D2.2 Data Collection Report

WP2 – Demonstration and Validation

Deliverable Lead: MeteoGrid

Dissemination Level: Public.

Deliverable due date: 30/11/2018

Actual submission date: 29/01/2019

Version 1.1.3

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730355

Document Control Page	
Title	D2.2 Data Collection Report
Creator	Angela Rivera-Campos (MeteoGrid)
Description	This document summarises the methodology set in place for data collection in the different pilots of the project
Publisher	CLARITY Consortium
Contributors	Angela Rivera-Campos (MeteoGrid), Luis Torres (Meteogrid), Mattia Leone (PLINIUS), Francesca Gallinella (PLINIVS), Laura Asensio (MeteoGrid), Sonia Rubio (MeteoGrid), Alberto Valverde (MeteoGrid), Astrid Kainz (ZAMG), Robert Goler (ZAMG), Maja Zuvela-Aloise (ZAMG), Wolfgang Loibl (AIT), Lena Strömbäck (SMHI), Jorge H. Amorin (SMHI), Claudia Hahn (ZAMG)
Creation date	03/10/2018
Type	Text
Language	en-GB
Rights	Copyright "CLARITY Consortium"
Audience	☒ Public ☐ Confidential ☐ Classified
Status	☐ In Progress ☐ For Review ☐ For Approval ☒ Approved

Revision History			
Version	Date	Modified by	Comments
0.1	03/10/2018	Angela Rivera-Campos (MeteoGrid)	Document layout and table of contents
0.2	30/11/2018	Mattia Leone, Francesca Gallinella (PLINIVS)	PLINIVS contribution on DC1
0.3	13/12/2018	Laura Asensio (MeteoGrid), Sonia Rubio (MeteoGrid), Alberto Valverde (MeteoGrid)	MTG contribution on DC4
0.4	21/12/2018	Astrid Kainz, Robert Goler, Maja Zuvela-Aloise (ZAMG)	Added information to Section 3.1
0.5	03/01/2019	Wolfgang Loibl (AIT)	Additional contribution on DC3
0.6	08/01/2019	Luis Torres (Meteogrid)	Review
0.6	08/01/2019	Astrid Kainz (ZAMG)	Contribution on DC3
0.8	09/01/2019	Luis Torres (Meteogrid)	Review
1.0	14/01/2019	Angela Rivera-Campos	Final version ready to submit
1.0.1	14/01/2019	Denis Havlik	Final review; fixed meta-information and formatting.
1.02	29/01/2019	Denis Havlik	Accepted improvements by ZAMG; uploaded to the Participants Portal
1.1.0	19/07/2019	Angela Rivera-Campos	Change introduction for DoA compliance

1.1.1	09/01/2020	Angela Rivera-Campos (Meteogrid), Luis Torres (Meteogrid), Lena Strömbäck (SMHI)	Changes to DC1, DC2 & DC3 to address revision comments.
1.1.2	04/02/2020	Claudia Hahn (ZAMG)	Added information to section 3.1. List of data sets that are used in the pan-European CLARITY data set is in the Annex 1.
1.2.3	10/02/2020	Denis Havlik	Introduced the five CLARITY "buildings" layers in section 3.1. Final control before uploading to Participants Portal.

Disclaimer

This deliverable is subject to final acceptance by the European Commission.

Disclaimer

Figure 1: CLARITY Disclamer

Table of Contents

CLARITY Project Overview 7
Abbreviations and Glossary 8
Executive Summary 9
Introduction 10
1 Methodology 11
1.1 Description 11
1.2 Identified Tasks 12
2 Software and Tools 13
2.1 Spreadsheet 14
2.2 Administration of data and metadata in CKAN 14
2.3 Data storage on servers 15
3 Development of the data collection task at Screening and DC level 16
3.1 CSIS screening level 16
3.1.1 Scope 16
3.1.2 Data Catalogue 18
3.2 General EU-scale data used as input for several DCs 18
3.3 DC1 19
3.3.1 Scope 19
3.3.2 Data Catalogue 21
3.4 DC2 22
3.4.1 Scope 22
3.4.2 Data Catalogue 24
3.5 DC3 25
3.5.1 Scope 25
3.5.2 Data Catalogue 26
3.6 DC4 27
3.6.1 Scope 27
3.6.2 Data Catalogue 29
4 Acknowledgement 30
5 Conclusions and Next Steps 30
References 30

List of Figures

Figure 1**:** CLARITY Disclamer 4
Figure 2. Eu-Gl logic update in CLARITY 11
Figure 3. Image of the layout of the road 13
Figure 4. Image of Clarity's CKAN instance 14
Figure 5. Image of GeoServer 15
Figure 5. Urban atlas Public/military/industrial areas around Castel St. Elmo in Napoli. 17
Figure 5. CLARITY public/military/industrial buildings layer around Castel St. Elmo in Napoli. 17
Figure 6. Localization of the considered climate-related hazards and focus on related projects 20
Figure 7: Uploading data and metadata within FTP server and CKAN 22
Figure 8. Visualization of a model 28

Table 1.Correlations between EU-GL steps and CLARITY macro-steps in relation to the main input data types to be collected. 11
Table 2. Models and datasets 21
Table 3. Mapping of models and datasets needed for DC2 implementation 24
Table 4. Datasets and Model output for DC3 implementation 26
Table 5. Datasets and Model output for DC4 implementation 29

CLARITY Project Overview

Urban areas and traffic infrastructure linking such areas are highly vulnerable to climate change. Smart use of existing climate intelligence can increase urban resilience and generate added value for businesses and society at large. Based on the results of FP7 climate change, future internet and crisis preparedness projects (SUDPLAN, ENVIROFI, CRISMA) with an average TRL of 4-5 and following an agile and user-centred design process, end-users, purveyors and providers of climate intelligence will co-create an integrated Climate Services Information System (CSIS) to integrate resilience into urban infrastructure.

As a result, CLARITY will provide an operational eco-system of cloud based climate services to calculate and present the expected effects of CC-induced and -amplified hazards at the level of risk, vulnerability and impact functions. CLARITY will offer what-If decision support functions to investigate the effects of adaptation measures and risk reduction options in the specific project context, and allow the comparison of alternative strategies. Four demonstration cases will showcase CLARITY climate services in different climatic, regional, infrastructure and hazard contexts in Italy, Sweden, Austria and Spain; focusing on the planning and implementation of urban infrastructure development projects.

CLARITY will provide the practical means to include the effects of CC hazards and possible adaptation and risk management strategies into planning and implementation of such projects, focusing on increasing CC resilience. Decision makers involved in these projects will be empowered to perform climate proof and adaptive planning of adaptation and risk reduction options.

Abbreviations and Glossary

A common glossary of terms for all CLARITY deliverables, as well as a list of abbreviations, can be found in the public document "CLARITY Glossary" available at http://cat.clarityCLARITY-h2020.eu/glossary/main.

Abbreviation/ Acronym	DEFINITION
CA	Consortium Agreement
CRM	Continuous Risk Management
DC	Demonstration Case
DPA	Data Protection Agency
DoA	Description of the Actions (Annex 1 to the Grant Agreement)
EC	European Commission
EM	Exploitation Manager
GA	General Assembly
IPR	Intellectual Property Rights
QA	Quality Assurance
QAP	Quality Assurance Plan
SQA	Software Quality Assurance
SQAP	Software Quality Assurance Plan
TM	Scientific & Technical Manager
TL	Task Leader
TOC	Table of Content
WP	Work Package
WPL	Work Package Leader
OGC	Open Geospatial Consortium
WMS	Web Map Service
WCS	Web Coverage Service
WPS	Web Processing Service

Executive Summary

This document summarises the methodology set in place to facilitate the collection of information from the pilots who are being carried out within the framework of the Clarity project. It includes both the procedures defined and the support tools that allow for keeping a record of what data are used and facilitate their publication.

A catalogue of CLARITY data and metadata has been set-up by the consortium with the help of a spreadsheet designed within the first activities of this task, and lately with CKAN, a powerful data management tool that allows to register, describe, publish and share data. This catalogue is foreseen to be continuously updated throughout the project in case new data will become available.

The datasets will be collected and made available to the pilots using the facilities set up by the consortium and described in this document (FTP server and Geoserver). As a part of this task, the catalogue of elements at risk and adaptation options was populated with a first set of data from the demonstration sites.

Introduction

This document summarizes the outcome of the activities carried out during Task 2.2, which were intended to support the data collection activities in the different demonstration cases and that lead to the production of deliverable D2.2, i.e., the data catalogue. This catalogue of CLARITY data and metadata has been set-up by the consortium and it is foreseen to be continuously updated throughout the project in case new data is needed or existing datasets need to be updated or modified . The datasets will be collected and made available to the pilots using the tools selected (FTP server and Geoserver). As a part of this task, the catalogue of elements at risk and adaptation options was populated with a first set of data from the demonstration sites and with the data from the different sources identified within each demo case. This will allow to validate the scenario transferability functionality (T4.4) later on and provide the initial data set for the CLARITY marketplace in T5.4. Where feasible datasets will be made accessible through the GEOSS platform following the GEOSS Data Sharing Principles.

The main objective of this task is to ensure that the data collected can cover the information needs defined in the user cases and provide the tools to ensure the fulfilment of this goal. Also, it aims to ensure that on the first stages of the task adequate procedures have been established for the collection of information and, on a later date, to give support to the members of the consortium in the generation of the set of data needed in order to ensure that the methodology is understood and that it meets the expected objective. It will be the responsibility of each of the demo-case coordinators to periodically update the data catalogues collected in the support tools defined in this document. As already stated, the end result will be the production of the deliverable: the CKAN data catalogue.

The compliance of collected data with the end-users' requirements (WP1), models' will be lately assessed through workshop sessions with key stakeholders along the validation task (T2.4), data suppliers and potential end-users' representative of the 4 CLARITY demonstrators (at least 2 per demonstration case). Complementing T2.3, dedicated workshops will provide stakeholders with the opportunity to evaluate/test/know/identify the current state of models and data in CLARITY climate services. During the workshops relevant pre-existing (legacy) tools, models and data required for the actual implementation of the demo-cases will be identified, also key limitations and integration requirements will be highlighted.

1 Methodology

1.1 Description

The data collection methodology has been intended as a guide to ensure that the steps derived from the EU-GL are followed and each Demo Case will be able to implement them.

The methodology consisted in the preliminary mapping of models and datasets with respect to the objectives of the DCs as outlined by the identified user stories. The 7 steps of the EU-GL logic are updated within CLARITY in relation to the modelling framework as defined in IPCC-AR5, identifying 5 operational macro-steps characterized by different data flows in relation to the models and tools made available through the CLARITY CSIS (Figure 1, Table 1, see D3.1 “Science support plan and concept”)

Figure 2. Eu-Gl logic update in CLARITY

Table 1.Correlations between EU-GL steps and CLARITY macro-steps in relation to the main input data types to be collected.

Updated EU-GL step	CLARITY macro-step	Main input data types
1. Hazard Characterization (HC)	1. Characterize Hazard(s)	• Historical meteorological data • Climate projections, climate indices • Other hazard(s) data (multi-risk) • Historical events records
2. Evaluation of Exposure (EE) 3. Vulnerability Analysis (VA)	2. Evaluate Exposure and Vulnerability of elements at risk	• Geometry (including terrain) • Typological, technical, construction data • Transport environment • Land use and building functions data

		• Socio-economic data
4. Risk / Impact Assessment (RA / IA)	3. Assess Risk and Impact	• Output from macro-steps 1, 2 • Economic data
5. Identification of Adaptation Options (IAO)	4. Identify and Appraise Adaptation Options	• Adaptation options catalogue (includes cost and performance indicators) • Project-specific data (functional program, design documents, etc.)
6. Appraisal of Adaptation Options (AAO)		
7. Integration of Adaptation Action Plan (IAAP)	5. Integrate / Implement Resilience Measures	• Output from macro-steps 1, 2, 3, 4

During T2.2 "Demonstrator-specific data collection", an identification of the data sources, being external data (that which will not be stored by CLARITY) or internal data (that which will be stored by CLARITY) has been performed. This covers the required data for User Stories, Test Cases and Exploitation Requirements for each of the DCs. Data to be stored in CLARITY's central repository has been identified along with guidelines to ensure the availability of all needed resources for the successful fulfilment of the DCs. For external data, it has also been necessary to gather information on their location, storage, and use during the life-cycle of the project. The definition and the development of the guidelines relies on a detailed description of each of these DCs, both in terms of the steps involved and the data needed in each one. Another important information that has been considered and registered is the meta-data for both types of data in standard meta-data formats.

1.2 Identified Tasks

CSIS LEVEL

1. Meta-data catalogue: Creation of CLARITY meta-data catalogue describing the Datasets.
    1. Define the catalogue structure
    2. Creation of a first version of the catalogue
    3. Link to the catalogue of elements at risk and adaptation options (WP3 – WP4)
    4. Marketplace

DC LEVEL

2. Identification: defined as the process of identifying the DS needed for each DC.
    1. US revision: study the "story line" of each US
    2. Identify TC/DS/BB of each DC
    3. Identify the "physical" location of the DS (Clarity, external sources?)
    4. Generate a detailed list of all DS needed linked to their TC/US
3. Identify current systems or applications that support our US.
    1. Identify data being used
    2. Functionality
    3. Integration requirements
    4. Marketplace DC needs

4. Workshops to evaluate the viability and usefulness of the data (reliability, uncertainty)

Follow up: defined as the continuous monitoring of the identified and available data)

1. Update
2. Add
3. Revision
4. Customize at DC level the catalogue of elements at risk and adaptation options. Identify the "physical" location of the DS (Clarity, external sources?)

2 Software and Tools

Data pre-processing. Standardization and integration in GIS

For each pilot of the project, diverse sources of data and resources will be used, some of them for shared use and others for particular use. This implies the need to homogenize the data used for its implementation within the system in order to create interoperable results for all participants. Data pre-processing tasks will be governed by the guidelines of the European INSPIRE directive. This includes the following activities:

- **Standardisation** of formats to those supported by INSPIRE and frequently used in open access geographic information systems, such as QGIS. Most of the information will be processed in raster formats, specifically with the GeoTiff extension. For this, the GDAL libraries will be used and the necessary conversion commands from different source formats will be systematized. Other information will be treated in vectorial format through shapefile formats of extended use.
- The data will be projected to the ETRS98 LAEA system (EPSG:3035) in Europe and will be projected in ETRS89 UTM in Spain.
- Finally, data **normalization** includes regulating the grid size of the data as well as its positioning from the point of origin of the grid. To do this, it is necessary to create a reference grid on which to structure the data model of the rest of the layers to be generated. This makes it possible to operate with different raster and obtain regularized databases. A European level but has generated a network of 500 regular meters.

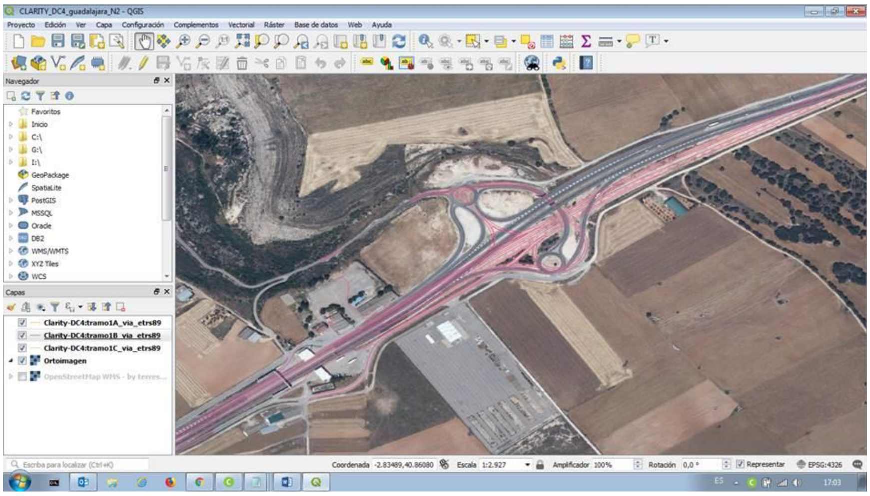

Figure 3. Image of the layout of the road

With the aim of harmonising data collection between different user cases, a suite of tools has been established in which metadata are collected and from which data sets can be accessed. A spreadsheet was initially used as a simple way to track the data collection. Subsequently, the use of a more powerful tool was established, although with a somewhat more complex use. CKAN is a powerful data management tool that allows to register, describe, publish and share data.

The datasets are being collected and made available to the pilots using the facilities set up by the consortium and described further on in this document (FTP server and Geoserver).

2.1 Spreadsheet

In order to facilitate and homogenise the metadata collected in each user case, a spreadsheet has been defined and shared with the other members of the project in which the fields to be reported for each data set are identified. This file has been divided by pilot cases, common information and management data. Each data has been registered incorporating the following information: data name, type of access, owner, link, format, area covered, resolution or scale, date of survey, type, use within modelling workflow, used as input for, notes (optional), data availability and responsible person.

2.2 Administration of data and metadata in CKAN

The different data sets are informed through a dedicated CKAN instance that can be found at https://ckan.myclimateservice.eu. This is an open resource that helps manage and publish datasets and has relevant utilities when large volumes of information are managed. Through CKAN the different project actors will be able to create data sets as well as identify the metadata associated with each one. The metadata can be raised by the users. Links to the source resources associated with each data set can be:

- External access to the project warehouses. When it comes to information maintained and created by external entities.
- Internal access through directories maintained by project members. When it comes to processed information, final or not.

In addition, within CKAN different organizations can be created and users can have different roles within each organization, depending on the level of authorization to create, edit or publish information. Within the framework of the Clarity project, 5 organisations have been set up, one for each pilot and a generic one at European level where the WP3 data are collected.

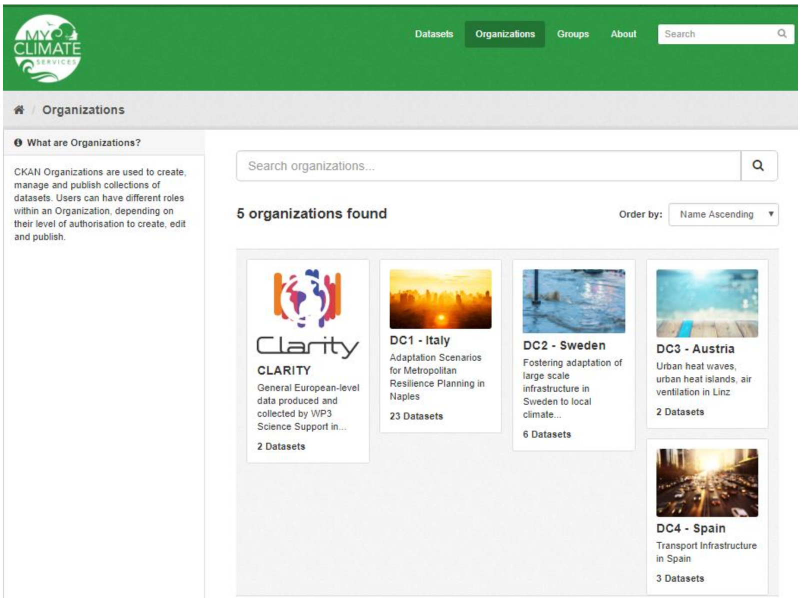

Figure 4. Image of Clarity's CKAN instance

2.3 Data storage on servers

The data generated in the framework of the project, both final data and those derived from intermediate processes as well as those reference data that are common, will be stored in internal servers. An FTP server supported by ATOS with common access to the rest of the pilots has been enabled. This file directory is structured in first, second, third order folders, etc. The first-order folders correspond to the name of each pilot along with a common folder. The following sub-folders refer to the databases they contain.

The FTP-enabled directory allows georeferenced data to be collected and published to open online resources. Geoserver has been used to share the processed layers through open standards (OGC) allowing the interoperability of the data.

GeoServer is a OGC compliant implementation of a number of open standards such as Web Feature Service (WFS), Web Map Service (WMS), and Web Coverage Service (WCS).

Additional formats and publication options are available including Web Map Tile Service (WMTS) and extensions for Catalogue Service (CSW) and Web Processing Service (WPS).

Within Geoserver the layers can be classified into work warehouses and workspaces. It is possible to create different workspaces with multiple source formats associated with the workspaces. Finally Geoserver allows multiple options of visualization of the published information, creation and application of styles or conversion of formats.

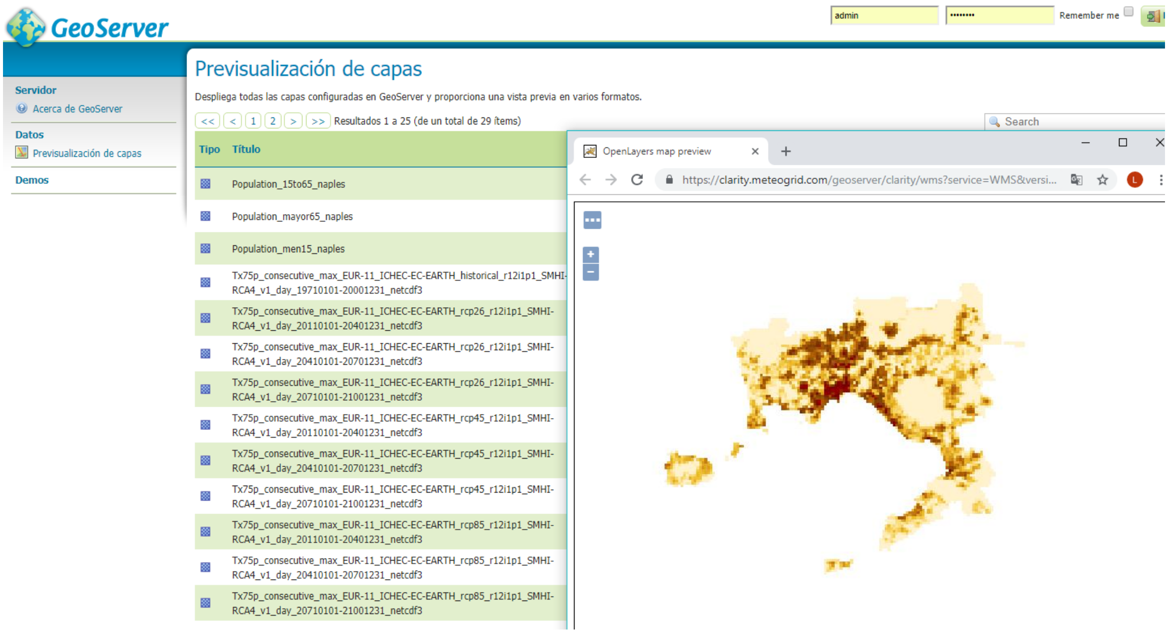

Figure 5. Image of GeoServer

3 Development of the data collection task at Screening and DC level

3.1 CSIS screening level

3.1.1 Scope

The CSIS screening tool will lead the user through the EU-GL steps, providing information from openly available European data sets for them to explore how climate change will affect their region in Europe.

For the hazard characterisation at European level, CSIS will provide climate indices with a spatial resolution of about 12km x 12km as well as higher resolution hazard information (500m x 500m) for heat and flood. The characterisation of the hazards at the European level is based on available observational and climate model data. The European Climate Assessment & Dataset (ECA&D) project offers a database of quality controlled daily meteorological data from measuring stations across Europe and includes the high-resolution gridded dataset E-OBS. Climate model results from EURO-CORDEX, which have a spatial resolution of 12km x 12km, were bias corrected using the E-OBS data set and used to calculate climate indices for a historical and three future time periods. The future climate projections from EURO-CORDEX include the emission pathways (RCP26, RCP45, RCP85), and are produced by a number of institutes with different combinations of driving global climate models (GCMs) and regional climate models (RCMs). These datasets enable a large number of climate indices to be calculated, which can be used to capture the climate change signal for temperature- and precipitation-related hazards. Several indices, which are focused on river flooding will be available from the SWICCA dataset, which has a spatial resolution of 50km and is available on an irregular grid for each catchment. Indices regarding forest fires have been tried to be calculated from the CORDEX climate models but the appropriate variables are not available. Attempts are being made to generate these variables from other available ones, although it is being evaluated whether the final results are reliable enough to be used, while indices concerning landslides will be supplemented with data from the European Soil Data Centre (ESDAC), which offers data at a spatial resolution of 200m.

For heat and flood, open European data like Urban Atlas, European Settlement Map, EU-DEM are used to derive hazard information at higher resolution. As a side-effect of this work, CLARITY team has generated five CLARITY “buildings” layers:

- Three “urban fabric buildings” layers,
- “public/military/industrial buildings” layer,
- and the “sport/leisure buildings” layer.

These layers that were generated by subtracting the vegetation, agricultural areas, and “built open spaces” (pavements) from the European Settlement map and the trees from the Street Tree Layer from the Urban atlas layers. The result is quite interesting, as illustrated in Figure 6 and Figure 7. The results improve upon the European settlement map in two ways:

1. First, we presume that whatever is left over after subtraction is a building. In this way, we were able to correctly *identify the buildings that aren’t identified in the European Settlement map.* This appears to be a rather common issue, as we were able to identify some such areas in every city where we did the testing.
2. Second, the five CLARITY “buildings” layers have distinct *usage classes* that are inherited from the Urban Atlas. This information can be useful, for modelling the local exposure (e.g. people don’t live in industrial complexes) as well as the local hazard effects (e.g. different building types may have different characteristics in the model).

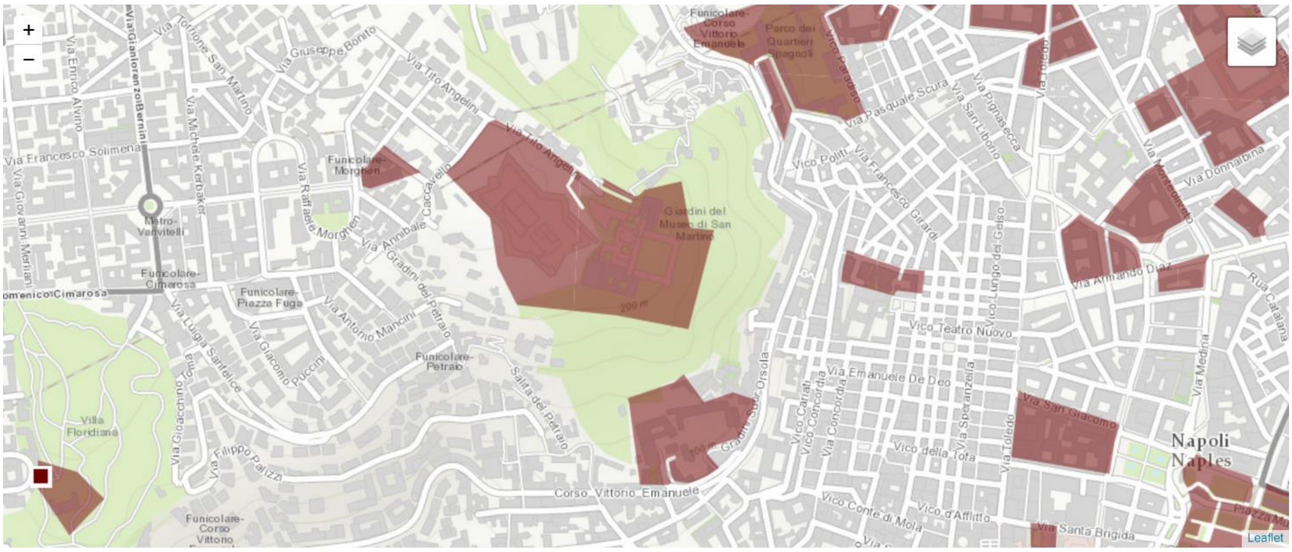

Figure 6. Urban atlas Public/military/industrial areas around Castel St. Elmo in Napoli.

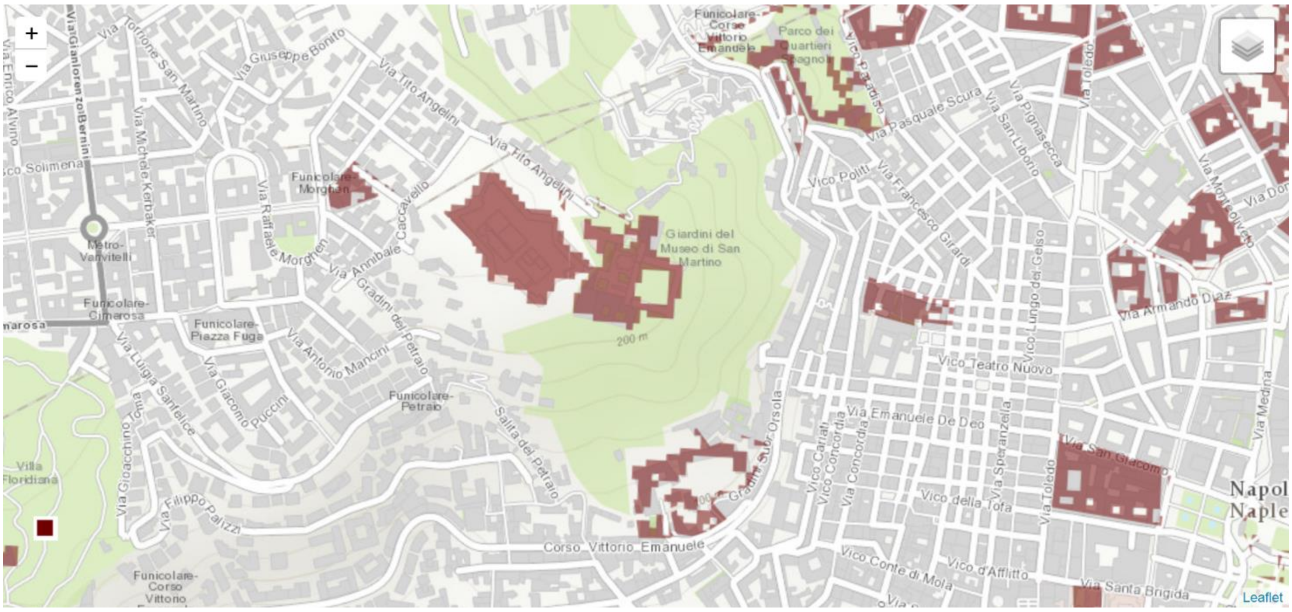

Figure 7. CLARITY public/military/industrial buildings layer around Castel St. Elmo in Napoli.

It will be possible to display all climate indices in CSIS together with additional relevant information like the location of elements at risk (people, buildings, roads). For heat and flood vulnerability curves are available and the full EU-GL cycle will be demonstrated.

Detailed information regarding the calculation of the climate indices, the procedure to derive higher resolution hazard data and the remaining EU-GL steps is provided in Deliverable D3.1 and D3.2 Science Support Report and will be provided in the upcoming Deliverable D3.3.

3.1.2 Data Catalogue

Models	Datasets – sources
PLINIVS simplified model (Heat wave)	• Land Use - Urban Atlas • European Settlement Map • Street Tree Layer
PLINIVS simplified model (Pluvial Flooding)	• EU-DEM • Land Use – Urban Atlas • Basins; streams
PLINIVS HW / PF Vulnerability model	• PF Urban Infrastructures Exposure – Urban Atlas • HW Population Exposure – Urban Atlas

Information about the calculated climate indices was inserted in CKAN and will be updated continuously, providing metadata information and a link to the respective files. For climate indices, which are not yet uploaded to Zenodo, the URL leads to the general Clarity Zenodo webpage. This will be updated as soon as the respective files are uploaded.

Climate indices calculated include:

Heat: consecutive summer days, heat wave duration, hot days, number of days exceeding 90th percentile of maximum daily temperature, summer days, tropical nights

Cold: consecutive frost days, frost days, ice days, number of days below 10th percentile of minimum daily temperature

Thermal stress: extreme temperature range

Precipitation: consecutive wet days, maximum 1 day / 5 day precipitation, number of days exceeding 1 mm / 20 mm, number of days exceeding 90th percentile of precipitation, snow days

Droughts: consecutive dry days

Wind storms: maximum wind speed, number of days with maximum wind speed exceeding 17 m/s, 98th percentile of maximum wind speed

Additional data sources, which were used e.g. for the local effect models to produce higher resolution hazard information and for the exposure evaluation, are also listed in CKAN.

3.2 General EU-scale data used as input for several DCs

A subset of the EURO-CORDEX climate simulations is used as input for the derivation of high-resolution climate indices on urban scale within the framework of DC1 and DC3, considering long-term historical and future climate periods. For this purpose, daily mean values of temperature, relative humidity, wind speed and direction have been extracted from the model data for a specific area representative for the background climate of the urban environment.

High-resolution datasets on a European level, like Urban Atlas (2012) land cover data from the Copernicus Land Monitoring Service[1] and a Digital Elevation Model (DEM) from the European Environment Agency[2],

1 http://www.copernicus.eu/
2 https://www.eea.europa.eu/

serve as input for several modelling activities within the DCs. These datasets have been extracted and processed for the specific areas accordingly.

Harmonization and standardisation are achieved through a European-wide data package containing all the datasets needed to perform screening studies of similar characteristic over the whole of Europe and in each of its cities, at least those included on the European Urban Atlas. Therefore, the limitations in terms of the viability of a study on any European city is limited by the data included in the Urban Atlas and not by limitations on the CSIS or the data package.

The screening level of three city-related demonstration cases (DC1, DC2 and DC3) would be covered by this European-wide data-package which structure is shown on Annex I

Although this data-package could be used to cover the information needed for the screening level of DC4, it has been deemed better to use the information of the official Spanish Climate scenarios to ensure their validity when used to complement official engineering tenders for which they are a requirement.

The data related to this type screening studies are shown on section 3.6.

More detailed information for expert studies on the DC-specific datasets is given in the following chapters. It should be noted that these sort of studies are very specific and the data needed to perform them are, in turn, very specific too. The purpose of each of these cases and the differences in the studies are meant to demonstrate that the CSIS is able and ready to manage a variety of non-standard cases.

3.3 DC1

3.3.1 Scope

DC1 implementation aims to demonstrate the outcomes of CLARITY Expert Services in assessing the benefit of integrating adaptation measures in urban redevelopment/retrofitting projects, with a specific focus on heat waves, pluvial flooding and landslide hazards. In terms of impacts, the planning support tool will focus on the following elements at risk:

- heat waves – population (diseases, mortality)
- pluvial floods – buildings and road network (economic value due to direct damage and duration of functionality interruption)
- landslides – population, buildings and road network

The application intends to link climate data, vulnerability assessment and potential adaptation/mitigation options across multiple scales of intervention (from urban planning, to neighbourhood scale regeneration and building/open spaces retrofitting), aimed at reducing the aggravating factors due to urban and territorial conditions, able to strongly amplify the “local effect” of temperature and precipitation extremes.

The localization of the considered climate-related hazards in the Metropolitan City of Naples area are identified as follows:

- Heat Waves: mainly in the Municipality of Napoli, both historical centre and suburbs (focus → Bagnoli-Coroglio redevelopment Plan; Ponticelli District Urban Regeneration Plan; new public transport lines in East Napoli; New Building Code of Municipality of Napoli);
- Pluvial Flooding: mainly east suburbs of Napoli and its floodplain suburbs (focus → Ponticelli District Urban Regeneration Plan).
- LandSlides: mainly municipalities around Vesuvius (focus → Municipality of Castellammare di Stabia).

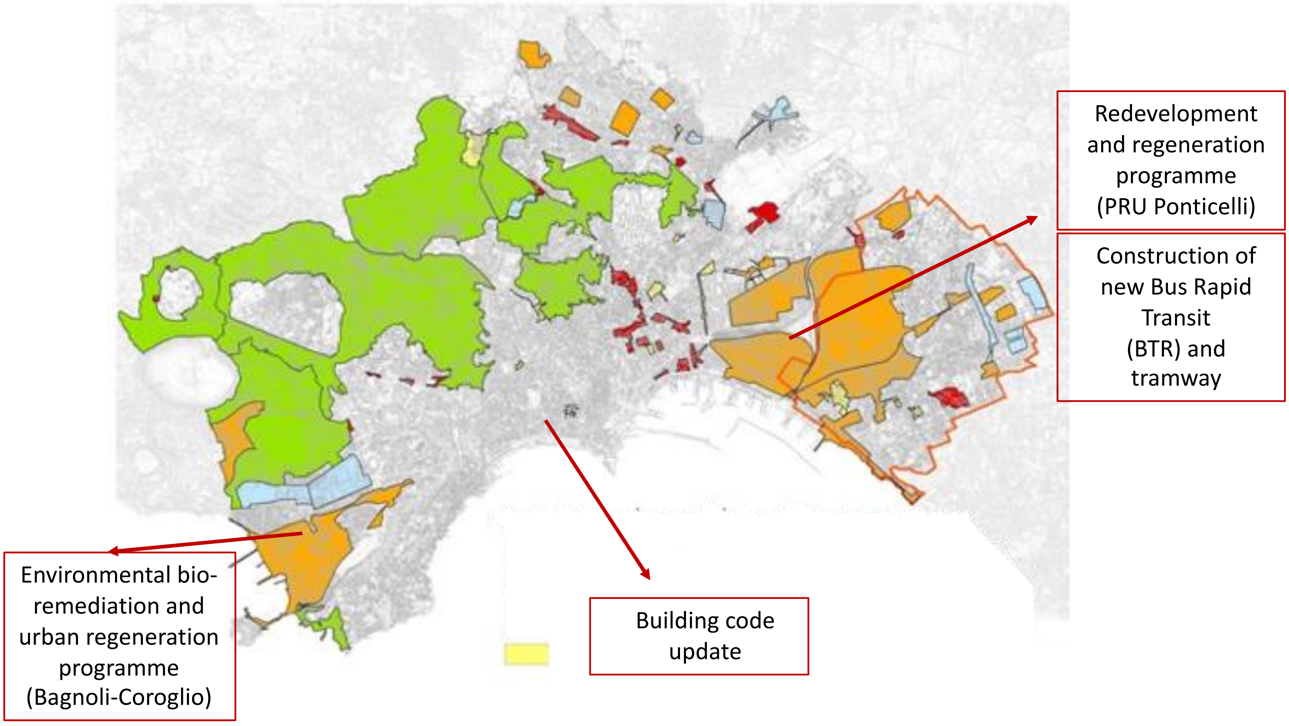

Figure 8. Localization of the considered climate-related hazards and focus on related projects

3.3.2 Data Catalogue

Multiple scales of analysis have been considered, subject to data availability. These high-resolution data sets for the expert model have been identified in order to make them applicable to the models used. The modelling logic has been designed towards flexibility and scale-independency.

Meteorological datasets, layers related to geomorphology, buildings, open spaces and vegetation, as well as hydrological data sets have been used as input for PLINIVS simplified models. Most of these data have been obtained from DSM and DTM of Naples. This model has not yet been fully implemented at this stage of DC1 development.

Table 2. Models and datasets

Models	**Datasets – sources**
MUKLIMO (heat - urban microclimate)	• Mean building height; Building typology classification; Wall area index; K-value of the building walls and roofs; Area heat capacity of the building walls and roofs – PLINIVS • Fraction of impervious surface between buildings; Surface roughness of the non-built-up areas – PLINIVS • Vegetation parameters (Tree height, Stem height, Leaf area density, Leaf area index, Vegetation height of the canopy layer, Tree cover, Vegetation cover) – PLINIVS • Albedo of the walls, roofs and impervious parts of the canopy layer – PLINIVS • Land Use – Urban Atlas, Naples Municipality
PLINIVS simplified model (Pluvial Flooding)	• DSM; DTM – Naples Metropolitan City (Lidar) • Land Use – Urban Atlas, Naples Municipality • Basins; Flow direction; Flow accumulation; Run off – PLINIVS
PLINIVS HW / PF Vulnerability model	• PF Urban Infrastructures Exposure – PLINIVS • HW Population Exposure – PLINIVS
PLINIVS HW / PF Impact model	MUKLIMO / PLINIVS simplified model output; PLINIVS HW / PF Vulnerability model output

The metadata of each single data has been uploaded, collected and catalogued within CKAN. For all the layers, the descriptive parameters have been uniquely identified, in order to have a harmonized structure of the entire database (Figure 9).

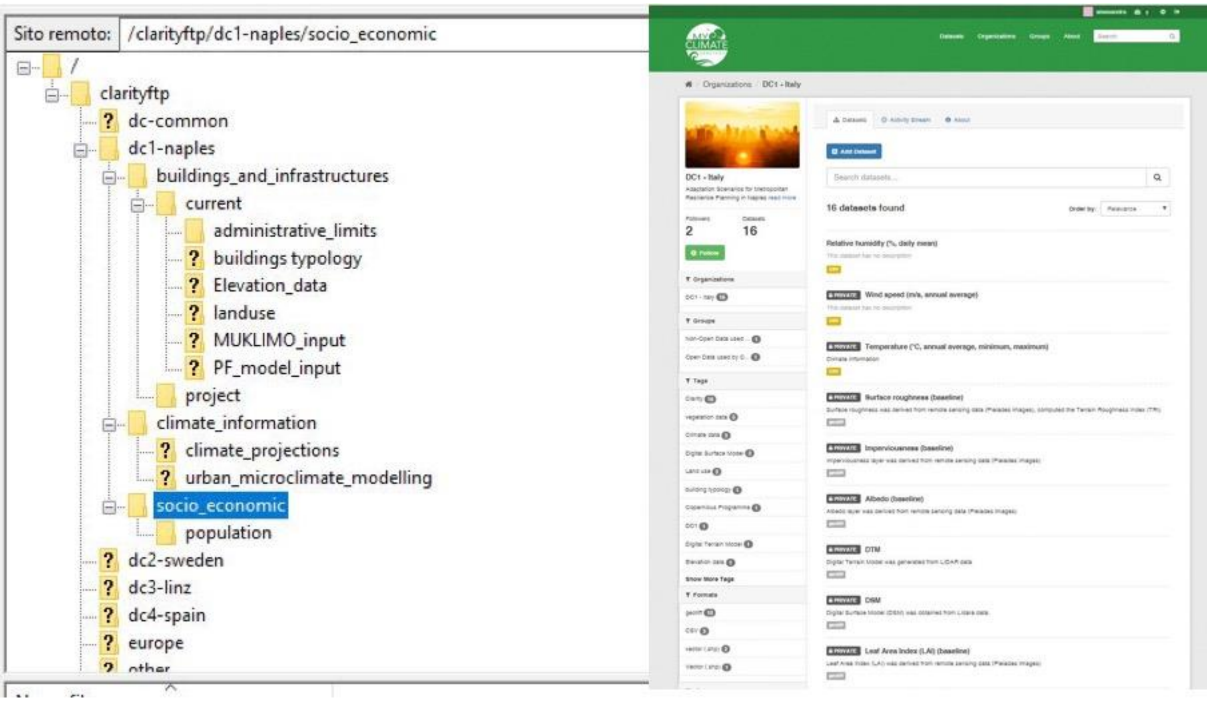

Figure 9: Uploading data and metadata within FTP server and CKAN

3.4 DC2

3.4.1 Scope

The use case is coordinated by SMHI and based on exploring data from two Copernicus Climate Change Services (C3S) projects, SWICCA (on water management) and Urban SIS (on urban climate and air quality). The demonstration will be focused on two sites in Sweden (the County of Jönköping and Stockholm city), where the use of indicators (in the scope of flooding, heat waves, and air/water pollution) in the process of building-up resilience on multi-million-euro development projects will be tested. For Stockholm one main interest is the impact of city development on the urban climate. Another main interest is to investigate the risk for flooding in both areas.

Based on this we have defined the following goals for further investigation within Clarity.

- **Flooding of the city centre of Jönköping:** This goal examines the future flooding risk for the city of Jönköping. The goal has already been explored in SWICCA and by the Swedish Civil Contingencies Agency. For more information about the original user story see http://www.swicca.eu/start/implemented-cases-of-local-change-adaptation/impact-based-flood-risk-assessment-in-present-and-future-climate/. The goal in CLARITY was to extend he study by adding information on lake level rise, higher resolution of climate information and combined effects of events including entrapped areas arriving in a risk assessment (cost – benefit analysis) and flood mitigation measures. After further discussions with CabJon it was decided that the main focus was to evaluate mitigation measures based on data made available by Swedish authorities. This gives interesting results as well as a method that can be reused.
- **Flooding of the city centre of Stockholm:** This goal examines the future flooding risk for the city of Stockholm. The goal is to be able to combine effects of lake level with precipitation and runoff and to be able to handle cloud burst events in dense city areas (also where important infrastructure is located). This would allow to evaluate the effects of adaptation measures, analyse risks associated with high precipitation, provide input to the Green Area Factor and analyse the relative importance of high precipitation, high sea level, and high lake level (Mälaren) in the future climate. After further

discussions the focus also in this case has been to evaluate a number of plausible mitigation measures that limit the risk of flooding in the city center.

- **Hydrological buffers in the landscape as ecosystem service:** This goal focuses on studying the potential of wetlands to act as buffers to prevent the negative effects of high flows at a drainage area basin level, i.e. by promoting specific areas to be flooded in order to protect other sensitive areas. The goal is to meet the governmental instructions of the subject on a regional level to minimize negative effects on public services like drinking water supply during periods of draughts, to point out specific drainage areas that are more sensitive to high and low flow regimes and localize specific areas to be flooded and act as hydrological buffers. This case study has not been further investigated as SMHI has worked on the questions as part of our governmental activities.
- **Urban vegetation in Stockholm as a climate adaptation tool:** The focus is to optimize the role of urban vegetation in Stockholm as a climate adaptation tool. Here we have investigated the effect of future building plans and the integration of green infrastructure for Stockholm.
- **Climate and health indicators for Stockholm**: Analysing the impacts of climate change and future land use (including large scale infrastructure projects) on the health of the population and the status of the environment. This is mainly based on the already available Urban SIS dataset.
- **Climate and environmental indicators on a regional level** (Jönköping County). Producing a new tool to present historical as well as modelled future outcome of a selected number of important indicators used in explanation for observations in environmental monitoring. With knowledge of selected critical parameters, predictions can be made on population levels for different organisms/habitats etc. The tool are to be projected on different regional levels like drainage area basin, height above sea level, exposure to rain/rain shadow, county etc. In a second step, the system must be applicable to other regions. This story was origin from one of the SWICCA study cases and has not been further developed due to lack of time.

3.4.2 Data Catalogue

For investigating how the new plans will impact on the urban climate we will use a high-resolution (temporal: 1 hour and spatial: 1 x 1 km^2) dataset from the Urban SIS project available at http://urbansis.climate.copernicus.eu/.

In table 3 we summarize the models and datasets that will be used for studies within DC2 as an extension to the data provided by UrbanSIS and SWICCA.

Table 3. Mapping of models and datasets needed for DC2 implementation

Models/tools	Datasets – sources
RCM HARMONIE (urban downscaling)	n/a (models outputs for Stockholm region already available at SMHI from the Urban SIS C3S project and the national project Hazard Support)
S-HYPE (hydrology)	• Meteorological data – Radar based hourly precipitation and corresponding temperature from MESAN reanalysis system (from SMHI) • Land use /Land cover data – CORINE data set and high resolution Urban Atlas data for urban regions • Soil data – European Soil Data Base augmented with Swedish soil information • Hourly river discharge data – SMHI's discharge data archive, data from local authorities (Stockholm Vatten)
MIKE (MIKE11 and MIKE21)	• DEM - 3D city model with buildings– Lidar data (2 m resolution) from the Swedish real property register (Lantmäteriet) • Land use map from the Swedish real property register (Lantmäteriet) • Soil map from the geological survey of Sweden (SGU) • Information about structures (dams and bridges) that affect the flow from the Swedish transport system (Trafikverket) and municipalities • Information about bathymetry (data need to be measured or can be available from the municipality).
Green Area Factor (GAF)	• Area occupied by a specific type of vegetation • Total land area • Data on buildings, streets and parks, both planned and existing (Lantmäteriet)

In addition to these sources we have used a number of the datasets that are provided by Swedish authorities For expert studies this data may need to be combined with local information such as land use maps, elevation data, drainage systems, and sites of pumping activity. The table below give an overview of authorities from where data is collected and examples of data used in the studies:

Authority, source	Example of datasets
Swedish Authority for Land Survey (Lantmäteriet)	Land use, Elevation data, Orthophoto, Terrain maps, Topography, Buildings
Geological Survey of Sweden (SGU)	Soil data
Jönköping Municipality	Overview map of plans, Mapping downpour, Water level,
Jönköping County Board	Climate adaption plans
Swedish meteorological and hydrological institute (SMHI)	Catchments in Sweden

Swedish Civil Contingencies Agency (MSB)	Landslide, flood
Statistics Sweden (SCB)	Critical services for the society such as schools, hospitals, population
Swedish transport administration (Trafikverket)	Roads and railways

These data are being collected in CKAN. This is an ongoing process that is dependent on the identification of new needs, as explained above.

3.5 DC3

3.5.1 Scope

DC3 implementation aims to demonstrate results of CLARITY Expert Services in assessing climate risk and vulnerability and the impact of integrating adaptation measures related to urban planning and urban redevelopment.

The objective of the City of Linz is to assess the interaction of urban densification with climate risk, urban densification and urban growth are affecting the urban micro-climate development, specifically with respect to heat island phenomenon and air flow. Considering local climate conditions, the influence of urban densification is expected to increase, requiring adaption activities to better direct the urban dynamics with respect to future climate change with a specific focus on heat waves, and urban ventilation.

The planning support will focus on the population as major element at risk due to climate change and due to change in surface properties (increased sealing) and buildings (increased building height) which increases heat trapping and decrease ability of ventilation.

The application intends to link climate data, vulnerability assessment and potential adaptation/mitigation options across the city scale and the neighbourhood scale.

The neighbourhood scale is considered for selected neighbourhood which are expected to show the climate related affects either due to climate change or due to urban densification and extension or due to both.

Datasets relevant for DC3 are used to calculate different scenarios according to the user stories and considering different adaptation measures (e.g. unsealing of land, roof greening, tree cover densification). Furthermore, the effects of new settlement areas on urban climate can be simulated. The obtained results will help to give recommendations in terms of resilient urban planning.

3.5.2 Data Catalogue

General input data for urban climate modelling have been taken from open data sources on a European level, like: Urban Atlas (2012), digital elevation models, soil sealing layer, etc. By integrating land use, street network, building footprints, building height and terrain data, a LOD1 3D city model for Linz and surroundings has been generated for the micro-climate modelling tasks. A vegetation layer has been derived from satellite image classification. Furthermore, long-term observational data from two monitoring stations and EURO-CORDEX regional climate model simulations have been processed to be used as input for the derivation of long-term climate indices on urban scale. Table 4 provides a list of the collected datasets in association with all applied models relevant for the implementation of DC3.

Table 4. Datasets and Model output for DC3 implementation

Models	Datasets – sources
RCM (regional downscaling)	• models output already available at EURO-CORDEX database)
COSMO-CLM (regional downscaling)	• Reclip-century simulations 1959 to 2015 10km resolution for Alpine Space, 10km resolution for Alpine Space, 4km for Austria, based on ECMWF ERA-40 & ERA Interim-forcing data • IPCC A1B Reclip-century simulations 2010 to 2100, 10km resolution for Alpine Space, 4km for Austria, based on HADCM3 A1B climate simulations • Based on this - CLARITY simulations at 1x1km resolution to be carried out for Greater Linz area area.
MUKLIMO_3 (heat - urban microclimate)	• Historical meteorological data – ZAMG • RCM simulations (1971-2100) – EURO-CORDEX, processed by ZAMG • Digital Elevation Model – Upper Austria • Urban Atlas (2012) landcover data – Copernicus Land Monitoring Service • Building footprints and mean building heights – City of Linz, processed by AIT • Fraction of impervious surface between buildings – Copernicus Land Monitoring Service, AIT • Tree/vegetation cover and respective height information – City of Linz, processed by AIT
MIcroclimate Simulation input. (different for ENVI-met, SOLWEIG and Grasshopper plugins)	• 10 m digital elevation model • Soil sealing shares • Cadastre map • Land use and zoning map • Building footprints • Tree inventory • Street network • Normalized digital surface model • 3D City model (building footprints with height information - LOD1) • Gridded building height and vegetation height layers • at 2m resolution for selected case study areas in Linz for Envimet simulations • Subsets of the 3D city models as shape files for SOLWEIG and Grasshopper simulations

All input data required for modelling are uploaded into the FTP server. In particular, the structure of the FTP server has been defined in a hierarchical manner. Also the data have been catalogued in the CKAN.

3.6 DC4

3.6.1 Scope

In the framework of the Clarity project, the pilot developed in Spain on road infrastructure aims to provide the user with a computer application that facilitates the risk assessment of a road project in the face of climate variability and change. In this case the screening and the expert levels do not deviate from one another due to the fact that both are based on expert assessment on the vulnerability of the identified elements. These elements need to be treated individually in each instance and cannot be statistically assessed, as is the case with urban vulnerable elements.

In addition, the pilot will address the needs of several types of potential users who in turn will demand different climate information with a different utility.

In order to respond to the needs detected, a catalogue of data has been drawn up to be incorporated into the risk analysis tool in each of the steps established by the EU-GL methodology.

The design of the system will be based on the following entry questions:

1. In hazard module, the system will contain pre-calculated climate information available to the user at European or national level that includes both climate change scenarios and indicators derived from the above or expected anomalies and their associated uncertainties. On the other hand, the system will contain simple weather forecast modules at daily and seasonal scales. The system must incorporate functions for the user to decide what information to use within the information available in the system according to specific needs.

   The different time horizons of information are in turn associated with different needs. The following is an overview of the main differences found:

   - Short-term - Meteorological data provided in daily environments that serve day-to-day management activities or support decision making at the operational level. Relevant inputs have been identified as those that predict periods of high and very high fire risk and also periods of fog that obstruct normal traffic.

   - Medium term - Seasonal data provided in environments of several months and that are used to plan seasonal activities and associate costs and necessary resources in the infrastructures. Within the relevant indicators on this horizon, the following can be differentiated: forecasts of the duration of periods of high fire risk, beginning of the snow or hail season, and others.

   - Long term - Climatic data that are provided at decadal scales and provide support in bidding companies and infrastructure design with a useful life of more than 30 years. The following are some of the relevant indices that have been defined and developed for long-term threat analysis:

     - 99th percentile of the maximum temperature during the year
     - 5th percentile of the minimum temperature during the year
     - 99th percentile of the daily thermal oscillation
     - annual mean precipitation
     - 99th percentile of the wind gust during the year
     - number of days with snow
     - highest precipitation amount for thirty day interval
     - highest precipitation amount for 24 hours interval

- mean solar radiation during the astronomical summer
- Number of days with risk of ice (temperature below 2ºC and relative humidity > 60%)
- wildfire related indexes

In addition to containing the original data source, the threat module can implement a simple user supervised hazard level classification module.

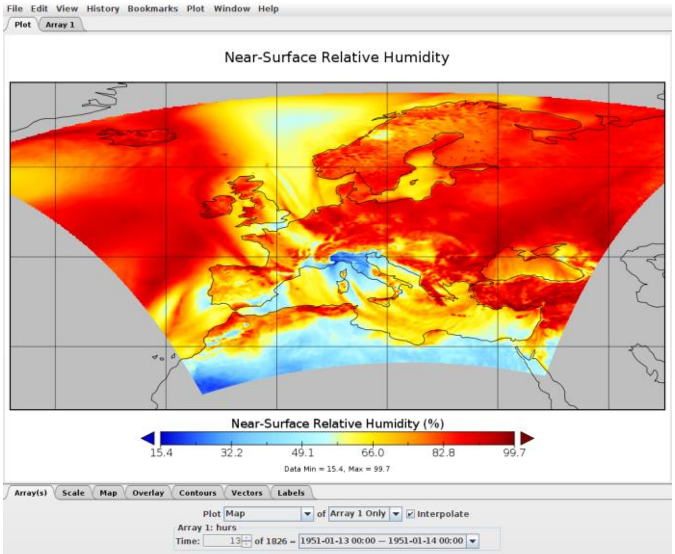

Figure 10. Visualization of a model

2. In the exposure module, the system incorporates those elements of the infrastructure that are likely to be affected by climate hazards. The analysis tool will offer the possibility to select which are the components of the road to obtain results of impact and vulnerability. The selection can be made from a list of pre-existing components. However, the system can incorporate the option to edit and create additional georeferenced elements through simple forms: points, lines or polygons with editable attributes. The following list expresses the components to be considered by default:

   - Cuttings (including tunnel mouths)
   - Embankments
   - Foundations and supports of viaducts and works of passage in riverbed
   - Transverse drainage works in roadway and branches
   - Longitudinal drainage next to the carriageway
   - Canalization of watercourses
   - Viaduct boards
   - Bituminous pavements
   - Roads

3. Finally, the analysis tool will offer an associated vulnerability and impact analysis module for the area and elements selected by the user. In addition to the above data it will be necessary to define the vulnerability components and their typology as well as to associate replacement costs associated with infrastructures with the aim of finally calculating the maximum probable and annual expected losses contemplated in the tool. In the final modules it is foreseen that the user will be able to interact with some calculation functions associated with vulnerability in order to establish critical thresholds over the total values.

3.6.2 Data Catalogue

The following is a list of the data associated with each study module that have been identified in the Spanish pilot framework:

Table 5. Datasets and Model output for DC4 implementation

Models	Datasets – sources
Statistical Downscaling in hazard module	• Meteorological observation data. Hourly resolution. Source: Aemet • Mid term meteorological forecasting. Resolution: 6h / 1 degree. Source: NOAA • Mid term meteorological forecasting. Resolution: 6h / 0.28 degree. Source: ECMWF
Modeling of future climate scenarios in hazard module	• EURO-CORDEX ensemble climate simulations. 0.11 resolution. Source: Cordex
Modeling of hydrology hazard and corrections of several variables	• Digital elevation Model. Resolution: 2 and 5 meters. Source: PNOA
Modeling of wildfire in hazard module	• Spanish forest fuel model. Scale: 1/100.000. Source: MAPAMA
Climate data	• Climate Forecast System (CFSv2). Scale: variable. Source: NOAA • Current climate data: Source: AEMet.
Ensemble climate simulation	• ECMWF System4. Scale: 1 degree. Source: Copernicus
Climate data prediction	• Decadal models outputs (CMIP5). Source: CMIP • AEMet-Spanish official projections. Source: AEMet • CMIP5 climate projections. Source: CMIP
Input exposure element	• Detailed highway design. Scale: 1/500. Source: ACCIONA • Spanish Transport Network layers. Scale: 1/25000. Source: IGN • Traffic volume of Spanish roads. Source: CEDEX • Detailed drainage systems. Scale: 1/500. Source: ACCIONA • Detailed Slopes design. Scale: 1/500. Source: ACCIONA

All data has been collected in a spreadsheet as an inventory and later in the CKAN catalogue. All the data have been arranged in a hierarchical way and have been shared with the rest of the members of the project.

4 Acknowledgement

According to Article 38.1.2 of the model grant agreement, all the documents related to CLARITY (deliverables, presentations, papers, newsletters, leaflets etc.) shall contain the following statement: ***"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730355."***

5 Conclusions and Next Steps

A catalogue of CLARITY data and metadata has been set-up by the consortium with the help of a spreadsheet designed within the first activities of this task, and lately with C-KAN, a powerful data management tool that allows to register, describe, publish and share data. This catalogue is forseen to be continuously updated throughout the project in case new data will become available

The compliance of collected data with the end-users' requirements (WP1), will be assessed through workshop sessions with key stakeholders, data suppliers and potential end-users along the demonstration and validation tasks (T2.3 and T2.4). Complementing T2.3, dedicated workshops will provide stakeholders with the opportunity to evaluate/test/know/identify the current state of models and data in CLARITY climate services.

References

[1] H2020 Reporting guide: http://ec.europa.eu/research/participants/docs/h2020-funding-guide/grants/grant-management/reports_en.htm
[2] H2020 Periodic Technical Report template: http://ec.europa.eu/research/participants/data/ref/h2020/gm/reporting/h2020-tmpl-periodic-rep_en.pdf
[3] H2020 COORDINATORS' DAY: Amendments / Reporting and Payments, 14 February 2017. REPORTING AND PAYMENTS, the Business Process and IT Tool [presentation]: http://ec.europa.eu/research/participants/data/ref/h2020/other/events/2017-02-14/5_reporting-and-payments-business-and-it.pdf
[4] European Union. Directive 95/46/EC of the European Parliament and of the Council of 24. October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data. Official Journal of the European Communities No L281/31; 23.11.1995.

Annex I

European screening data-package

Layers	Description	Licenses	Coverage
Water Areas in Europe	Water Areas in Europe	Copernicus	Europe
Public, military and industrial areas in Europe	Public, military and industrial areas in Europe (just the buildings)	Copernicus	Europe
Basins Areas in Europe	Basins Areas in Europe	Copernicus	Europe
~~Built-up Areas in Europe~~	~~Built-up Areas in Europe (obsoleted)~~	~~Undefined~~	~~European Cities~~
Built Open Spaces in Europe	Built Open Spaces in Europe	Copernicus	European Cities
Dense Urban Fabric Spaces in Europe	Dense Urban Fabric Spaces in Europe (just the buildings[3])	Copernicus	European Cities
Low Urban Fabric Spaces in Europe	Low Urban Fabric Spaces in Europe (just the buildings)	Copernicus	European Cities
Medium Urban Fabric Spaces in Europe	Medium Urban Fabric Spaces in Europe (just the buildings)	Copernicus	European Cities
Railways Transport Infrastructure in Europe	Railways Transport Infrastructure in Europe	Copernicus	Europe
Roads Transport Infrastructure in Europe	Roads Transport Infrastructure in Europe	Copernicus	Europe
Streams in Europe	Streams in Europe	Copernicus	Europe
Trees Areas in Europe	Trees Areas in Europe	Copernicus	Europe
Vegetation Areas in Europe	Vegetation Areas in Europe	Copernicus	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp26), period (2011-2040), ensemble mean	Maxium number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp26 emissions scenario in the 2011-2040 period (ensemble mean)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp26), period (2041-2070), ensemble mean	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp26 emissions	CORDEX	Europe

[33] "Just the buildings" means that the vegetation, agricultural areas, trees and "built open spaces" (pavements) from the European Settlement map and from the Street Tree Layer were subtracted from corresponding Urban atlas layer, leaving just the actual buildings in this layer. This data is available for hundreds of European cities.

Layers	Description	Licenses	Coverage
	scenario in the 2041-2070 period (ensemble mean)		
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp26), period (2071-2100), ensemble mean	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp26 emissions scenario in the 2071-2100 period (ensemble mean)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp45), period (2011-2040), ensemble mean	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp45 emissions scenario in the 2011-2040 period (ensemble mean)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp45), period (2041-2070), ensemble mean	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp45 emissions scenario in the 2041-2070 period (ensemble mean)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp45), period (2071-2100), ensemble mean	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp45 emissions scenario in the 2071-2100 period (ensemble mean)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp85), period (2011-2040), ensemble mean	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp85 emissions scenario in the 2011-2040 period (ensemble mean)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp85), period (2041-2070), ensemble mean	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp85 emissions scenario in the 2041-2070 period (ensemble mean)	CORDEX	Europe

Layers	Description	Licenses	Coverage
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp85), period (2071-2100), ensemble mean	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp85 emissions scenario in the 2071-2100 period (ensemble mean)	CORDEX	Europe Adaptation Options
Maximum consecutive days (summer) 75th percentile, emissions scenario (historical), period (1971-2000), ensemble standard deviation	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the baseline emissions scenario in the 1971-2000 period (ensemble standard deviation)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp85), period (2071-2100), ensemble standard deviation	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp85 emissions scenario in the 2071-2100 period (ensemble standard deviation)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp85), period (2041-2070), ensemble standard deviation	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp85 emissions scenario in the 2041-2070 period (ensemble standard deviation)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp85), period (2011-2040), ensemble standard deviation	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp85 emissions scenario in the 2011-2040 period (ensemble standard deviation)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp45), period (2070-2100), ensemble standard deviation	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp45 emissions scenario in the 2071-2100 period (ensemble standard deviation)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp45),	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th	CORDEX	Europe

Layers	Description	Licenses	Coverage
period (2041-2070), ensemble standard deviation	percentile during summer months (Apr-Sep) for the rcp45 emissions scenario in the 2041-2070 period (ensemble standard deviation)		
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp45), period (2011-2040), ensemble standard deviation	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp45 emissions scenario in the 2011-2040 period (ensemble standard deviation)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp26), period (2071-2100), ensemble standard deviation	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp26 emissions scenario in the 2071-2100 period (ensemble standard deviation)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp26), period (2041-2070), ensemble standard deviation	Maximum number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp26 emissions scenario in the 2041-2070 period (ensemble standard deviation)	CORDEX	Europe
Maximum consecutive days (summer) 75th percentile, emissions scenario (rcp26), period (2011-2040), ensemble standard deviation	Maxium number of days per year with a mean air temperature at 2 m above ground above the 75th percentile during summer months (Apr-Sep) for the rcp26 emissions scenario in the 2011-2040 period (ensemble standard deviation)	CORDEX	Europe
HI_summer-days_rcp26_20110101-20401231_ensmean	The average yearly number of summer days in Europe for the RCP26 emissions scenario in the 2011-2040 period (ensemble mean). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp45_20110101-20401231_ensmean	The average yearly number of summer days in Europe for the RCP45 emissions scenario in the 2011-2040 period (ensemble mean). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe

Layers	Description	Licenses	Coverage
HI_summer-days_rcp85_20110101-20401231_ensmean	The average yearly number of summer days in Europe for the RCP85 emissions scenario in the 2011-2040 period (ensemble mean). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp26_20410101-20701231_ensmean	The average yearly number of summer days in Europe for the RCP26 emissions scenario in the 2041-2070 period (ensemble mean). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_historical_19710101-20001231_ensmean	The average yearly number of summer days in Europe for the baseline period 1971-2000 (ensemble mean). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp45_20410101-20701231_ensmean	The average yearly number of summer days in Europe for the RCP45 emissions scenario in the 2041-2070 period (ensemble mean). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp85_20410101-20701231_ensmean	The average yearly number of summer days in Europe for the RCP85 emissions scenario in the 2041-2070 period (ensemble mean). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp45_20710101-21001231_ensmean	The average yearly number of summer days in Europe for the RCP45 emissions scenario in the 2071-2100 period (ensemble mean). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp26_20710101-21001231_ensstd	The average yearly number of summer days in Europe for the RCP26 emissions scenario in the 2071-2100 period (ensemble standard deviation). A summer	CORDEX	Europe

Layers	Description	Licenses	Coverage
	day is a day where the maximum temperature is greater than 25.0C.		
HI_summer-days_rcp45_20710101-21001231_ensstd	The average yearly number of summer days in Europe for the RCP45 emissions scenario in the 2071-2100 period (ensemble standard deviation). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp85_20710101-21001231_ensstd	The average yearly number of summer days in Europe for the RCP85 emissions scenario in the 2071-2100 period (ensemble standard deviation). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp85_20110101-20401231_ensstd	The average yearly number of summer days in Europe for the RCP85 emissions scenario in the 2011-2040 period (ensemble standard deviation). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp26_20410101-20701231_ensstd	The average yearly number of summer days in Europe for the RCP26 emissions scenario in the 2041-2070 period (ensemble standard deviation). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp45_20410101-20701231_ensstd	The average yearly number of summer days in Europe for the RCP45 emissions scenario in the 2041-2070 period (ensemble standard deviation). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp85_20410101-20701231_ensstd	The average yearly number of summer days in Europe for the RCP85 emissions scenario in the 2041-2070 period (ensemble standard deviation). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe

Layers	Description	Licenses	Coverage
HI_summer-days_rcp85_20710101-21001231_ensmean	The average yearly number of summer days in Europe for the RCP85 emissions scenario in the 2071-2100 period (ensemble mean). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_historical_19710101-20001231_ensstd	The average yearly number of summer days in Europe for the baseline period 1971-2000 (ensemble standard deviation). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp45_20110101-20401231_ensstd	The average yearly number of summer days in Europe for the RCP45 emissions scenario in the 2011-2040 period (ensemble standard deviation). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp26_20710101-21001231_ensmean	The average yearly number of summer days in Europe for the RCP26 emissions scenario in the 2071-2100 period (ensemble mean). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_summer-days_rcp26_20110101-20401231_ensstd	The average yearly number of summer days in Europe for the RCP26 emissions scenario in the 2011-2040 period (ensemble standard deviation). A summer day is a day where the maximum temperature is greater than 25.0C.	CORDEX	Europe
HI_hot-days_historical_19710101-20001231_ensmean	The average yearly number of hot days in Europe for the baseline period 1971-2000 (ensemble mean). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_historical_19710101-20001231_ensstd	The average yearly number of hot days in Europe for the baseline period 1971-2000 (ensemble standard deviation). A hot day is	CORDEX	Europe

Layers	Description	Licenses	Coverage
	a day where the maximum temperature is greater than 30.0C.		
HI_hot-days_rcp45_20110101-20401231_ensstd	The average yearly number of hot days in Europe for the RCP45 emissions scenario in the 2011-2040 period (ensemble standard deviation). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp45_20110101-20401231_ensmean	The average yearly number of hot days in Europe for the RCP45 emissions scenario in the 2011-2040 period (ensemble mean). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp85_20110101-20401231_ensstd	The average yearly number of hot days in Europe for the RCP85 emissions scenario in the 2011-2040 period (ensemble standard deviation). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp85_20110101-20401231_ensmean	The average yearly number of hot days in Europe for the RCP85 emissions scenario in the 2011-2040 period (ensemble mean). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp26_20110101-20401231_ensmean	The average yearly number of hot days in Europe for the RCP26 emissions scenario in the 2011-2040 period (ensemble mean). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp26_20110101-20401231_ensstd	The average yearly number of hot days in Europe for the RCP26 emissions scenario in the 2011-2040 period (ensemble standard deviation). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe

Layers	Description	Licenses	Coverage
HI_hot-days_rcp26_20410101-20701231_ensmean	The average yearly number of hot days in Europe for the RCP26 emissions scenario in the 2041-2070 period (ensemble mean). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp26_20410101-20701231_ensstd	The average yearly number of hot days in Europe for the RCP26 emissions scenario in the 2041-2070 period (ensemble standard deviation). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp26_20710101-21001231_ensmean	The average yearly number of hot days in Europe for the RCP26 emissions scenario in the 2071-2100 period (ensemble mean). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp26_20710101-21001231_ensstd	The average yearly number of hot days in Europe for the RCP26 emissions scenario in the 2071-2100 period (ensemble standard deviation). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp45_20410101-20701231_ensmean	The average yearly number of hot days in Europe for the RCP45 emissions scenario in the 2041-2070 period (ensemble mean). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp45_20410101-20701231_ensstd	The average yearly number of hot days in Europe for the RCP45 emissions scenario in the 2041-2070 period (ensemble standard deviation). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp85_20410101-20701231_ensmean	The average yearly number of hot days in Europe for the RCP85 emissions scenario in the 2041-2070 period (ensemble mean). A	CORDEX	Europe

Layers	Description	Licenses	Coverage
	hot day is a day where the maximum temperature is greater than 30.0C.		
HI_hot-days_rcp45_20710101-21001231_ensmean	The average yearly number of hot days in Europe for the RCP45 emissions scenario in the 2071-2100 period (ensemble mean). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp45_20710101-21001231_ensstd	The average yearly number of hot days in Europe for the RCP45 emissions scenario in the 2071-2100 period (ensemble standard deviation). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp85_20710101-21001231_ensmean	The average yearly number of hot days in Europe for the RCP85 emissions scenario in the 2071-2100 period (ensemble mean). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp85_20410101-20701231_ensstd	The average yearly number of hot days in Europe for the RCP85 emissions scenario in the 2041-2070 period (ensemble standard deviation). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_hot-days_rcp85_20710101-21001231_ensstd	The average yearly number of hot days in Europe for the RCP85 emissions scenario in the 2071-2100 period (ensemble standard deviation). A hot day is a day where the maximum temperature is greater than 30.0C.	CORDEX	Europe
HI_tropical-nights_historical_19710101-20001231_ensstd	The average yearly number of tropical nights in Europe for the baseline period 1971-2000 (ensemble standard deviation). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe

Layers	Description	Licenses	Coverage
HI_tropical-nights_rcp85_20410101-20701231_ensmean	The average yearly number of tropical nights in Europe for the RCP85 emissions scenario in the 2041-2070 period (ensemble mean). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp26_20710101-21001231_ensmean	The average yearly number of tropical nights in Europe for the RCP26 emissions scenario in the 2071-2100 period (ensemble mean). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp45_20110101-20401231_ensmean	The average yearly number of tropical nights in Europe for the RCP45 emissions scenario in the 2011-2040 period (ensemble mean). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_historical_19710101-20001231_ensmean	The average yearly number of tropical nights in Europe for the baseline period 1971-2000 (ensemble mean). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp45_20710101-21001231_ensstd	The average yearly number of tropical nights in Europe for the RCP45 emissions scenario in the 2071-2100 period (ensemble standard deviation). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp26_20110101-20401231_ensstd	The average yearly number of tropical nights in Europe for the RCP26 emissions scenario in the 2011-2040 period (ensemble standard deviation). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp26_20710101-21001231_ensstd	The average yearly number of tropical nights in Europe for the RCP26 emissions scenario in the 2071-2100 period (ensemble standard deviation). A tropical	CORDEX	Europe

Layers	Description	Licenses	Coverage
	night is a day where the minimum temperature is greater than 20.0C.		
HI_tropical-nights_rcp45_20710101-21001231_ensmean	The average yearly number of tropical nights in Europe for the RCP45 emissions scenario in the 2071-2100 period (ensemble mean). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp26_20110101-20401231_ensmean	The average yearly number of tropical nights in Europe for the RCP26 emissions scenario in the 2011-2040 period (ensemble mean). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp45_20110101-20401231_ensstd	The average yearly number of tropical nights in Europe for the RCP45 emissions scenario in the 2011-2040 period (ensemble standard deviation). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp26_20410101-20701231_ensmean	The average yearly number of tropical nights in Europe for the RCP26 emissions scenario in the 2041-2070 period (ensemble mean). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp26_20410101-20701231_ensstd	The average yearly number of tropical nights in Europe for the RCP26 emissions scenario in the 2041-2070 period (ensemble standard deviation). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp45_20410101-20701231_ensmean	The average yearly number of tropical nights in Europe for the RCP45 emissions scenario in the 2041-2070 period (ensemble mean). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe

Layers	Description	Licenses	Coverage
HI_tropical-nights_rcp45_20410101-20701231_ensstd	The average yearly number of tropical nights in Europe for the RCP45 emissions scenario in the 2041-2070 period (ensemble standard deviation). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp85_20110101-20401231_ensmean	The average yearly number of tropical nights in Europe for the RCP85 emissions scenario in the 2011-2040 period (ensemble mean). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp85_20110101-20401231_ensstd	The average yearly number of tropical nights in Europe for the RCP85 emissions scenario in the 2011-2040 period (ensemble standard deviation). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp85_20410101-20701231_ensstd	The average yearly number of tropical nights in Europe for the RCP85 emissions scenario in the 2041-2070 period (ensemble standard deviation). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp85_20710101-21001231_ensmean	The average yearly number of tropical nights in Europe for the RCP85 emissions scenario in the 2071-2100 period (ensemble mean). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
HI_tropical-nights_rcp85_20710101-21001231_ensstd	The average yearly number of tropical nights in Europe for the RCP85 emissions scenario in the 2071-2100 period (ensemble standard deviation). A tropical night is a day where the minimum temperature is greater than 20.0C.	CORDEX	Europe
Adaptation Options	General list of possible adaptation options for application	Undefined	Undefined