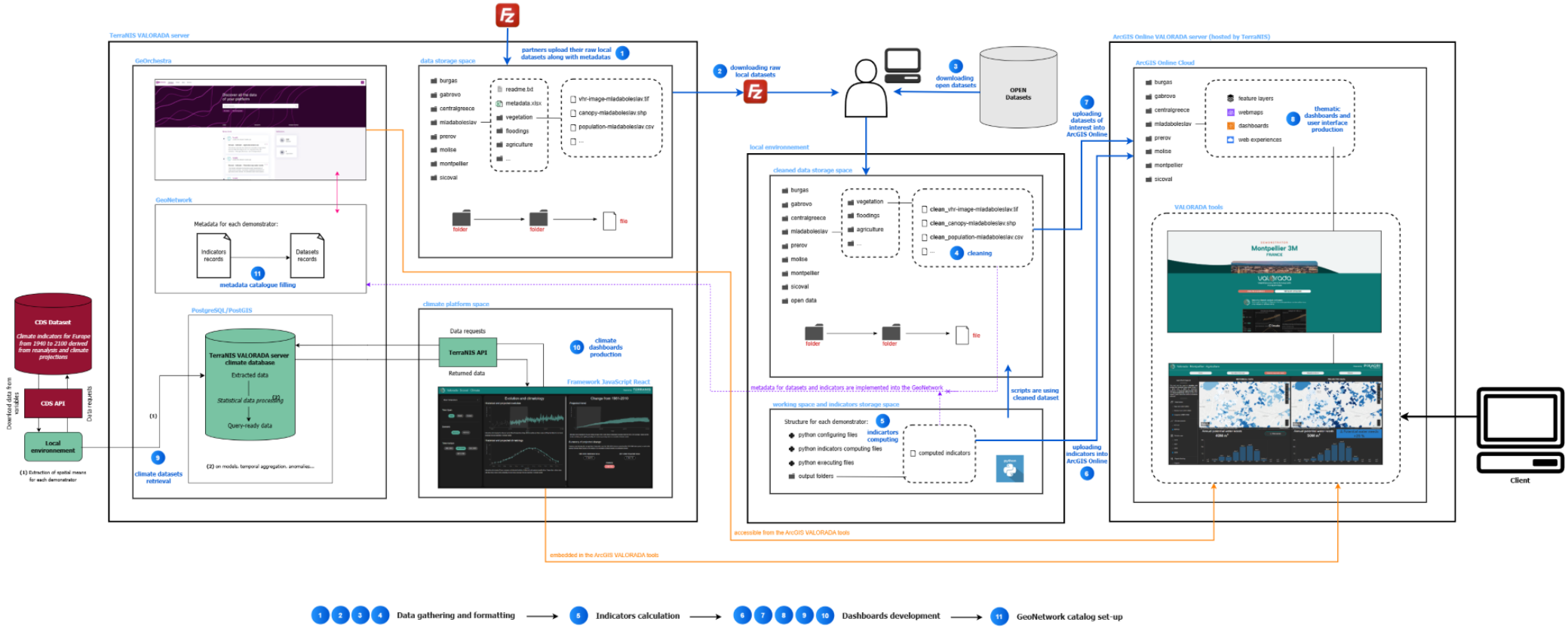
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	Abandoned lands: · Agricultural abandoned lands area · Agricultural abandoned lands area with a very-high agronomic potential · Share of agricultural abandoned lands · Share of abandoned lands under Protected Designation of Origin (PDO) · Share of abandoned lands under legal obligation for vegetation cleareance (OLD) · Share of abandoned lands suitable for irrigation
Sicoval	Urban vegetation
	Share of green area
	Share of canopy area
	Share of herbaceous area
	Share of green open public area
	Green area per capita
	Canopy area per capita
	Share of public green area
	Public green area per capita
	Accessibility to public green area
	Urban climatology
	Share of vulnerable population
	Poverty rate
	Accessibility to refreshment areas
	Vulnerability of populations linked to the age of residents (/5)
	Vulnerability of populations linked to the economic situation of residents (/5)
	Vulnerability of populations linked to accessibility to cooling areas (/5)
	Vulnerability of populations linked to the typomorphology of UMUs (/5)
	Synthetic indicator of population vulnerability to heat waves aggravated by the ICU effect (/5)
	Agriculture
	Agricultural land use: · Total agricultural area · Total organic farming area · Breakdown of crop types · Number of farms within Sicoval · Irrigation rate within Sicoval
	Potential crop water needs

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4. ANNEXES

ANNEX 1: Details of the processing chain



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ANNEX 2: List of indicators

Note concerning the dataset used for the indicators calculation : the calculation of some of the following indicators need more than 2 or 3 datasets but for the sake of clarity, not all datasets have been included in this table.

Indicator ID	Indicator Name	Description	Hazard	Data1_Name	Data2_Name
I1001	Number of households affected by drought	Drought impacts households, e.g., through water shortages, restrictions in water use or dependence on alternative water sources (e.g. the number of days per year with water use regulation on certain areas, number of households there). It can affect food security or cause economic strain increased costs (water, electricity). Indicator can also just describe the number of households in a high risk area.	Drought	Areas affected by drought (incl. Timing and severity of drought conditions)	Location and number of households in the target area
I1003	**Number of people at high risk of heat stress**	Describes risk areas for heat stress and the number of population residing there. Provides better understanding if additional risk factors (vulnerability) such as old or very young age, chronic health conditions, low income, low level of education etc. among population re condidered.	Extreme heat waves	Areas exposed to high temperature extremes	Local demographic data describing factors of vulnerability, affected population, and their location
I1004	**Number of people living in flood-prone areas**	A high number of people living in flood prone areas shows a high exposure to flood risks. Could be completed with other indicators to assess the impacts of floods on	Extreme heavy precipitation (short-term, e.g. leading to flooding), Coastal erosion or	Flood zone maps	Human population counts or density for the target area

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		people living in flood prone areas	coastal flooding		
Indicator ID	**Indicator Name**	**Description**	**Hazard**	**Data1_Name**	**Data2_Name**
I1005	Number of properties flooded per year	Climate change increases the frequency and intensity of extreme weather events such as floods. It can also change the location and timing of floods.	Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding)	Flooding events, their timing and extent	Location and number of properties or parcels in the target area
I1006	Number of businesses located in areas of flood/coastal erosion risk	Smaller number of businesses located in areas of flood/coastal erosion risk shows a reduced exposure of businesses to those risks. This includes also number/locations of industries vulnerable to flooding (that can cause a further threat, e.g., of chemical dispersion).	Extreme heavy precipitation (short-term, e.g. leading to flooding), Coastal erosion or coastal flooding	Flood zone maps	Number, location, and type of businesses in local area
I1008	Number of critical infrastructures in areas at risk from flooding	Essential services, such as hospitals should be located outside of risk areas to prevent them from being damaged and/or destroyed from floods/coastal erosion. Could be completed with other indicators to assess the vulnerability (i.e. sensitivity and adaptive capacity)	Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Coastal erosion or coastal flooding	Flood zone maps	Location and number of critical infrastructures in target area

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I1010	Share of flood risk area in the city or region	Describes the location and/or share of flood risk areas within city or region.	Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Coastal erosion or coastal flooding	Flood zone maps	
Indicator ID	**Indicator Name**	**Description**	**Hazard**	**Data1_Name**	**Data2_Name**
I1016	Location of abandoned lands	Abandoned or mal-maintained land areas pose an increased wildfire risk.	Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought, Coastal erosion or coastal flooding	Location of abandoned properties or parcels and type of previous use	
I1033	Disruptions to economy/livelihoods due to water scarcity, wildfire, or flooding	Could describe the losses, number of disruptions to certain professions/sectors, number of professions (and people working in them) vulnerable to or been affected by water scarcity, wildfires, or flooding. Requires information of locally relevant professions/livelihoods that are affected.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought, Coastal erosion or coastal flooding	Areas affected by drought (incl. Timing and severity of drought conditions)	Wildfire location, number, and geographic extent

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Indicator ID	Indicator Name	Description	Hazard	Data1_Name	Data2_Name
I1041	Number of weather-related disruptions in energy or electricity distribution	Number and/or distribution of weather-related disruptions. Can help understand, which weather-related events cause disruptions currently and does the changing climate increase/decrease the risk of occurrence.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought, Coastal erosion or coastal flooding	Energy provider system status data	Timing and type of weather events in the target area
I1043	Disruptions to population due to water scarcity	Describing, for example, the number of days per year with water use regulation	Changes to mean precipitation, Drought	Human population counts or density for the target area	Water supply and access data in the target area
I1046	Increase in soil degradation and desertification	Describes either future risk based on climate projections and possibly land use. And/or combines projections with local information on high-risk areas of soil degradation, increased erosion (including agricultural lands) and desertification due to, e.g., their current state, type of vegetation, activities such as agriculture or changes in land use.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Drought	Soil degradation and desertification risk characteristics	Soil maps incl. Soil type, extent, and quality or status

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Indicator ID	Indicator Name	Description	Hazard	Data1_Name	Data2_Name
I1047	**Changes in biodiversity (e.g., populations of birds and butterflies) around agricultural lands**	Monitoring locally relevant species, for example birds and butterflies, that are sensitive to environmental change. For example, butterflies are sensitive to environmental change and a good indicator of the health of the environment. Currently their numbers are declining in many areas of Europe (Source: EEA).	Increase in mean temperatures, Changes to mean precipitation, Drought	Target species habitat location and extents	List of local species determined relevant to biodiversity
I1048	Water usage rate in agriculture	Important indicator in understanding water needs and need for more efficient practices.	Increase in mean temperatures, Changes to mean precipitation, Drought	Agricultural water usage data (by crop or water source location)	Land use map and activities in the region
I1049	Number of hectares of productive land lost to soil erosion		Extreme heavy precipitation (short-term, e.g. leading to flooding), Coastal erosion or coastal flooding	Soil maps incl. Soil type, extent, and quality or status	Location, type, and amount of local crop production
I1050	Share/percentage of agricultural crops vulnerable to climatic changes	Changing crops to more resilient ones can increase resilience of agricultural sector and food security.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation	Location, type, and amount of local crop production	Climate sensitivity of crops by crop type

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Indicator ID	Indicator Name	Description	Hazard	Data1_Name	Data2_Name
I1051	**Share of mixed forest of all forests and general tree composition of forests**	Mixed forest is more resilient towards changing climatic conditions. Different tree types and varieties have different sensitivity level to climatic changes, also age of trees plays a role. New tree plantations need to account for future potential climate change impacts at the regional level.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought, Coastal erosion or coastal flooding	Forest area location and composition (vegetation species)	
I1052	**Change in the threat of pests and diseases harming agriculture/forestry**	Changing climate is expected to significantly impact agricultural insect pests in Europe by making the climatic preconditions more suitable for certain pests to reproduce and diseases to spread. Vulnerable forests can be prone to diseases in changing climate. Rising temperatures are likely to cause poleward range shifts and increase in the number of generations for many pest species, and to increase prevalence and severity of crop pathogens and fungal infections in some crops. Also new invasive pests and diseases might arrive to Europe.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought, Coastal erosion or coastal flooding	Climatic factors of relevance to the local pests and pathogens	Types of local pests and pathogens and their sensitivity to climatic changes

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Indicator ID	Indicator Name	Description	Hazard	Data1_Name	Data2_Name
I1053	Annual timber losses from pests and pathogens	Changes in temperature and rainfall conditions can lead to changes in pests and pathogens with negative impacts on the timber industry and state of environment.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought, Coastal erosion or coastal flooding	Status of forest health and cause of damage or loss	Forest area location and composition (vegetation species)
I1054	Damages in forests due to weather-related events	Describes the amount, percentage or areal distribution of weather-related damages.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought, Coastal erosion or coastal flooding	Timing and type of weather events in the target area	Status of forest health and cause of damage or loss
I1057	Total forest area impacted by wildfire per year	Increasing temperature due to climate change can lead to increase wildfire with negative impactson forest resources, local populations and tourism.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Drought	Forest area location and composition (vegetation species)	Wildfire location, number, and geographic extent

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Indicator ID	Indicator Name	Description	Hazard	Data1_Name	Data2_Name
I1058	Mapping of vulnerable populations	Describes social vulnerability in relation to certain hazard (in general, high social vulnerability affects capability to cope in case of most hazards). Recognizing who and where the vulnerable populations are is the starting point to decrease vulnerabilities and increase adaptive capacity. Factors of vulnerability may vary according to the specific climate risk and can be elaborated separately (see data needs). Can be presented as hotspots, maps, risk indexes.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought, Coastal erosion or coastal flooding	Local demographic data describing factors of vulnerability, affected population, and their location	
I1059	Development of tools, guides, and policies to support action on climate risks	This indicator could be expanded to track various elements chosen, e.g.: - number of tools, guides, policies developed - number of users of such resources - number of working groups or agencies involved in actions - status of development (production, testing, issued, in use) of tools,	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought,	List of tools, guides, policies, measures, etc. of relevance to climate adaptation that are under discussion, planned, adopted, etc. locally	List of departments, agencies, institutions, initiatives, etc. involved in climate adaptation planning, decision-making, and actions locally

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Indicator ID	Indicator Name	Description	Hazard	Data1_Name	Data2_Name
I1071	**Uptake of early warning and disaster preparedness systems**	This indicator could include the chosen elements, e.g. systems for: - air or water quality - soil and land degradation - flood or fire protection - etc.	Extreme heat waves, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought, Coastal erosion or coastal flooding	Register of users of early warning and disaster preparedness systems	
I1074	**Share of permeable surfaces in urban environments**	Describes the share of permeable surfaces in urban environment, related to risk of pluvial flooding. Can also be related to human comfort during heat.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding)	*Detailed land cover map (incl. Urban vegetation, permeation rates, etc.)*	*Copernicus HRL Imperviousness*
I1075	Percentage of coastline under marine protection		Coastal erosion or coastal flooding	Areas defined as coastline and protection status of these areas	
I1078	Share of forested area	Ratio of forest area to municipal area			
I1079	Share of protected natural area	Ratio of the area of protected natural sites (NATURA 2000 and CDDA) to the municipal area			

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Indicator ID	Indicator Name	Description	Hazard	Data1_Name	Data2_Name
I1054	Damages in forests due to weather-related events	Describes the amount, percentage or areal distribution of weather-related damages.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought, Coastal erosion or coastal flooding	Timing and type of weather events in the target area	Status of forest health and cause of damage or loss
I1057	Total forest area impacted by wildfire per year	Increasing temperature due to climate change can lead to increase wildfire with negative impactson forest resources, local populations and tourism.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Drought	Forest area location and composition (vegetation species)	Wildfire location, number, and geographic extent
I1058	Mapping of vulnerable populations	Describes social vulnerability in relation to certain hazard (in general, high social vulnerability affects capability to cope in case of most hazards). Recognizing who and where the vulnerable populations are is the starting point to decrease vulnerabilities and increase adaptive capacity. Factors of vulnerability may vary according to the specific climate risk and can be elaborated separately (see data	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought, Coastal erosion or coastal flooding	Local demographic data describing factors of vulnerability, affected population, and their location	

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		needs). Can be presented as hotspots, maps, risk indexes.			
I1059	Development of tools, guides, and policies to support action on climate risks	This indicator could be expanded to track various elements chosen, e.g.: - number of tools, guides, policies developed - number of users of such resources - number of working groups or agencies involved in actions - status of development (production, testing, issued, in use) of tools, guides, or policies - etc.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought, Coastal erosion or coastal flooding	List of tools, guides, policies, measures, etc. of relevance to climate adaptation that are under discussion, planned, adopted, etc. locally	List of departments, agencies, institutions, initiatives, etc. involved in climate adaptation planning, decision-making, and actions locally
I1071	**Uptake of early warning and disaster preparedness systems**	This indicator could include the chosen elements, e.g. systems for: - air or water quality - soil and land degradation - flood or fire protection - etc.	Extreme heat waves, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought, Coastal erosion or coastal flooding	Register of users of early warning and disaster preparedness systems	
I1074	**Share of permeable surfaces in urban environments**	Describes the share of permeable surfaces in urban environment, related to risk of pluvial flooding. Can also be related to human comfort during heat.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation	*Detailed land cover map (incl. Urban vegetation, permeation rates, etc.)*	*Copernicus HRL Imperviousness*

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Indicator ID	Indicator Name	Description	Hazard	Data1_Name	Data2_Name
I1075	Percentage of coastline under marine protection		Coastal erosion or coastal flooding	Areas defined as coastline and protection status of these areas	
I1078	Share of forested area	Ratio of forest area to municipal area			
I1079	Share of protected natural area	Ratio of the area of protected natural sites (NATURA 2000 and CDDA) to the municipal area			
I1080	Share of agricultural area	Ratio of agricultural area to municipal area			

Indicator ID	Indicator Name	Description	Hazard	Data1_Name	Data2_Name	Data3 Name
I1081	Water needs of crops	Assesses the water balance of a field by comparing water inputs and soil moisture with plant water use through evapotranspiration.	Increase in mean temperatures	Location, type, and amount of local crop production	Rainfall map of the target area	ETP on the target area

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I1082	Vulnerability of crops to climatic hazards	This indicator takes the form of a toolbox. It can be used to select a crop and highlight the risks associated with the climate at certain key moments in the vegetative development process.	Increase in mean temperatures, Extreme heat waves, Changes to mean precipitation, Extreme heavy precipitation (short-term, e.g. leading to flooding), Drought	Historical and projected daily temperatures	Historical and projected daily precipitation	Historical and projected monthly evapotranspiration
I1083	Impact of climate change on annual crops yield	This indicator is based on the AquaCrop crop growth model developed by the Land and Water Division of FAO to address food security and to assess the effect of environment and management on crop production. AquaCrop simulates yield response to water of herbaceous crops, and is particularly suited to address conditions where water is a key limiting factor in crop production.	Increase in mean temperatures, Changes to mean precipitation	Historical and projected daily temperatures	Historical and projected daily precipitation	Historical and projected Daily values of Reference evapotranspiration
I1084	Population vulnerability to heat waves	Level of vulnerability of populations to a heat wave aggravated by the potential UHI (urban heat island) effect.	Extreme heat waves	Local Climate Zones in the area	Demographic data	

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I1085	Quality and structure of the green network	This index is a weighted sum of most relevant biodiversity indicators such as share of green, canopy and herbaceous area as well as connectivity and distance between canopy areas	Extreme heat waves	Very High Resolution images for vegetation recognition	Surface Height Numerical model	
I1086	Urban vegetation and well-being	This index is a weighted sum of most relevant well-being (related to vegetation) indicators such as green, canopy and public green areas per capita as well as accessibility to public green spaces	Increase in mean temperatures	Very High Resolution images for vegetation recognition	Surface Height Numerical model	Demographic data
I1087	Land Surface temperature	Mean Land surface temperature in the unit of analysis under consideration	Increase in mean temperatures	Landsat-8 imagery		

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ANNEX 3: List of Climate variables used for simple display or for indicators calculation

Variable name	Used in	Status	Origin	Resolution
Mean Temperature	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Growing Degree Days	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Heating Degree Days	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Cooling Degree Days	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Tropical Nights	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Hot Days (30°C Threshold)	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Hot Days (35°C Threshold)	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Hot Days (40°C Threshold)	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Warmest Three-Day Period	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Climatological Heatwave Days	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°

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Frost Days	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Total Precipitaiton	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Maximum Consecutive Five-Day Precipitation	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Extreme Precipitation Total	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Extreme Precipitation Days	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Consecutive Dry Days	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Meteorological Droughts Duration	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Meteorological Droughts Magnitude	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
High Fire Danger Days	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Mean Wind Speed	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Extreme Wind Speed Days	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Daily Maximum Temperature	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections	0.25° x 0.25°

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			https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	
Daily Minimum Temperature	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Fire Weather Index	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	0.25° x 0.25°
Aridity actual	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	5km x 5km
Mean Soil Moisture	Climate dashboard	Operational	Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections https://cds.climate.copernicus.eu/datasets/sis-ecde-climate-indicators	5km x 5km
Precipitation	Agriculture dashboard	Operational	Copernicus Interactive Climate Atlas https://atlas.climate.copernicus.eu/atlas ERA5-Land & CORDEX-EUR-11	0.1° x 0.1° (ERA5-Land) 0.11° x 0.11° (CORDEX-EUR-11)
Mean of daily accumulated evaporation	Agriculture dashboard	Operational	Copernicus Interactive Climate Atlas https://atlas.climate.copernicus.eu/atlas ERA5-Land & CORDEX-EUR-11	0.1° x 0.1° (ERA5-Land) 0.11° x 0.11° (CORDEX-EUR-11)

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ANNEX 4: List of indicators (ID, name, description, area of interest) with producers and tool(s) used for its calculation.

Indicator ID	Indicator Name	Description	Interested area	Producer	Tool used	Open (O) or Limited Access (LA)
I1001	Number of households affected by drought	Drought impacts households, e.g., through water shortages, restrictions in water use or dependence on alternative water sources (e.g. the number of days per year with water use regulation on certain areas, number of households there). It can affect food security or cause economic strain increased costs (water, electricity). Indicator can also just describe the number of households in a high risk area.	Mlada Boleslav	TerraNIS	GIS	O
I1004	Number of people living in flood-prone areas	A high number of people living in flood prone areas shows a high exposure to flood risks. Could be completed with other indicators to assess the impacts of floods on people living in flood prone areas (in terms of socio-economic impacts).	Gabrovo & Burgas Central Greece Mlada Boleslav Prerov Molise	Terra Spatium for Central Greece TerraNIS for others	GIS	O
I1005	Number of properties flooded per year	Climate change increases the frequency and intensity of extreme weather events such as floods. It can also change the location and timing of floods.	Gabrovo & Burgas Central Greece Mlada Boleslav Prerov	Terra Spatium for Central Greece TerraNIS for others	GIS	O

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I1008	Number of critical infrastructures in areas at risk from flooding	Essential services, such as hospitals should be located outside of risk areas to prevent them from being damaged and/or destroyed from floods/coastal erosion. Could be completed with other indicators to assess the vulnerability (i.e. sensitivity and adaptive capacity)	Central Greece Prerov Molise	Terra Spatium for Central Greece TerraNIS for others	GIS	O
I1010	Share of flood risk area in the city or region	Describes the location and/or share of flood risk areas within city or region.	Gabrovo & Burgas MladaBoleslav Prerov Molise	TerraNIS	GIS	O
I1016	Location of abandoned lands	Abandoned or mal-maintained land areas pose an increased wildfire risk.	Montpellier	TerraNIS	GIS	O
I1033	Disruptions to economy/livelihoods due to water scarcity, wildfire, or flooding	Could describe the losses, number of disruptions to certain professions/sectors, number of professions (and people working in them) vulnerable to or been affected by water scarcity, wildfires, or flooding. Requires information of locally relevant professions/livelihoods that are affected.	Molise	TerraNIS	GIS	O
I1041	Number of weather-related disruptions in energy or electricity distribution	Number and/or distribution of weather-related disruptions. Can help understand, which weather-related events cause disruptions currently and does the changing climate	Prerov	TerraNIS	GIS	O

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		increase/decrease the risk of occurrence.				
I1043	Disruptions to population due to water scarcity	Describing, for example, the number of days per year with water use regulation	Prerov	TerraNIS	GIS	O
I1046	Increase in soil degradation and desertification	Describes either future risk based on climate projections and possibly land use. And/or combines projections with local information on high-risk areas of soil degradation, increased erosion (including agricultural lands) and desertification due to, e.g., their current state, type of vegetation, activities such as agriculture or changes in land use.	Prerov Molise	TerraNIS	GIS	O
I1049	Number of hectares of productive land lost to soil erosion		Prerov	TerraNIS	GIS	O
I1050	Share/percentage of agricultural crops vulnerable to climatic changes	Changing crops to more resilient ones can increase resilience of agricultural sector and food security.	Molise	TerraNIS	Pixagri	LA
I1051	Share of mixed forest of all forests and general tree composition of forests	Mixed forest is more resilient towards changing climatic conditions. Different tree types and varieties have different sensitivity level to climatic	Gabrovo Central Greece MladaBoleslav Prerov Molise	Terra Spatium for Central Greece TerraNIS for others	GIS	O

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		changes, also age of trees plays a role. New tree plantations need to account for future potential climate change impacts at the regional level.				
I1054	Damages in forests due to weather-related events	Describes the amount, percentage or areal distribution of weather-related damages.	Prerov	TerraNIS	GIS	O
I1057	Total forest area impacted by wildfire per year	Increasing temperature due to climate change can lead to increase wildfire with negative impactson forest resources, local populations and tourism.	Gabrovo Central Greece	Terra Spatium for Central Greece TerraNIS for others	GIS	O
I1074	Share of permeable surfaces in urban environments	Describes the share of permeable surfaces in urban environment, related to risk of pluvial flooding. Can also be related to human comfort during heat.	Gabrovo & Burgas MladaBoleslav Prerov Montpellier	TerraNIS	GIS	O
I1075	Percentage of coastline under marine protection		Central Greece	Terra Spatium	Terracoast	
I1078	Share of forested area	Ratio of forest area to municipal area	Molise	TerraNIS	GIS	O
I1079	Share of protected natural area	Ratio of the area of protected natural sites (NATURA 2000 and CDDA) to the municipal area	Molise	TerraNIS	GIS	O

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I1080	Share of agricultural area	Ratio of agricultural area to municipal area	Molise	TerraNIS	GIS	O
I1081	Water needs of crops	Assesses the water balance of a field by comparing water inputs with plant water use through evapotranspiration.	Central Greece MladaBoleslav Prerov Molise Montpellier Sicoval	TerraNIS	"Pixagri Territories "	LA
I1082	Vulnerability of crops to climatic hazards	This indicator takes the form of a toolbox. It can be used to select a crop and highlight the risks associated with the climate at certain key moments in the vegetative development process.	Montpellier Sicoval	TerraNIS	"Pixagri Territories "	LA
I1083	Impact of climate change on annual crops yield	This indicator is based on the AquaCrop crop growth model developed by the Land and Water Division of FAO to address food security and to assess the effect of environment and management on crop production. AquaCrop simulates yield response to water of herbaceous crops,	Montpellier Sicoval	TerraNIS	"Pixagri Territories "	LA
I1084	Population vulnerability to heat waves	Level of vulnerability of populations to a heat wave aggravated by the potential UHI (urban heat island) effect. Use I1021 and I1003	Gabrovo & Burgas MladaBoleslav Prerov Montpellier Sicoval	TerraNIS	Landia	LA
I1085	LCZ vulnerability level	Vulnerability class of the unit of analysis to urban heat islands in	Montpellier	TerraNIS	Landia	LA

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		relation to the local climate zone class to which it belongs				
I1089	Quality and structure of the green network	This index is a weighted sum of most relevant biodiversity indicators such as share of green, canopy and herbaceous area as well as connectivity and distance between canopy areas	Gabrovo & Burgas MladaBoleslav Prerov Montpellier Sicoval	TerraNIS	Landia	LA
I1090	Share of green area	Percentage of the surface area of the unit of analysis occupied by vegetation (private and public spaces combined)	Montpellier Sicoval	TerraNIS	Landia	LA
I1091	Share of canopy area	Percentage of the surface area of the unit of analysis occupied by wooded vegetation (private and public spaces combined) also called canopy index	Montpellier Sicoval	TerraNIS	Landia	LA
I1092	Share of herbaceous area	Percentage of the surface area of the analysis unit occupied by low vegetation like shrub and grassland (private and public spaces combined)	Montpellier Sicoval	TerraNIS	Landia	LA
I1094	Urban vegetation and well-being	This index is a weighted sum of most relevant well-being (related to vegetation) indicators such as green, canopy and public green areas per capita as well as accessibility to public green spaces	Gabrovo & Burgas MladaBoleslav Prerov Montpellier Sicoval	TerraNIS	Landia	LA
I1096	Area of public green spaces per capita	Average area of public green space per inhabitant per analysis unit	Montpellier Sicoval	TerraNIS	Landia	LA

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I1098	Share of public green spaces	Percentage of the surface area of the analysis unit made up of public green spaces	Montpellier Sicoval	TerraNIS	Landia	LA
I1099	Accessiblity to public green spaces	Proportion of the population with access to a relatively large public green space (over 5000m²) nearby (less than 10 minutes' walk)	Montpellier Sicoval	TerraNIS	Landia	LA
I1100	Land Surface temperature	Mean Land surface temperature in the unit of analysis under consideration	Gabrovo & Burgas MladaBoleslav Prerov Montpellier Sicoval	TerraNIS	Landia	LA

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