
# D4.4 Technology Support Report v2

## WP4 - Technology Support

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## CLARITY project overview

Urban areas and traffic infrastructures that are linking such areas are highly vulnerable to climate change. Smart use of existing climate intelligence can increase urban resilience and generate benefits 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 co-create an integrated climate services Information System (CSIS) to systematically plan the integration of resilience measures 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.

# Executive summary

This report is the fourth and last deliverable of WP4 “Technology Support” of the CLARITY project, funded by the EU’s Horizon 2020 Programme under Grant Agreement number 730355. WP4 provides the technological backbone of the CLARITY Climate Services Information System (CSIS) by tailoring the technological background to project needs. For this, WP4 integrates and adapts existing (background) tools and services that are necessary for realisation of the CLARITY reference scenarios (demonstration cases) and the implementation of the EU-GL [1] into the CLARITY climate services.

It is an accompanying report to the technologies and software components that have been adapted, extended, customised and deployed by WP4 and configured, assembled and integrated by WP1 to implement the CLARITY Climate Services Information System (CSIS). It reports on the work performed in WP4 since the release of D4.3 “Technology Support Report v1” [2] and provides links to access the software, tools and documentation resulting from this work.

It provides furthermore the final overview of all the tools and models that were either inherited from previous projects or developed in CLARITY WP4 and explains how the inherited tools were used and/or extended in CLARITY. This overview is provided as annex document.

# 1 Introduction

The introduction chapter defines the purpose and scope of the technology support report as well as its relation to other deliverables and briefly explains the structure of the document.

## 1.1 Purpose of this document

This document is an accompanying report to the technologies and software components that are adapted, extended, customised and deployed by WP4 and configured, assembled and integrated by WP1 to implement the CLARITY CSIS. It reports on the work performed in WP4 since the release of D4.3 "Technology Support Report v1" [2], provides links to access the software, tools and documentation resulting from this work.

It provides furthermore the final overview of all the tools and models that were either inherited from previous projects or developed in CLARITY WP4 and explains how the inherited tools were used and/or extended in CLARITY. This overview is provided as annex document that serves also to document the emergent architecture introduced in D4.2 "CLARITY CSIS Architecture" [3].

Besides the document at hand, the actual nature of this deliverable is software (source code and/or binaries) and their technical documentation made available in online repositories, (micro)-services deployed in CLARITY's containerised service infrastructure and the online CSIS product backlog[1] linked with kanban-style[2] task boards representing a dynamic work plan in support of CLARITY's agile project management approach.

## 1.2 Relation to other deliverables

The technology support report heavily builds upon the results of the deliverables D4.1 "Technology Support Plan" [4], D4.2 "CLARITY CSIS Architecture" [3] and D4.3 "Technology Support Report v1" [2], which are recommended readings to understand the underlying assumptions, concepts and design decisions.

To avoid too many repetitions and to keep this report focused and concise, this document makes extensive use of references to these deliverables. However, in order to offer a self-contained deliverable, some of the most important concepts introduced in the previous documents of WP4 are briefly summarised in the following.

**D4.2 "CLARITY CSIS Architecture"** established the shared understanding among all CLARITY stakeholders about the overall goals of the CSIS Architecture and the essential design decisions and architectural principles to realise these goals. The architecture is structured according to the four-layered MCRI - mission, concepts, realisation and implementation scheme (Figure 1), whereby the technology support reports represent mainly the implementation layer. The architecture is also organised in such a way that it offers two overlapping perspectives: An explicit architecture and an emergent architecture. The main reason for making this distinction between explicit- and emergent architecture is to be able to manage complexity and changeability in an agile and evolving product design and development, where many technical and implementation details cannot be specified upfront. The explicit architecture thereby defines the essence of the system, that is the, the design decisions with the "highest impact and cost of change" [5].

[1] "A list of all things that needs to be done within the agile product development cycle." [7]

[2] "Kanban is a popular framework used to implement agile software development. It requires real-time communication of capacity and full transparency of work. Work items are represented visually on a kanban board, allowing team members to see the state of every piece of work at any time." https://www.atlassian.com/agile/kanban

All non-critical decisions and technology choices can then be deferred to the emergent architecture that iteratively evolves during the agile co-creation process. An additional transition layer between these architectural perspectives anticipates the expected changes as opportunity to generate value while preserving the invariant essence of the system. In this sense, the technology support reports represent the emergent architecture and serve as a means to document the implementation of the CSIS building blocks following a detailed technology support report.

**D4.1 "Technology Support Plan"** identified and specified the different building blocks and software components of the CSIS. A building block is a generic, composable, adaptable and domain- and location-independent unit of functionality (component) that meets the identified business and user requirements by implementing a set of related functional requirements. A software component on the other hand is a concrete IT service, tool, system or model that is suitable for the realisation of a building block. While the technology support plan covers mainly the realisation layer of the architecture, the technology choices for realising a certain building block are part of the transition layer and subject to change.

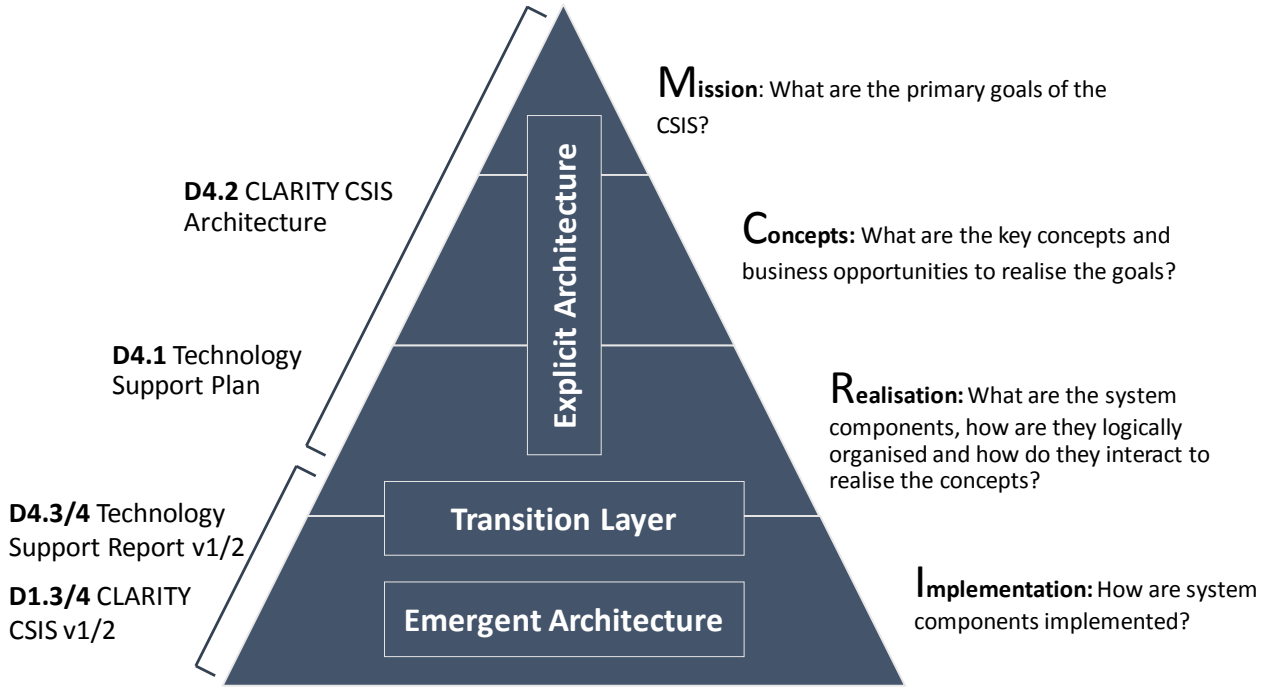



Figure 1: CLARITY CSIS architecture layers and perspectives

**D4.3 "Technology Support Report v1"** provided besides a report on the work performed in WP4 since the project start also a summary of the realisation and implementation parts of the overall CSIS Architecture and thus the transition layer and emergent architecture, respectively (Figure 2). It presented the project management tools that are used by CLARITY agile co-creation teams to discuss, coordinate and steer the entire product development life-cycle. To support a smooth transition between component development and system integration as well as demonstration and validation, it introduced the project-wide CSIS product backlog (Figure 3) at https://github.com/orgs/clarity-h2020/projects/2. The backlog represents all identified tasks ("issues"[3]) that need to be accomplished in order to advance the development and integration of the CSIS.

[3] "Issues are a great way to keep track of tasks, enhancements, and bugs for your projects. They're kind of like email - except they can be shared and discussed with the rest of your team." https://guides.github.com/features/issues/

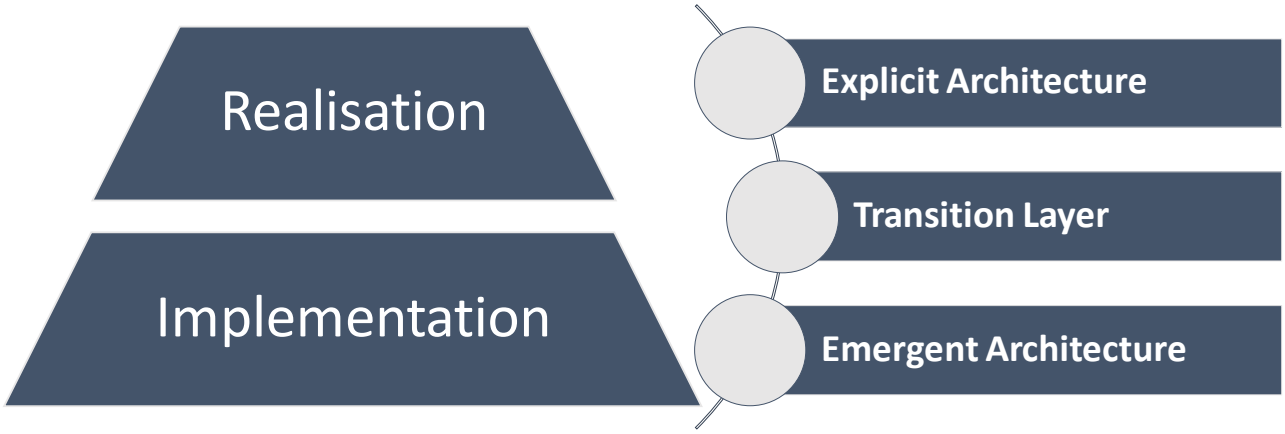



Figure 2: Realisation and implementation

While the technology support reports mainly addressed independent components (building blocks), **D1.3 "CLARITY CSIS v1"** specified how the CSIS should function from user perspective and how it technically implements the EU-GL/CLARITY Modelling Methodology defined in **D3.2 "Science Support Report v1"**. For this purpose it used the means of User Stories and Mock-Ups to design the CSIS prototype as an integrated software system composed of interacting building blocks. It thereby represents that part of the emergent architecture and the implementation, which covers the integrated CSIS as a whole.

**D1.4 "CLARITY CSIS v2"** will accompany the final version of the CSIS that integrates not only the building blocks offered by WP4 but also all relevant data sets used and produced in the project by means of CLARITY Data Packages. Important changes to building blocks like bug fixes and security updates will then be performed under the umbrella of **T1.4 "Industrialisation and Support"** and reported **in D1.5 "Final Industrialisation and Support Report"**.

## 1.3 Intended audience

The target readers of this document are all members of the CLARITY consortium as they cover all categories of stakeholders (end users, service suppliers, developers, etc.) of the CSIS.

## 1.4 Structure of the document

The structure of the document and the relationships between the different chapters is as follows:

**Chapter 1** (this chapter) introduces the document and explains the overall purpose of this document and its relation to other work packages and deliverables.

**Chapter 2** lists the documents that were used or referenced in the development of this report and provides a document-specific list of abbreviations.

**Chapter 3** provides an incremental summary on implementation of building blocks on the level of project tasks.

**Chapter 4** provides the conclusions and a summary on follow-up activities in other work packages.

**Annex 1** reports on the actual usage of tools and technologies that were either inherited from previous projects or developed in CLARITY.

# 2 Reference documents

The following documents were used or referenced in the development of this report:

- D1.3 “CLARITY C SIS Architecture v1”
- D2.2 “Catalogue of local data sources and sample datasets”
- D3.1 “Science Support Plan and Concept“
- D3.2 “Science Support Report v1“
- D4.1 “Technology Support Plan v1”
- D4.2 “CLARITY CSIS Architecture”
- D4.3 “Technology Support Report v1”
- D5.1 “Exploitation Requirements and Innovation Design v1”
- D5.2 “Exploitation Requirements and Innovation Design v2”
- D5.7 “MyClimateServices.eu Marketplace”
- D7.9 “Data Management Plan v2”

## 2.1 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 https://cat.clarity-h2020.eu/glossary/main.

| Abbreviation/Acronym | Definition |
|---|---|
| AJAX | Asynchronous JavaScript and XML |
| BB | Building Block |
| CC | Climate Change |
| CCA | Climate Change Adaptation |
| CCCA | Climate Change Centre Austria |
| CKAN | Comprehensive Kerbal Archive Network |
| CLARITY | Integrated Climate Adaptation Service Tools for Improving Resilience Measure |
| CRISMA | Modelling crisis management for improved action and preparedness |
| CS | climate service |
| CSIS | CLARITY climate services Information System |
| CSW | Catalogue Service for the Web |
| DC | Demonstration Case |
| DoA | Description of Action (Annex 1 to the Grant Agreement) |
| EC | European Commission |
| EU-GL | Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient (Document) |
| GeoJSON | geographical JavaScript Object Notation |
| HTML5 | Hypertext Markup Language, version 5 |
| HTTP | Hypertext Transfer Protocol |

| | |
|---|---|
| JSON | JavaScript Object Notation |
| MCDA | Multi-Criteria Decision Analysis |
| OGC | Open Geospatial Consortium |
| RDBMS | Relational Database Management System |
| REST | Representational State Transfer |
| RIA | Rich Internet Application |
| SMS | Scenario Management System |
| SUDPLAN | Sustainable Urban Development Planner for Climate Change Adaptation |
| WMS | Web Map Service |
| WMTS | Web Map Tile Service |
| WP | Work Package |

# 3 Technology Support Report

This chapter provides an incremental update of D4.3 “Technology Support Report v1” [2] on the level of project tasks and individual building blocks. A complete description of all building blocks is given in Annex 1.

For the development of the CSIS and the co-creation of related climate services, CLARITY uses the GitHub[4] platform as central code repository and co-creation environment. GitHub offers a set of project management tools that are used by multidisciplinary agile teams to discuss, coordinate and steer the entire product development life-cycle. The main artefacts in support of CLARITY’s agile project management approach are implementation-level tasks (”issues”) that are linked with kanban-style[5] task boards representing both a dynamic work plan and a means for documenting all technology support related activities.

The origin of these implementation tasks goes back to user stories and test cases initially elicitated in T1.2 “Climate Service Requirement” that have been iteratively refined during the agile co-creation process following feedback from the stakeholders of the CSIS. The technology support report provides therefore an important contribution the emergent architecture of the CSIS by documenting the implementation of evolving functional requirements on building blocks.

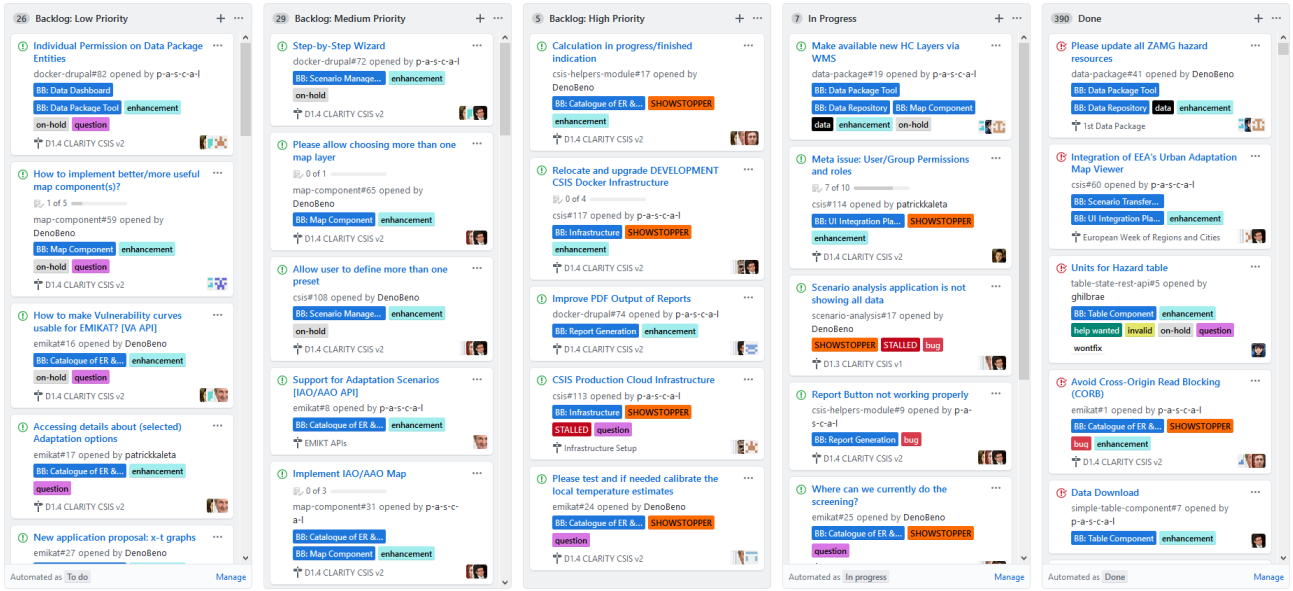



Figure 3: Overall CSIS product backlog

Thereby, T1.3 ”Co-Creation” is responsible for maintaining the big picture of CSIS development and thus the overall CSIS product backlog[6] (Figure 3) and the related incremental development sprints[7]. This backlog is further broken down into several project boards (Figure 4) according to CLARITY workplan.

4 “GitHub Inc. is a web-based hosting service for version control using Git. It is mostly used for computer code.” https://en.wikipedia.org/wiki/GitHub

5 “Kanban is a popular framework used to implement agile software development. It requires real-time communication of capacity and full transparency of work.” https://www.atlassian.com/agile/kanban

6 “The product backlog is a breakdown of work to be done and contains an ordered list of product requirements.“ https://en.wikipedia.org/wiki/Scrum_(software_development)#Product_backlog

7 “A Sprint is a repeatable fixed time-box during which a "Done" product of the highest possible value is created.” https://en.wikipedia.org/wiki/Scrum_Sprint

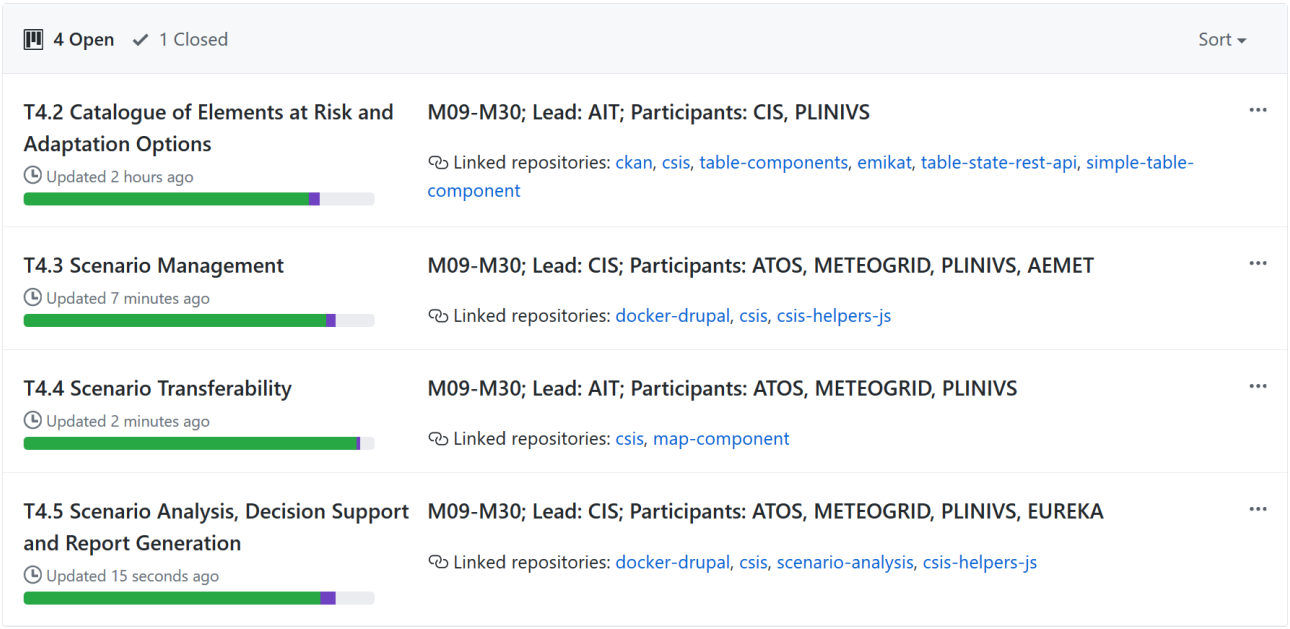



Figure 4: WP4 project boards

The technology support plan at hand provides a condensed summary on the work based on these implementation level tasks in relation to the respective project tasks of WP4 ”Technology Support”. While Annex 1 also addresses building blocks covered by T1.4 ”Climate Services Industrialization and Support”, an update and a summary of work in this task will be provided in deliverable D1.5 ”Final Industrialisation and Support Report”.

## 3.1 T4.2 “Catalogue of Elements at Risk and Adaptation Options”

According to the CLARITY work plan, the objective of this task is to “Adapt the existing catalogue software background such as the AIT EMIKAT (Environmental Catalogue) to serve as a repository of elements at risks and adaptation options. This catalogue will allow users to link the sensitivities of elements at risk to key hazards, indicate the applicability, impact, implementation price and time needed for implementation of different adaptation options for different element at risk/hazard combinations.”

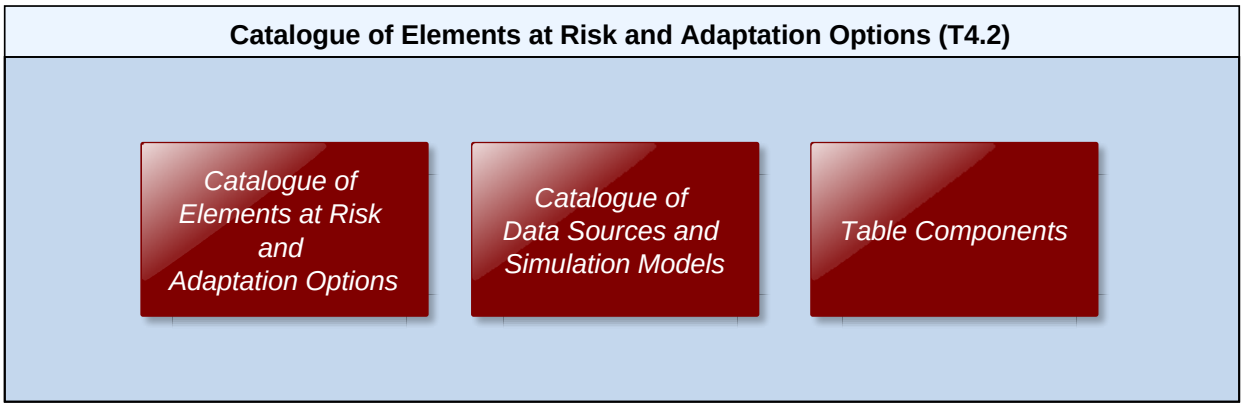



Figure 5: T4.2 building blocks

In line with the task description, AIT EMIKAT is used for the realisation of Catalogue of Elements at Risk and Adaptation Options building block (Figure 7).

EMIKAT is both used for the management of the element at risk ("exposure") and for the implementation of the pre-feasibility ("screening") study workflow. Additional building blocks covered by this task (Figure 5) are the Catalogue of Data Sources and Simulation Models (Figure 8) and the Table Components (Figure 9). A detailed technical description of these building blocks can be found in Annex 1.

The project board (Figure 6) used to coordinate the development activities of this project task is available at https://github.com/orgs/clarity-h2020/projects/7.

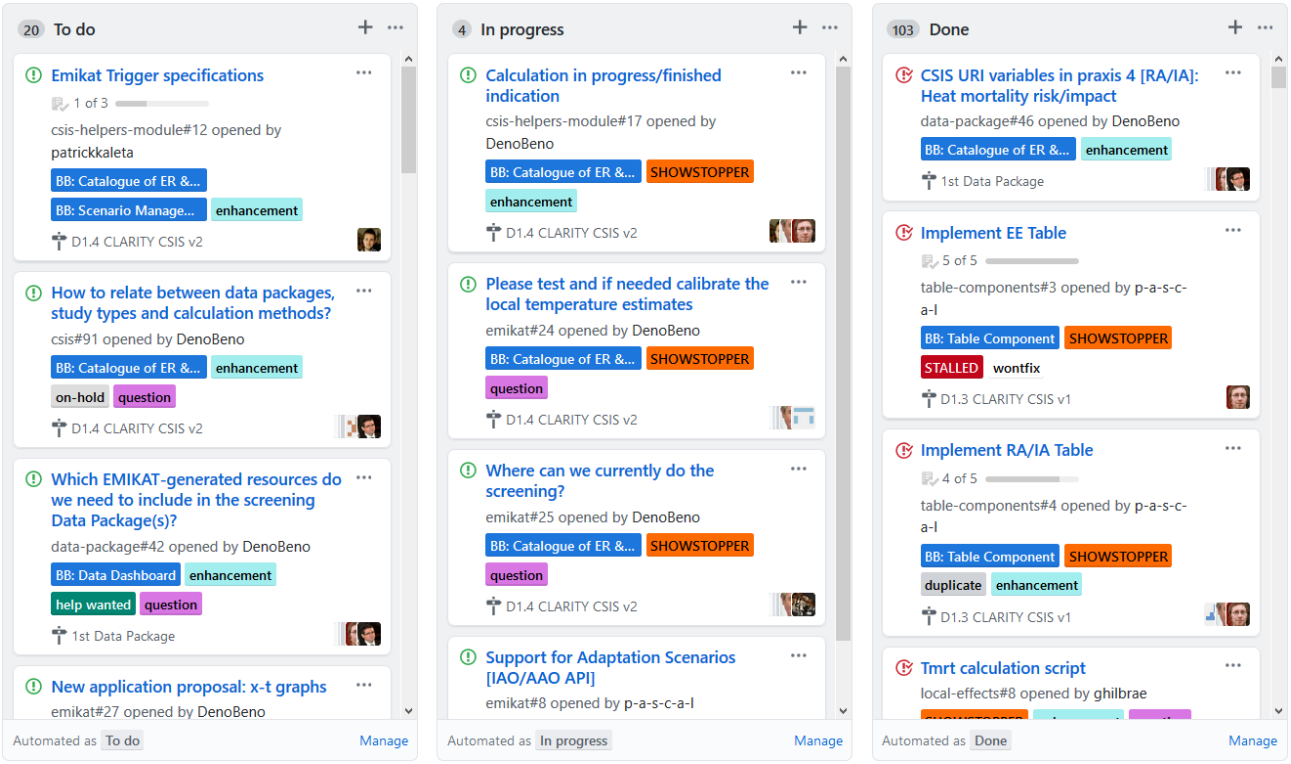
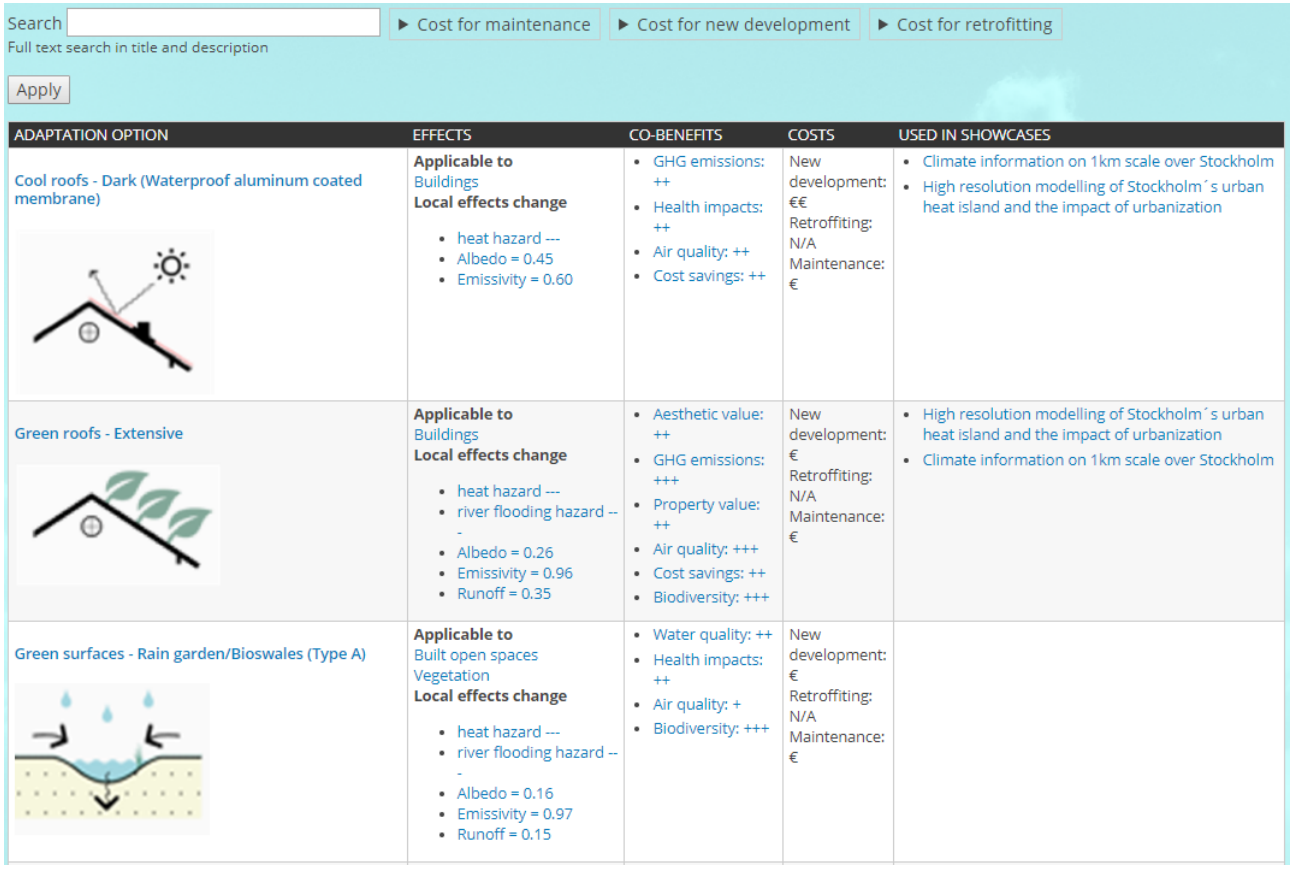



Figure 6: T4.2 project board (excerpt)

A summary of the most important development achievements since the release of D4.3 "Technology Support Report v1" [2] in relation to the building blocks of this task is listed below.

**Catalogue of Elements at Risk and Adaptation Options**

- Implemented new REST APIs in EMIKAT including support for data download in different formats (JSON, CSV).
- Optimised algorithms for calculation of mortality rates related to heat wave hazard based on Urban Atlas and EUROSTAT data.
- Implemented a CSIS-EMIKAT-bridge for triggering impact calculations in EMIKAT directly from Scenario Management.
- API-support for CSIS URI variables like *${EMIKAT_ID}* and thus template resources in Data Packages.
- Implementation of the hazard local effects modelling workflow in EMIKAT.
- Implemented the data model for adaptation options in the CSIS Drupal platform.
- Added collection of adaptation option for future usage.
- Added REST endpoints for external services to access adaptation option information.
- Extended the data model of studies and Data Packages to include adaptation options.
- Allow users to select adaptation options and include them in the final study report.
- Allow users to view all available adaptation options in detail aside from a study context.




| ADAPTATION OPTION | EFFECTS | CO-BENEFITS | COSTS | USED IN SHOWCASES |
|---|---|---|---|---|
| Cool roofs - Dark (Waterproof aluminum coated membrane) | **Applicable to** Buildings **Local effects change** • heat hazard --- • Albedo = 0.45 • Emissivity = 0.60 | • GHG emissions: ++ • Health impacts: ++ • Air quality: ++ • Cost savings: ++ | New development: €€ Retroffiting: N/A Maintenance: € | • Climate information on 1km scale over Stockholm • High resolution modelling of Stockholm´s urban heat island and the impact of urbanization |
| Green roofs - Extensive | **Applicable to** Buildings **Local effects change** • heat hazard --- • river flooding hazard --- • Albedo = 0.26 • Emissivity = 0.96 • Runoff = 0.35 | • Aesthetic value: ++ • GHG emissions: +++ • Property value: ++ • Air quality: +++ • Cost savings: ++ • Biodiversity: +++ | New development: € Retroffiting: N/A Maintenance: € | • High resolution modelling of Stockholm´s urban heat island and the impact of urbanization • Climate information on 1km scale over Stockholm |
| Green surfaces - Rain garden/Bioswales (Type A) | **Applicable to** Built open spaces Vegetation **Local effects change** • heat hazard --- • river flooding hazard --- • Albedo = 0.16 • Emissivity = 0.97 • Runoff = 0.15 | • Water quality: ++ • Health impacts: ++ • Air quality: + • Biodiversity: +++ | New development: € Retroffiting: N/A Maintenance: € | |

Figure 7: Catalogue of Elements at Risk and Adaptation Options

**Catalogue of Data Sources and Simulation Models**

The following tasks related to data management (WP7) were supported:

- Make calculated hazard indices based on (bias corrected) EURO-CORDEX data available publicly available for re-use by other interested parties at Climate Change Centre Austria's data catalogue (https://data.ccca.ac.at).
- Deposit additionally ensemble mean values at Zenodo research data repository (https://zenodo.org/communities/clarity).
- Add the dataset meta-data with links to the respective repository where the actual data is stored (Zenodo or CCCA).
- Generate offline Data Management Plan from online catalogue.

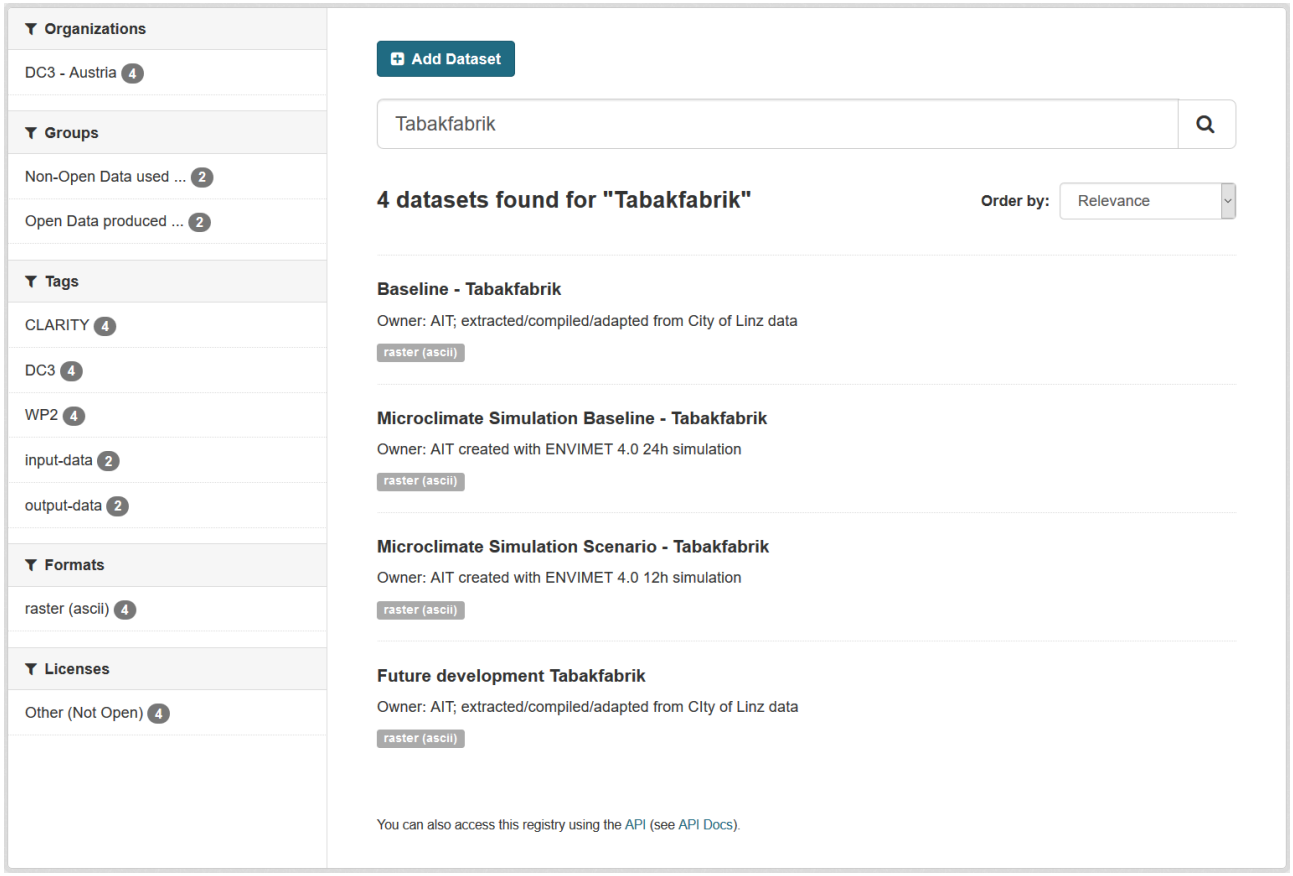



Figure 8: Catalogue of Data Sources and Simulation Models (datasets)

**Table Components**

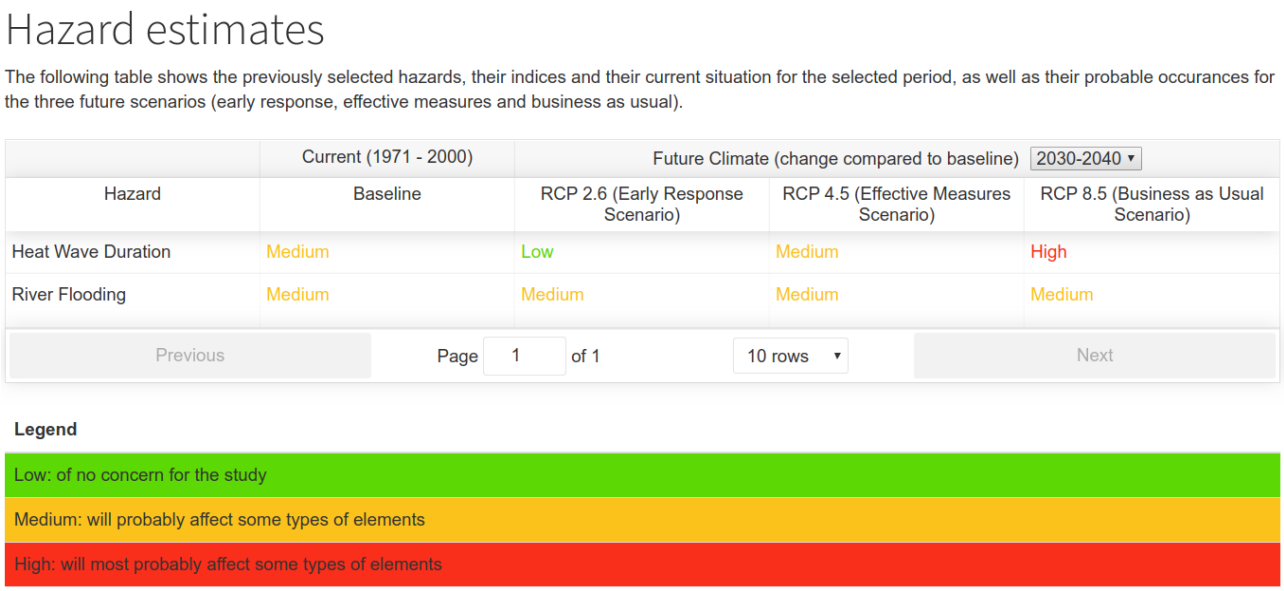



Figure 9: Advanced Table Component (hazard estimates)

- Support download of data in different formats, for example GeoJSON, JSON and CSV formats supported by the EMIKAT APIs.
- Support for displaying unit information which should be stored within the meta-data of each climate index, e.g. for summer days, tropical nights, Tx75p, the units would be days.
- Calculation of thresholds for tabular hazard and exposure data.

- Support for the improved Data Package meta-data format which allows to categorise resources according to different tags.
- Integration with the common reporting functionality and inclusion of additional information about the current table, so that the report generator can use this information as additional comment about the table
- Support scenario management by adding configuration variables embedded in to the UI Integration Platform.
- Support for the Jenkins continuous integration system provided by the Integration and Development Platform.

## 3.2 T4.3 “Scenario Management”

According to the CLARITY work plan, the objective of this task is to “adapt the climate scenario management system software prototype from SUDPLAN for use in CLARITY. This software will allow end-users to easily produce and manage new scenarios by editing the parameters of the pre-defined core scenarios as defined in WP1.”

As observed in previous reports (D4.1 “Technology Support Plan” [4] and D4.3 “Technology Support Report v1” [2]), the user interface of the SUDPLAN SMS is developed as Java Web Start Desktop Application. Oracle, the vendor of Java Web Start technology stated in 2016 that “modern browser vendors working to restrict or reduce the support of plugins like Flash, Silverlight and Java in their products” [19]. Developers of Rich Internet Applications (RIA) are therefore migrating their legacy and browser-plugin based applications to modern technologies like HTML5 and AJAX (Asynchronous JavaScript and XML). Consequently it has been decided to realise the scenario management functionality of the CSIS with help of the common web-based UI Integration Platform (Drupal 8).

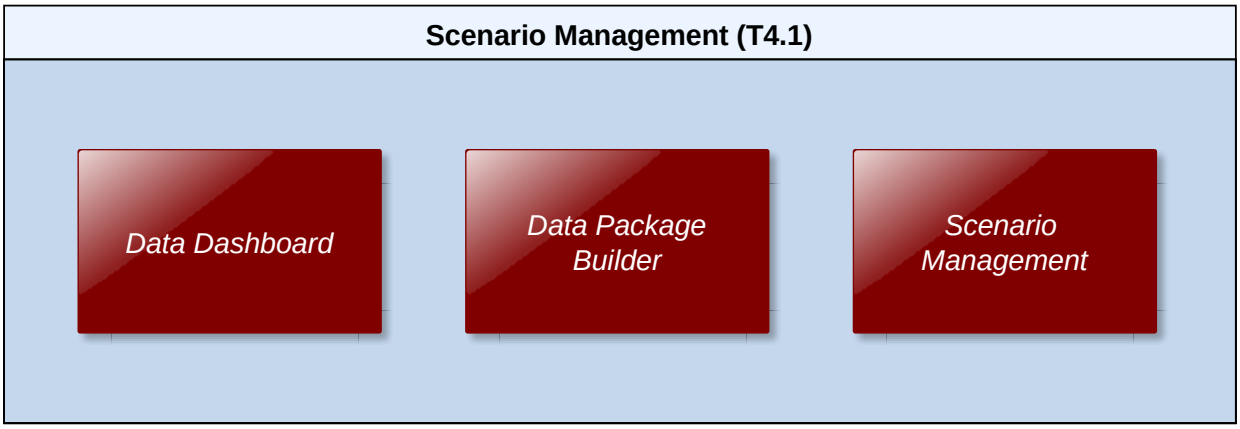



Figure 10: T4.3 building blocks

Apart from the Scenario Management (Figure 12) building block, additional building blocks covered by this task (Figure 10) are the Data Dashboard (Figure 13) and the Data Package Builder (Figure 14). A detailed technical description of these building blocks can be found in Annex 1.

The project board (Figure 11) used to coordinate the development activities of this project task is available at https://github.com/orgs/clarity-h2020/projects/8.

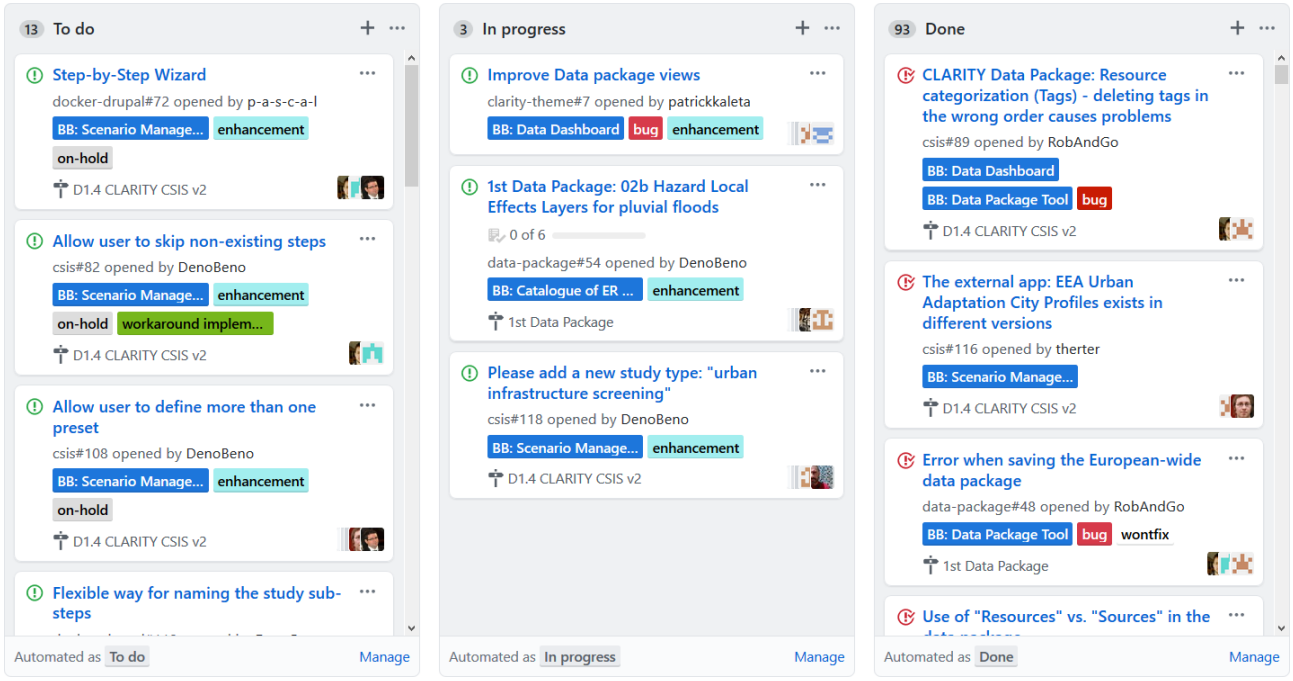



Figure 11: T4.3 project board (excerpt)

A summary of the most important development achievements since the release of D4.3 “Technology Support Report v1” [2] in relation to the building blocks of this task is listed below.

### Scenario Management

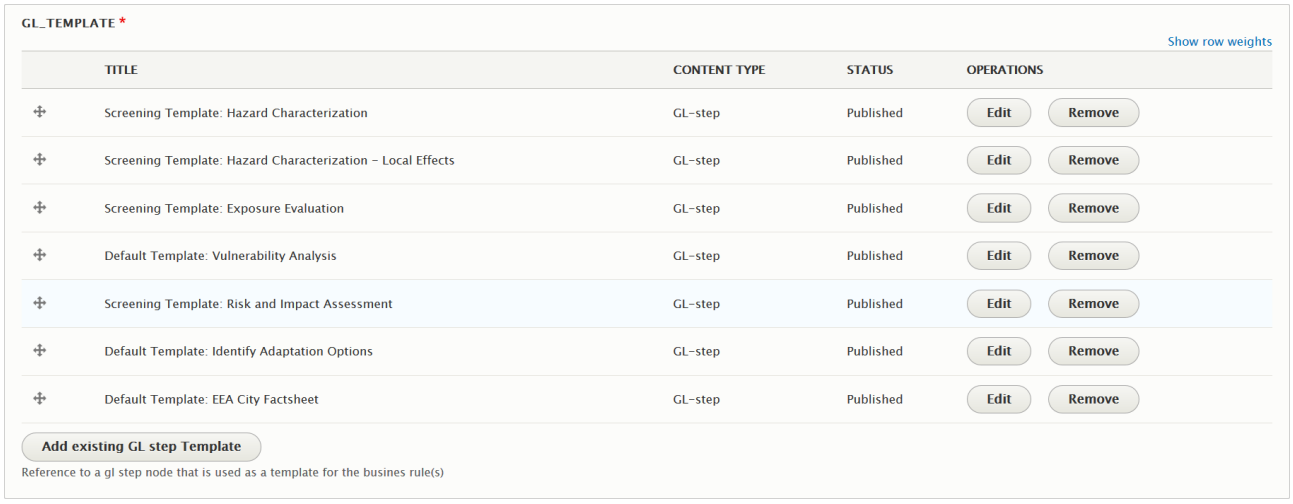



Figure 12: Configuration of study templates for Scenario Management

- Support for the additional screening study type “transport infrastructure screening”.
- Allow users to define more than one scenario (“preset”) and allow them to choose several scenarios at once for simple comparison without the need to switch to the Multi Criteria Decision Analysis Tool.
- Flexible way for naming the study sub-steps (data, map, table, …) to support more types of custom (expert) studies.
- Let the user choose a combination of the parameters of a scenario (“preset”) at some point in the study definition (Figure 58).
- Support for changing the type (e.g. advanced screening, expert, etc.) of an existing study and implementation of the respective business rules to update all previously completed study steps.

- Support for different study templates (expert, screening) that control the number, the appearance, and the content of distinct study steps (EU-GL modules) presented to the user (Figure 12).
- Improved study and step summary pages that are the basis for Report Generation.
- Creating of numerous new taxonomies in support of study temples and step templates.
- Activating and testing a new CLARITY theme and improving the styling of buttons, forms, etc.
- Support for changing the study area and automatic re-calculation of local effects and impact model for screening in EMIKAT.
- Support for triggering impact calculation in EMIKAT and monitoring the progress of the model execution.

**Data Dashboard**

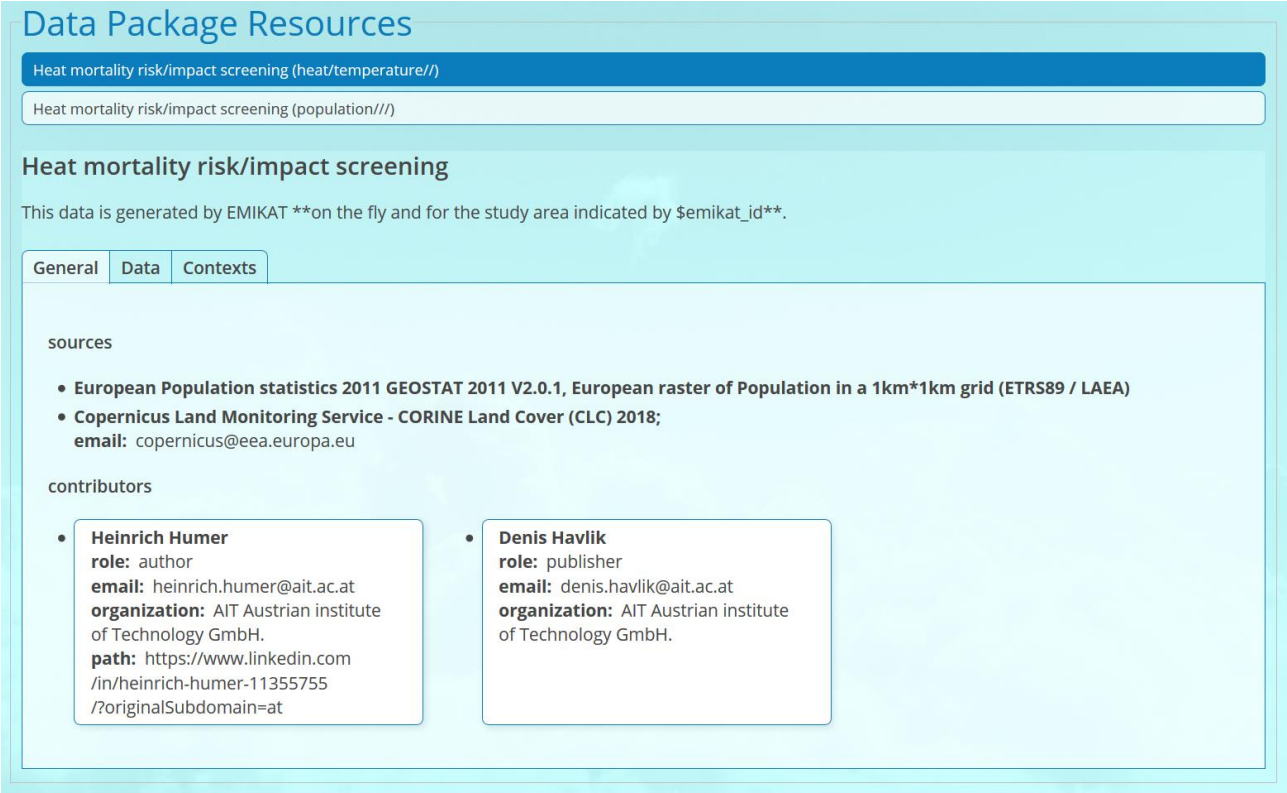



Figure 13: Data Dashboard

- Support for vulnerability curves and adaption options as built-in CSIS resources that can directly be used in impact calculation and edited by the user.
- Support for dynamically generated resources like impact model results (Figure 13) and results of the hazard local effects calculation.
- Improved layout and appearance of the dashboard in view and edit mode.
- Integration of resource data preview apps (e.g. Map Component) in the Data Package overview.

**Data Package Builder**

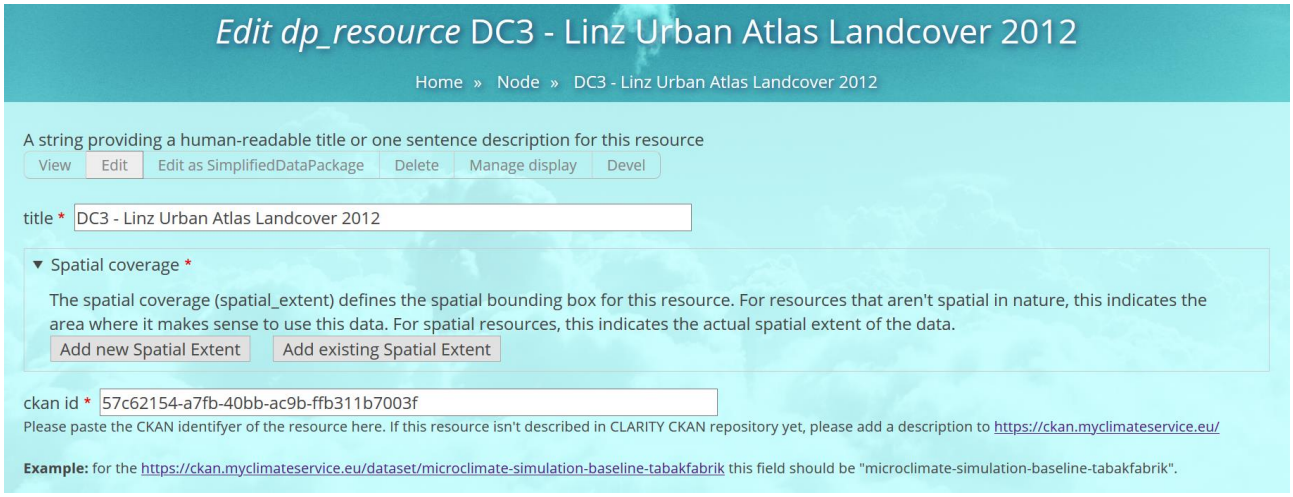



Figure 14: Data Package Builder (resource form)

- Redesign of the Data Package Builder forms for better usability and creation of a simplified form for external non-expert users that want make their data available in CSIS.
- Support for individual permissions on Data Packages and thus for “premium” Data Packages that are available to subscribers only.
- Support for creating a copy of an existing Data Package.
- Support for additional variables in Data Package resources that characterise the current scenario.
- Improved layout and styling of edit and preview modes for general Data Package meta-data as well as for resources.
- Support for data visualisation directly in Data Package forms.

## 3.3 T4.4 “Scenario Transferability”

According to the CLARITY work plan, “within this task, we will adapt the “climate twins” concept and related software from the TaToo project: To allow “real world insights” about future climate impact and appropriate adaptation, one can search for “twin” regions, where the current climate appears similar to an expected future climate of a point of interest (POI). We call such region pairs with similar climate conditions (at different times) “Climate Twins”. From these current climate twin regions we can learn “hands on” how future climate impacts may be experienced in the POI and how to adapt to the changing climate conditions, expected in the future. In CLARITY, the Climate Twins similarity concept will be extended to include other multi-criteria metrics, e.g. the similarity of the projects and measures.”

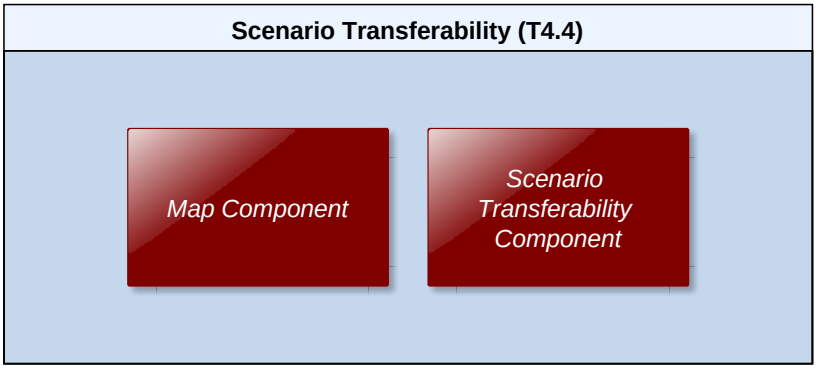



Figure 15: T4.4 building blocks

The aforementioned idea is realised by the Scenario Transferability Component building block (Figure 17) which is implemented as integral part of the CSIS Drupal 8 platform (UI Integration Platform). It applies the "twins" concept not only to climate hazards ("hazard twins") but also to other artefacts like (infrastructure) projects and adaptation measures (Figure 60). An additional building block covered by this task is the Map Component (Figure 18). A detailed technical description of these building blocks can be found in Annex 1.

The project board used to coordinate the development activities of this project task is available at https://github.com/orgs/clarity-h2020/projects/9.

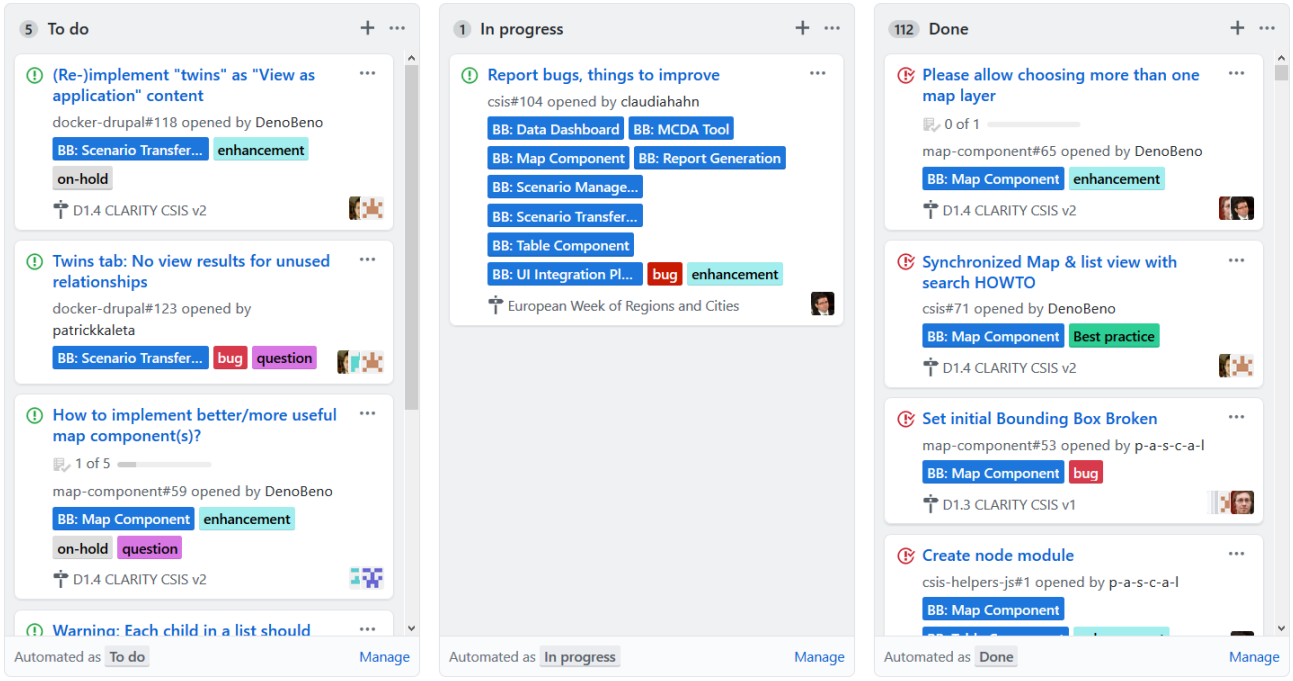



Figure 16: T4.3 project board (excerpt)

A summary of the most important development achievements since the release of D4.3 "Technology Support Report v1" [2] in relation to the building blocks of this task is listed below.

**Scenario Transferability Component**

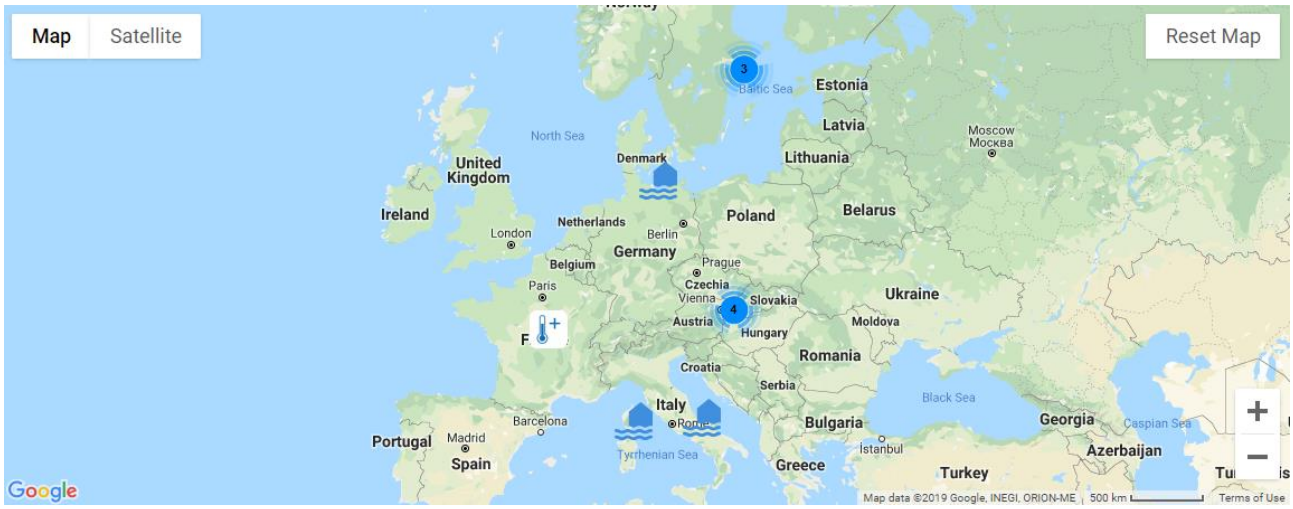



Figure 17: Scenario Transferability Component

- Implemented separate twins displays for hazards, exposure and adaptation options.
- Support for filtering based on selected hazards or elements at risk (depending on the type of twin).

- Support for additional filtering based on a search radius around current location.
- Support for displaying different elements (e.g. showcases, past hazard events) on the same map.
- Allowing users to directly view twins inside the map.
- Added separate tables with selected and available twins as a secondary way of visualization.
- Allowing users to include twins or remove them from the final study report.

**Map Component**

- Allowing the users to select more than one background layer, e.g. urban atlas layers.
- Support for background layers in Data Packages.
- Support for style parameter for getLegend requests to show available legends for map layers.
- Support for visualising and selecting city areas where European-level screening is possible.
- Support for restricting the user-defined study area to the supported city areas.
- Support for template resources with processing variables in Data Packages used by Scenario Management.
- Redesign of the Map Component so that it can be embedded as iFrame into the UI Integration Platform.
- Support for the Jenkins continuous integration system pipelines provided by the Integration and Development Platform.
- Modularisation of the Map Component and thus support for customised map types like hazard map, exposure map, impact map, etc.

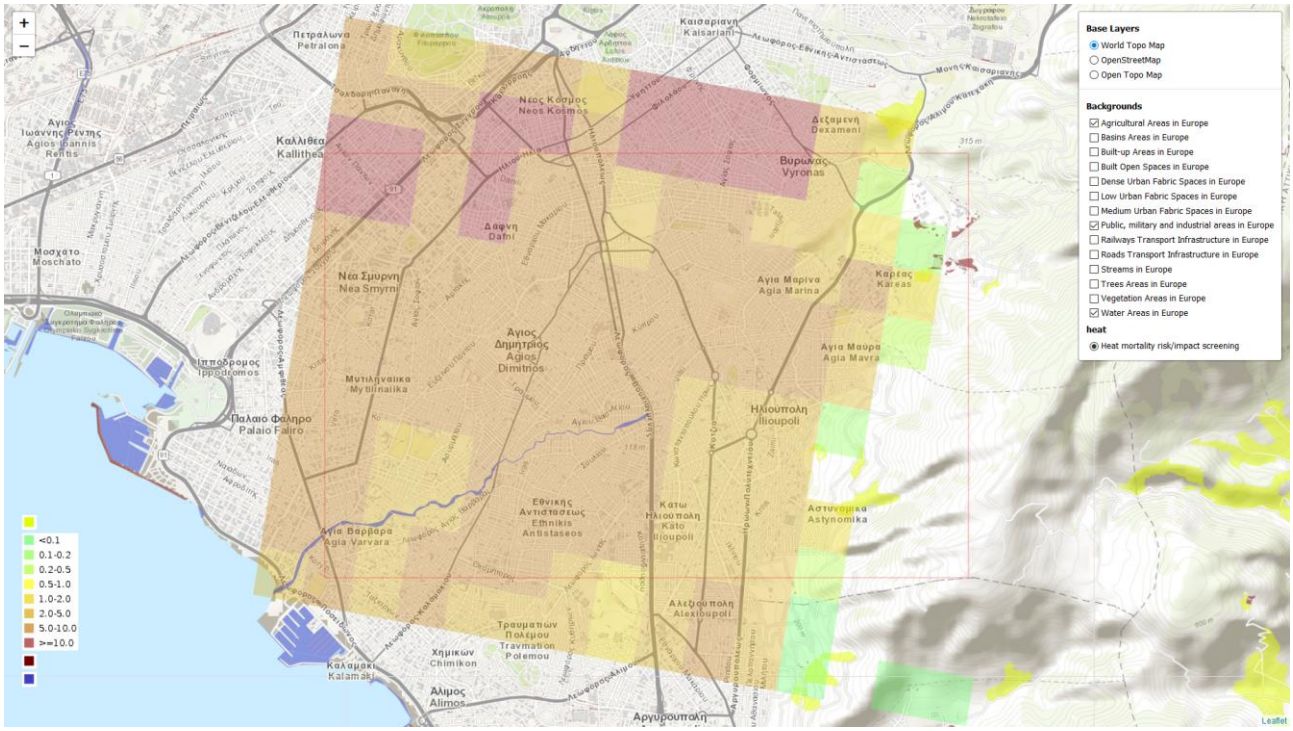



Figure 18: Map Component (heat mortality impact)

## 3.4 T4.5 “Scenario Analysis, Decision Support and Report Generation”

According to the CLARITY work plan, “the software provided by this task will support the analysis and comparison of scenario candidates (options) regarding performance indicators that can be defined by the end user. Indicator based decision support functionalities will be provided using concepts and software of the CRISMA FP7 Project. The climate services will incorporate concepts for collaborative decision making offering a large variability regarding specific decision strategies. The software will address the issue of

assessing the results and helping the users to find a compromise solution that satisfies the multiple and often opposed requirements of the key stakeholders. For this, criteria sets are aggregated by a multi-criteria ranking functions that allow the users to easily compare and rank different scenarios and corresponding adaptation plans according to different criteria and their relative weight and level of importance."

The web-based Multi Criteria Decision Analysis Tools developed in the context of the CRISMA project allows a comparison of indicators and criteria for different scenarios and a ranking of different scenarios with respect to a specific decision strategy. Since these tools are developed as generic HTML5/AJAX widgets, they could successfully be integrated in the CSIS following the concepts of UI Integration Platform. Although CRISMA tools have been implemented on basis of the outdated AngularJS 1.0 JavaScript framework, they could be adapted to CLARITY needs.

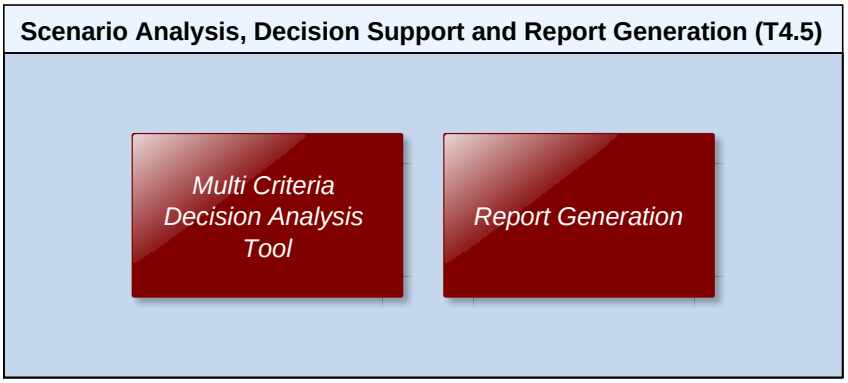



Figure 19: T4.5 building blocks

In addition to aforementioned Multi Criteria Decision Analysis Tool (Figure 21) this task (Figure 19) covers also the Report Generation (Figure 22) building block. A detailed technical description of these building blocks can be found in Annex 1.

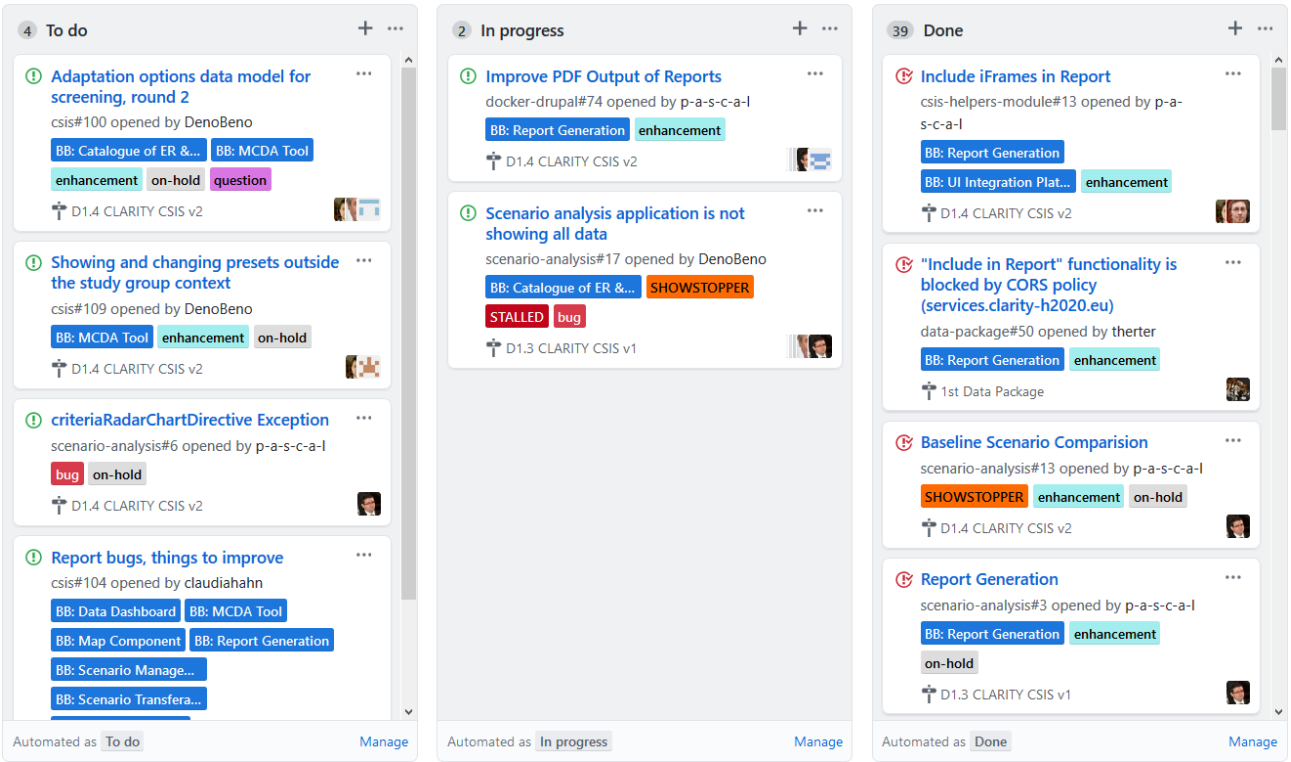



Figure 20: T4.5 project board (excerpt)

The project board (Figure 20) used to coordinate the development activities of this project task is available at https://github.com/orgs/clarity-h2020/projects/10.

A summary of the most important development achievements since the release of D4.3 “Technology Support Report v1” [2] in relation to the building blocks of this task is listed below.

**Multi Criteria Decision Analysis Tool**

- Adaptation of indicator functions to the new impact model and result data format.
- Support for parameterisable template resources in Data Packages.
- Update of damage class labels to correspond to damage descriptions in Data Package.
- Enhanced support for report generation.
- Support for baseline scenario comparison of different impact scenarios characterised by time period and RCP.
- Support for communication with the CSIS Drupal platform (UI Integration Platform) via the JSON:API and the seamless.js iFrame connector.

**Report Generation**

- General support for taking screenshots of iFrames and thus for any kind of embedded (3rd-party) web applications.
- Support for generation of PDFs out of HTML reports and implementation of custom styling for generated PDFs.
- Support for an aggregated report that contains the distinct reports of all steps (EU-GL modules).
- Implemented a Generic “Include in Report” button that uses the html2canvas.js library to create images from rendered HTML content.
- Support adding user-defined comments to report images created via the “Include in Report” button.
- Support for automatic report image comments obtained from embedded web applications like Table Components and Map Component.

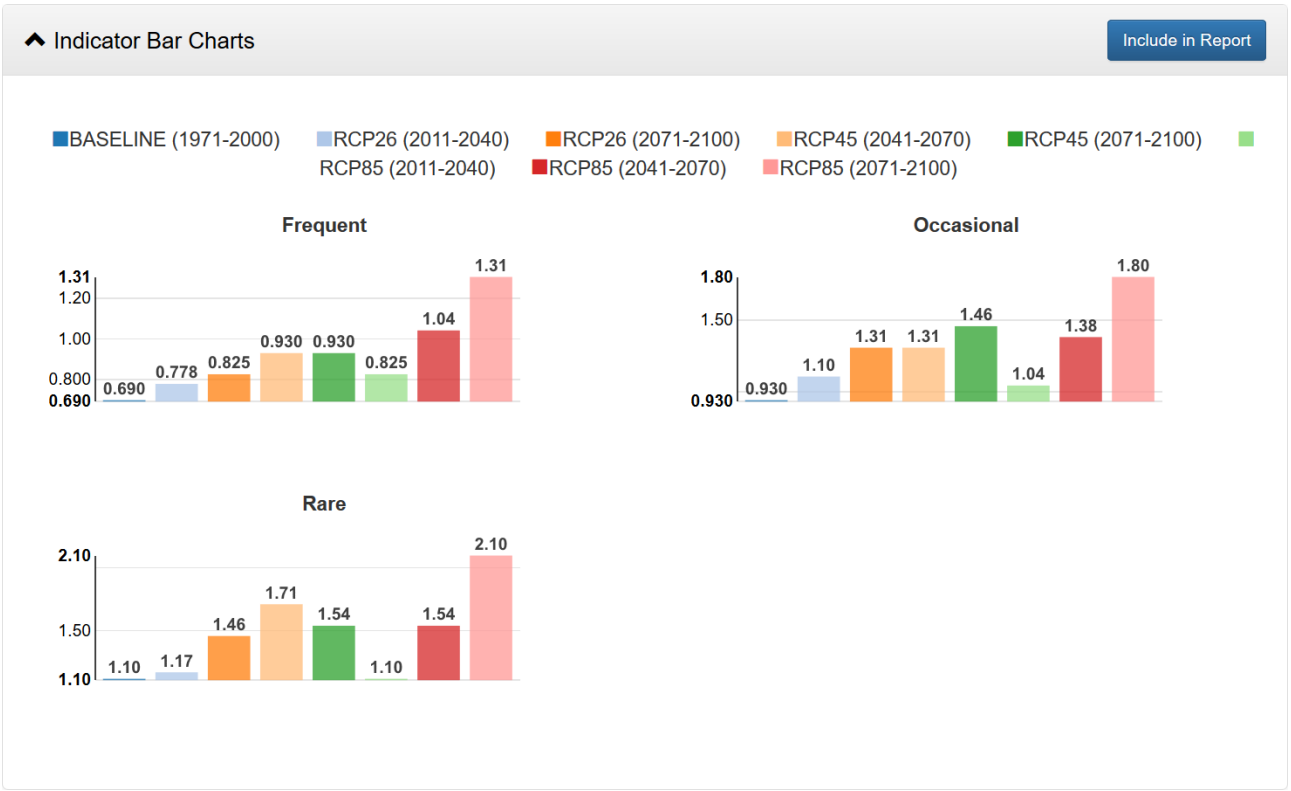



Figure 21: Multi Criteria Decision Analysis Tool

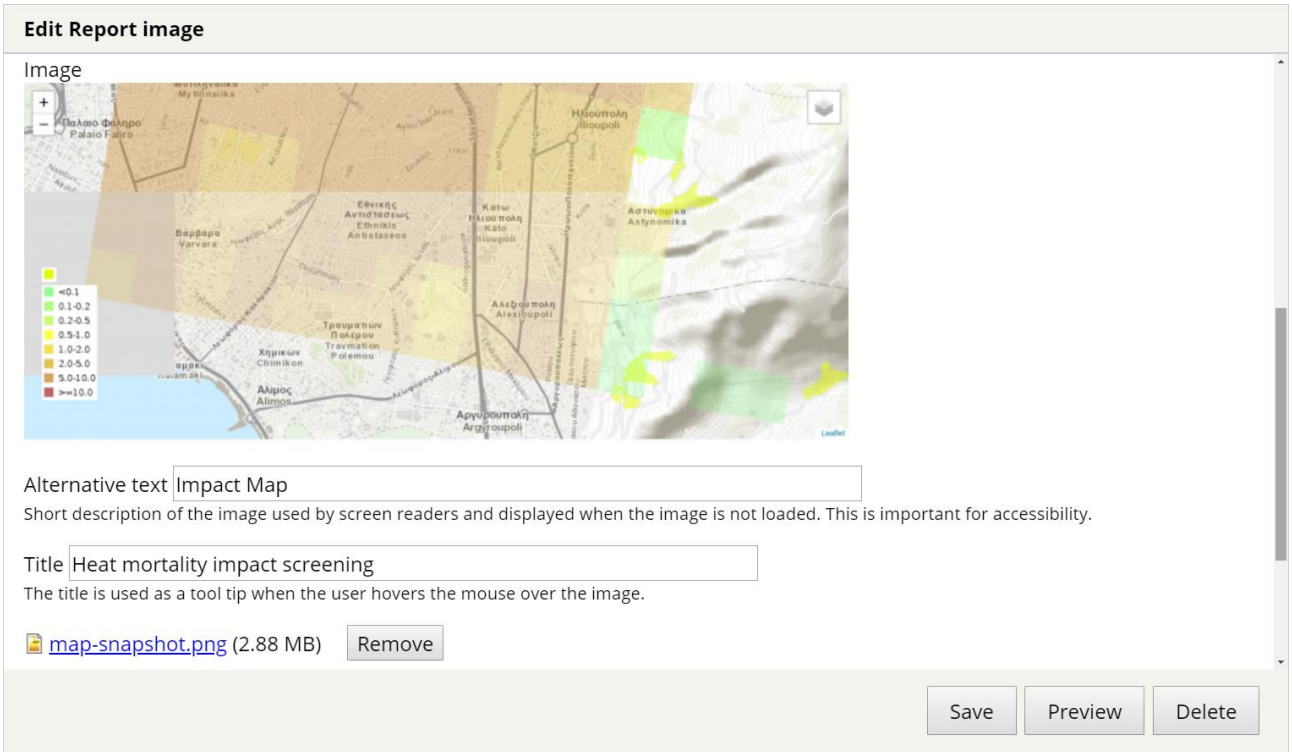



Figure 22: Report Generation

# 4 Conclusion

This document is the last report of WP4 "Technology Support" and thus provides a final overview of the results in terms of software created within the context of this work package. The general role of WP4 is thereby to support the project with fit-for-purpose software and technologies that can be used to co-develop the CLARITY Climate Services Information System.

The overall objectives of WP4 are to

- Provide the technological backbone of the CLARITY CSIS based on the methodological concept and end-user driven requirements defined in WP1 "Co Creation";
- Integrate and adapt all required and existing IT (background) tools and services that are needed for the implementation of the EU-GL in CSIS And CLARITY Climate Services; and
- Span the arc from IT architecture and infrastructure over software for data and scenario management, to visualisation and ranking of potential adaptation options

The main achievements of WP4 in the last 30 months of the project have been:

- Specification of an architecture that successfully combines traditional software engineering methodologies applied in former projects with agile software development and co-creation practices;
- Identification and description of the goals and mission of the CSIS on basis of project objectives, elicitation and evaluation of exploitation requirements and input from stakeholder workshops;
- Conceptualisation of the initial the product vision that was shaped during several workshops into high level innovation design that connects business and domain models
- Introduction of state-of-the art management practices for agile software development projects to steer, organise, monitor, and document the development of the CSIS and its building blocks;
- Identification and description of functional building blocks and their position within the CSIS architecture and selection, extension and adaptation of fit-for-purpose technologies and open-source software that meet not only functional requirements but also sustainability and maturity requirements; and
- Implementation of the building blocks and support for integrating them into the CSIS.

The tangible results in terms of documents represented by project deliverables produced by WP4 are:

- **D4.1 "Technology Support Plan"**
  This document contains the results of a critical assessment of background technologies inherited from former research & development projects regarding their principal suitability for the implementation of the CLARITY CSIS. It furthermore provides the initial specification of the CSIS architecture and its primary build blocks as well as a plan for the work in WP4 per task.
- **D4.2 "CLARITY CSIS Architecture"**
  This documents represents a lean and self-explanatory architectural documentation that fosters the shared understanding among all CLARITY stakeholders and equips CLARITY co-creation teams with the necessary conceptual background information to successfully implement the CSIS.
- **D4.3 "Technology Support Report v1"**
  This document represents an accompanying report to the technologies and software components that are adapted, extended, customised and deployed by WP4 and configured, assembled and integrated by WP1 to implement the CLARITY CSIS.
- **D4.4 "Technology Support Report v2"** (this document)
  This document reports on the work performed in WP4 since the release of D4.3 "Technology Support Plan v1" and provides the final overview of all the tools and models that were either inherited from previous projects or developed in CLARITY WP4 and explains how the inherited tools were used and/or extended in CLARITY.

Following CLARITY data management principles aiming at supporting open data, open science and open source, these public deliverable documents are also available in Zenodo open science repository at https://zenodo.org/communities/clarity/.

The tangible results produced by WP4 in terms of (mainly) open source software (source code and/or binaries) and their technical documentation are made available in online repositories at GitHub at https://github.com/clarity-h2020/.

Although D4.4 “Technology Support Plan v2” is the last deliverable of WP4, the work on building blocks will continue in WP1. Integration of building blocks into the CSIS and further development of the CSIS platform as such are performed in T1.3 “Climate Service Co-Creation”. Important changes to building blocks like bug fixes and security updates will be performed in T1.4 “Industrialisation and Support”. The result of these activities will be reported in D1.4 “CLARITY CSIS v2” and D1.5 “Final Industrialisation and Support Report“, respectively.

# References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[12] J. Ungar, J. Peters-Anders and W. Loibl, “Climate Twins - An Attempt to Quantify Climatological Similarities,” *Environmental Software Systems. Frameworks of eEnvironment,* 2011.

# Annex 1: Building Blocks and Software Components

This Annex provides the final overview of all software components that were either inherited from previous projects or developed in CLARITY and explains how the inherited components were used and/or extended in CLARITY to realise the building blocks of the CSIS. It also provides links to access the documentation, source code, binaries and deployed instances resulting from this work.

## Catalogue of Data Sources and Simulation Models

### Overview

"The Catalogue of Data Sources and Simulation Models is a meta-data catalogue that makes climate-related information accessible by providing functionalities to streamline publishing, sharing, finding and using data and models. The catalogue can be used for data discovery and meta-data storage by different climate services and building blocks, respectively." [3] Additionally, this catalogue is used for the implementation of the deliverables D2.2 "Catalogue of local data sources and sample datasets" and D7.x "Data Management Plan".

### Results

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Catalogue-of-Data-Sources-and-Simulation-Models

**Source code, software releases and technical documentation:**
https://github.com/clarity-h2020/ckan/

**Deployed instance:**
https://ckan.myclimateservice.eu/

### Realisation

Figure 23 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

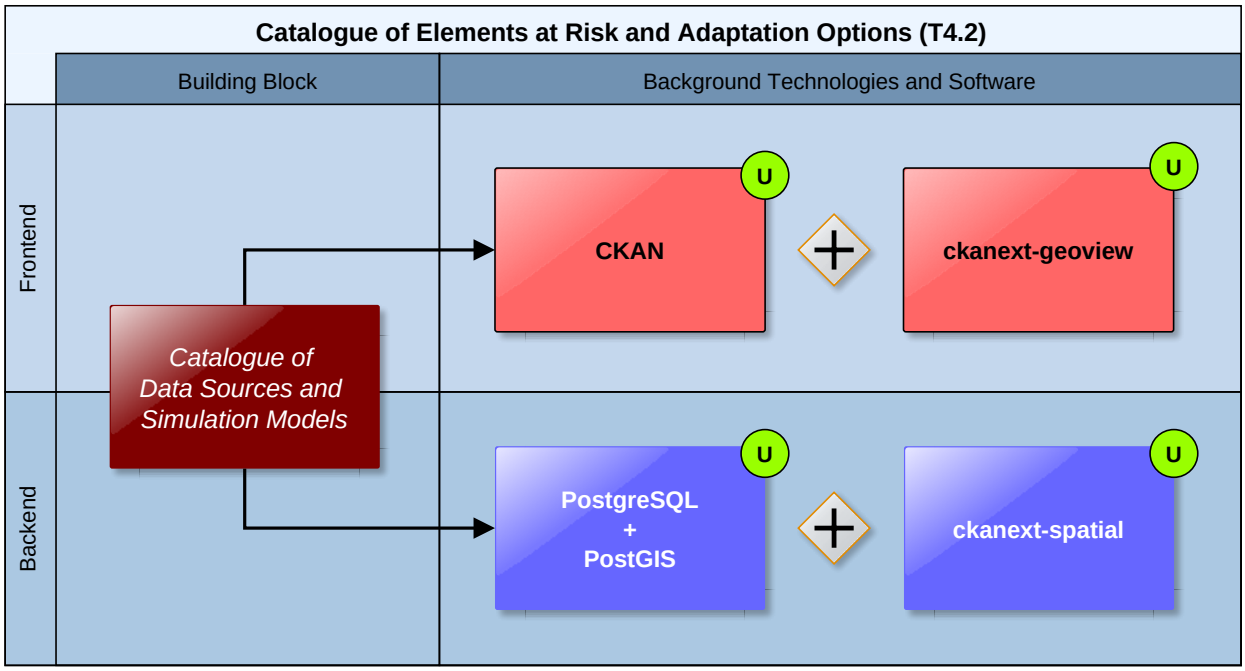


Figure 23: Catalogue of Data Sources and Simulation Models technology support

As foreseen in the initial technology support plan, this building block is realised by the open-source cataloguing software **CKAN**.

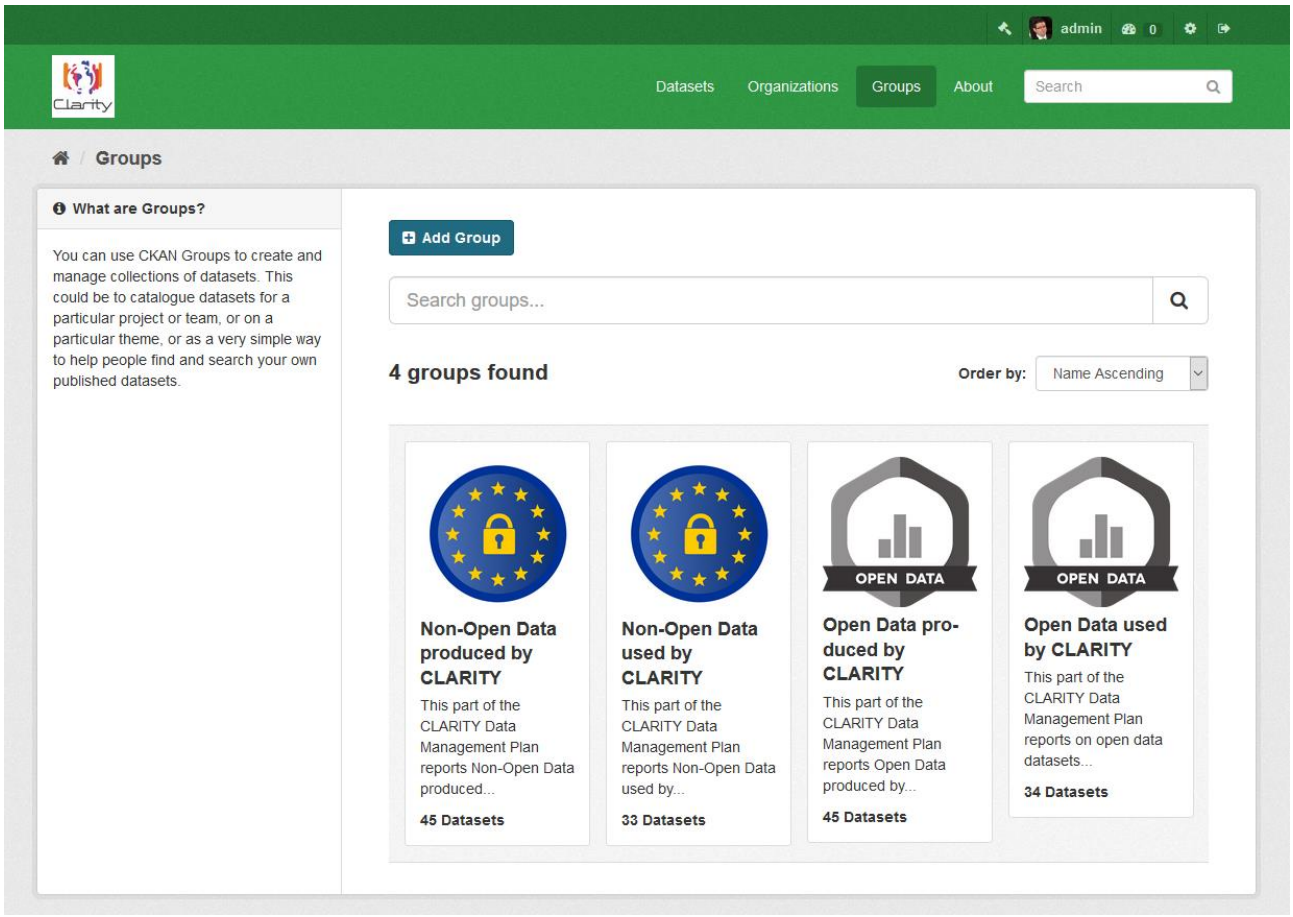


Figure 24: Catalogue of Data Sources and Simulation Models

To satisfy the functional requirements of this building block, WP4 created a CLARITY-specific configuration (branding, meta-data model, categories, organisations, documentation, etc.) and installed configured the respective plugins and add-ons. These configurations are available as open-source in a public GitHub repository that was forked from the original CKAN repository. No direct changes to the source code of CKAN where necessary. The actual service instance (Figure 24) is deployed as Docker container in CLARITY's cloud infrastructure.

As the meta-data on datasets used and produced in CLARITY project is stored in a **PostgreSQL** database, an offline D7.10 "Data Management Plan v3" can be automatically generated from the contents of this database.

**Report**

A detailed technical report of the development activities by means of implementation-level tasks ("issues") is available on the GitHub platform. A brief summary of these activities can be found in section 3.1 of this document.

**Detailed technology support report:**
https://github.com/clarity-h2020/ckan/issues?utf8=%E2%9C%93&q=

# Catalogue of Elements at Risk and Adaptation Options

**Overview**

The Catalogue of Elements at Risk and Adaptation Options is strongly linked to the EU-GL modules/steps "Characterise Hazard", "Evaluate Exposure", "Vulnerability Analysis", "Assess Risks and Impact" and "Identify Adaptation Options" as the actions to be carried out in these steps (except for "Characterise Hazard") are based on the respective "elements at risk types" or "elements at risk inventories". The catalogue is capable of handling geo-data (e.g. points, lines, grids, political areas, etc.) which is especially relevant for the handling of the elements at risk (e.g. points for building locations, lines for roads/transport networks, grids for population densities, etc.

**Results**

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Catalogue-of-Elements-at-Risk-and-Adaptation-Options

**Source code, software releases and technical documentation:**
https://github.com/clarity-h2020/emikat

**Description of API Endpoints**
https://github.com/clarity-h2020/csis/wiki/Services-endpoints-(used-by-CSIS)#emikat-apis

**Deployed instance (access protected):**
https://service.emikat.at/EmiKat/swagger/index.html

**Realisation**

Figure 25 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

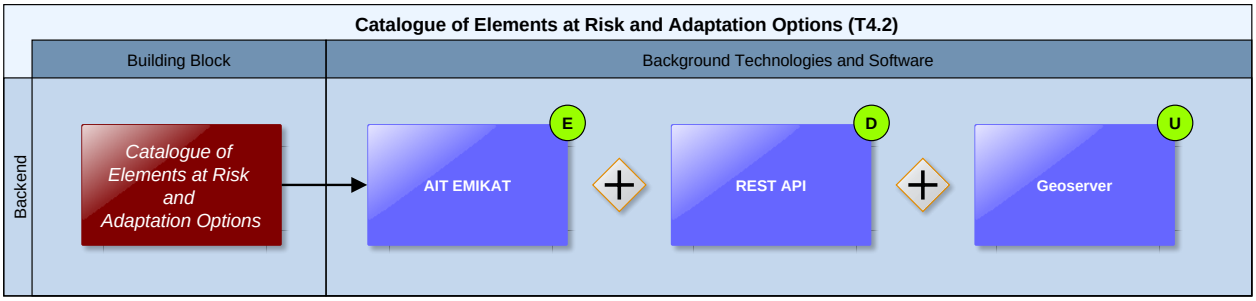


Figure 25: Realisation of the Catalogue of Elements at Risk and Adaptation Options

The back-end of this building block is realised by AIT's proprietary EMIKAT software system. The service instance is deployed on AIT servers. The front-end part is implemented as Drupal 8 Views in the Scenario Management building block. The relevant data, maps and other information is exchanged via a new **REST-API** and **GeoServer WFS/WMS/WCS APIs**. EMIKAT software system itself gets initial parameters from Drupal CSIS application and starts calculation of several processing steps on the definition parameters of a CSIS study.

The most important parameters are:

- Name and type of the CSIS-Study
- Location of the city
- Bounding area
- Definition of the Data Packages

The calculation of the processing steps is triggered by CSIS application automatically. EMIKAT software system fetches the necessary data contents via OGC WMS or WFS calls from other data sources, like the GeoServer hosted by project partners ATOS or METEOGRID.

The work regarding this building block was extended to also implement a European-level screening service for assessing the impact on exposed elements like population and infrastructure resulting from heat and flood hazards. It mainly focuses on the implementation of a REST API for impact calculation and for creating new adaptation scenarios by modifying and land use distribution as well the parameters like albedo.

The actual data to be used for the impact calculation is part of the exposure layers of the respective Data Package. For the purpose of showing meaningful results to users, element at risk types are implemented (Figure 26).

| EARType_ID | Name | Acronym | QuantityUnit | Quantity unit (short) | Taxonomy_ID |
|---|---|---|---|---|---|
| 1 | people | POP | number of people | number | element-at-risk:population |
| 2 | buildings | BUILD | number of buildings | number | element-at-risk:buildings |
| 3 | buildings | BUILD | m² of buildings | m² of | element-at-risk:buildings |
| 4 | critical infr... | INFR | number of critical infr... | number | elements-at-risk:infrastructure |
| 5 | transport i... | ROAD | road length km | road l | |

Figure 26: EMIKAT table showing some Element at Risk Types

For the calculation of impact and risk data from different maps/layers and parameters ("hazard-local-effects" layers, exposure layers) have to be combined by the impact calculation model for the respective project area of the user. The method of calculating of impact has changed since D4.3 "Technology Support Report v1" [2]. Currently, the heat wave impact on population is not any more dependent on age classes.

Some rows (5 out of 15.900) of the result of an impact calculation using exemplary data are shown in Figure 27.

| Project ID | Event ID | Event Name | Emissionss... | Time Period | Event Freq... | Grid_ID | ExposedQuantity | DamageProbability | Damage Quantity |
|---|---|---|---|---|---|---|---|---|---|
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 2.147 | 0,001561 | 3,352 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 3.304 | 0,001623 | 5,363 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 3.748 | 0,001656 | 6,207 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 3.748 | 0,001697 | 6,359 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 4.495 | 0,001686 | 7,578 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 4.495 | 0,001697 | 7,627 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 4.909 | 0,001721 | 8,45 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 4.909 | 0,001718 | 8,434 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 6.617 | 0,00178 | 11,78 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 6.617 | 0,001758 | 11,64 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 5.155 | 0,001671 | 8,613 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 5.155 | 0,001775 | 9,15 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 3.146 | 0,001621 | 5,1 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 3.304 | 0,001587 | 5,244 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 3.748 | 0,001665 | 6,24 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 3.748 | 0,001666 | 6,242 |
| 44 | 2511 | 43.5_0.066d | 2 | 2 | Rare | 500mE55... | 4.495 | 0,001699 | 7,639 |

Figure 27: First rows from the Result of an Impact Calculation carried out by EMIKAT (excerpt)

The results of the population exposure, mean radiant temperature (Tmrt) and impact calculation can be accessed by several services, like REST or GeoServer OGC/WMS interface.

To create a human-readable form that can be used in the Multi Criteria Decision Analysis Tool and the Table Components the detailed results of the calculation are aggregated by EMIKAT (Figure 28).

| ImpactSc... | ImpactC... | HazardSc... | HazardInd... | HazardIndexTypeName | ... | ... | EaRTypeName | VulnerabilityClass_ID | VulnerabilityClassName | SUM_EXPOSEDQUANTITY | SUM_DL1... | SUM_DL2... | SU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1 | 2 | 1 | heat-wave:consecutive-summer-days | ... | ... | people | 26 | Age 15-65 | 1.249.549 | 0,3311 | 32,49 | 1. |
| 1 | 1 | 1 | 1 | heat-wave:consecutive-summer-days | ... | ... | people | 26 | Age 15-65 | 1.249.549 | 0,3311 | 32,49 | 1. |
| 1 | 1 | 1 | 1 | heat-wave:consecutive-summer-days | ... | ... | people | 25 | Age<14 | 499.820 | 0,01015 | 1,699 | 11 |
| 2 | 1 | 2 | 1 | heat-wave:consecutive-summer-days | ... | ... | people | 25 | Age<14 | 499.820 | 0,01015 | 1,699 | 11 |
| 1 | 1 | 1 | 1 | heat-wave:consecutive-summer-days | ... | ... | people | 21 | Age>65 | 749.730 | 0,0000117 | 0,008397 | 2, |
| 2 | 1 | 2 | 1 | heat-wave:consecutive-summer-days | ... | ... | people | 21 | Age>65 | 749.730 | 0,0000117 | 0,008397 | 2. |

Figure 28: Aggregated impact results for the (excerpt)

When impact/risk is calculated, the CSIS front-end sends a request to the Impact/Risk Model Service (EMIKAT + REST interface) with the URI of the current object of study. The impact/risk model service retrieves the study object JSON representation. Figure 29 shows some of the functionalities of the EMIKAT REST-API. Swagger[8] provides documentation and testing possibilities of the REST-API.

[8] Swagger is a powerful yet easy-to-use suite of API developer tools for teams and individuals, enabling development across the entire API lifecycle, from design and documentation, to test and deployment. https://swagger.io/about/

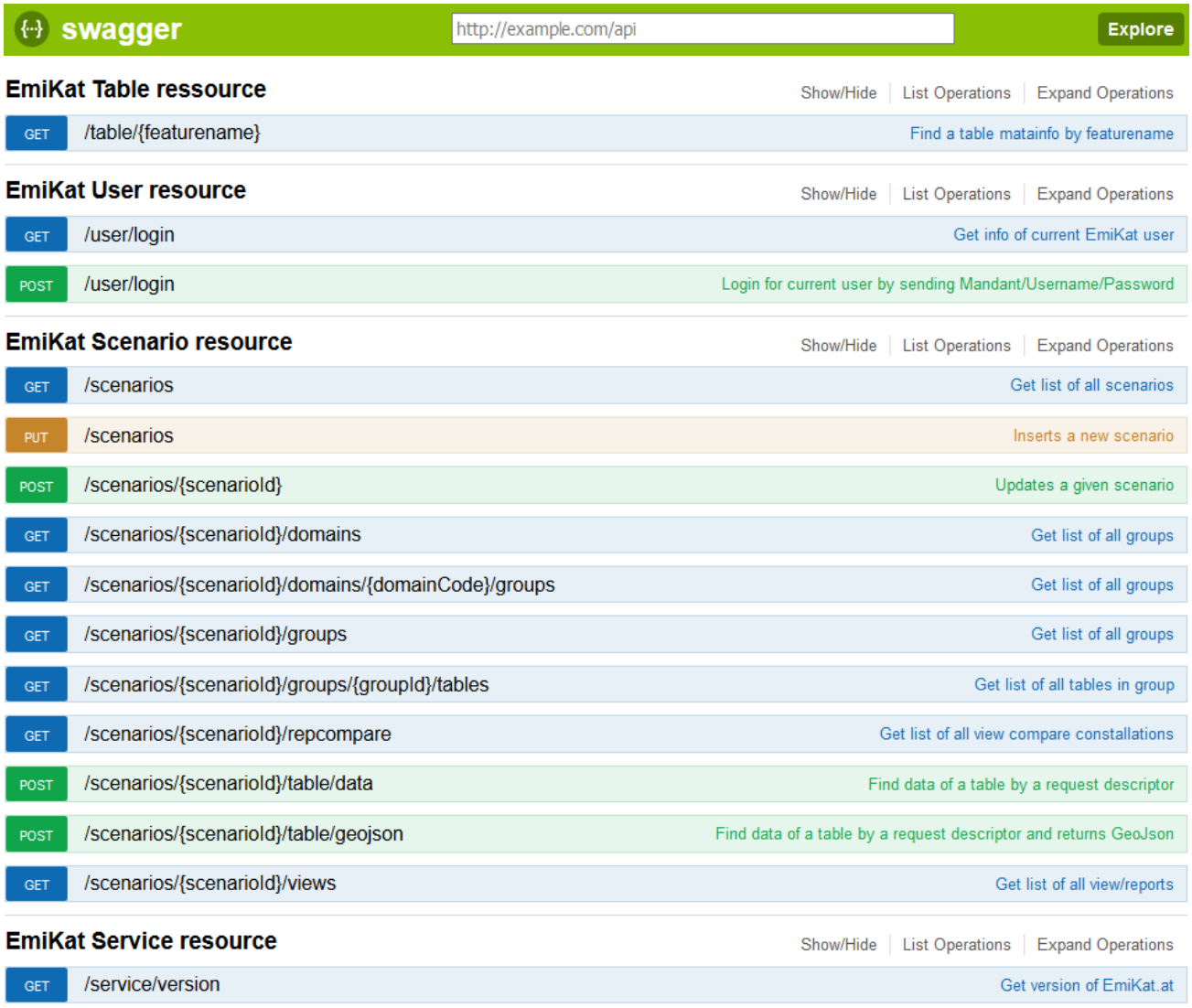


Figure 29: EMIKAT REST-API functionalities

Adaptation options are implemented as a custom content type in the CSIS Drupal platform. Content types are a fundamental feature of Drupal allowing for structuring and organizing content. The adaptation options in the CSIS can be linked to individual Data Packages. This makes it possible for users to view a table of available adaptation options based on the Data Package that has been selected for the study in the “Identify Adaptation Options” EU-GL step (Figure 30). This table is generated by a “View” (another core feature of the Drupal system, responsible for visualising content), which further enables the users to select individual adaptation options to be added to the study. These selected adaptation options are then included in the final study report. Additionally, this table also influences the “adaptation twins”, since only those twins will be displayed that reference the adaptation options selected by the user.

| ILLUSTRATION | ADAPTATION OPTION | ACTION |
|---|---|---|
|  | Cool roofs - Light (Mineral membrane coated white reflex ultra) | Include in Report |
|  | Cool roofs - Medium (Mineral membrane reflex white) | Include in Report |
|  | Green roofs - Intensive | Include in Report |
|  | Permeable flooring - Permeable concrete (Permeability < 20%) | Include in Report |
|  | Permeable flooring - Porous paving (Permeability > 90%) | Include in Report |
|  | Reflective surfaces - Dark (Cool flooring, Cool coated) | Include in Report |
|  | Reflective surfaces - Light (Cool flooring, Cool coated) | Include in Report |
|  | Shielding open spaces - Fixed canopy (Type A) | Include in Report |
|  | Shielding open spaces - Green pergolas (Type C) | Include in Report |
|  | Shielding open spaces - Removable canopy (Type B) | Include in Report |
|  | Trees - Type C - Small canopy diameter (Φ Canopy < 3 m; h tree < 12 m) | Include in Report |

Figure 30: Table of adaptation options available in Data Package

Apart from that, the CSIS offers a possibility to display an overview with all available adaptation options that are stored on the platform. This again is handled by a dedicated View in Drupal, which allows users to view individual adaptation options in more detail and shows in which showcases they are used.

Furthermore, another View creates a REST endpoint for EMIKAT, which provides a possibility for EMIKAT to get the information about which adaptation options are selected in a study and what their properties are.

**Report**

A detailed technical report of the development activities by means of implementation-level tasks (“issues”) is available on the GitHub platform. A brief summary of these activities can be found in section 3.1 of this document.

**Detailed technology support report:**
https://github.com/search?o=desc&q=org%3Aclarity-h2020+label%3A%22BB%3A+Catalogue+of+ER+%26+AO%22+sort%3Acreated-asc++sort%3Acreated-asc&s=created&type=Issues

# Container Engine and Cloud Infrastructure

### Overview

The CSIS is composed of a set of (micro) services that can independently be deployed as isolated containers either on a self-hosted physical server that provides its own container engine or in a virtualized environment offered by a cloud-hosting provider. For this purpose, a Container Engine and Cloud Infrastructure building block (Figure 32) is provided by T4.1 “Industrialisation and Support”.

### Results

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Container-Engine-and-Cloud-Infrastructure

**Docker configuration files repositories:**
https://github.com/clarity-h2020/docker-pgadmin
https://github.com/clarity-h2020/docker-duplicity
https://github.com/clarity-h2020/docker-compose-letsencrypt-nginx-proxy-companion
https://github.com/clarity-h2020/docker-hoster

**Deployed instances:**
https://www.myclimateservice.eu/ and subdomains

### Realisation

Figure 31 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

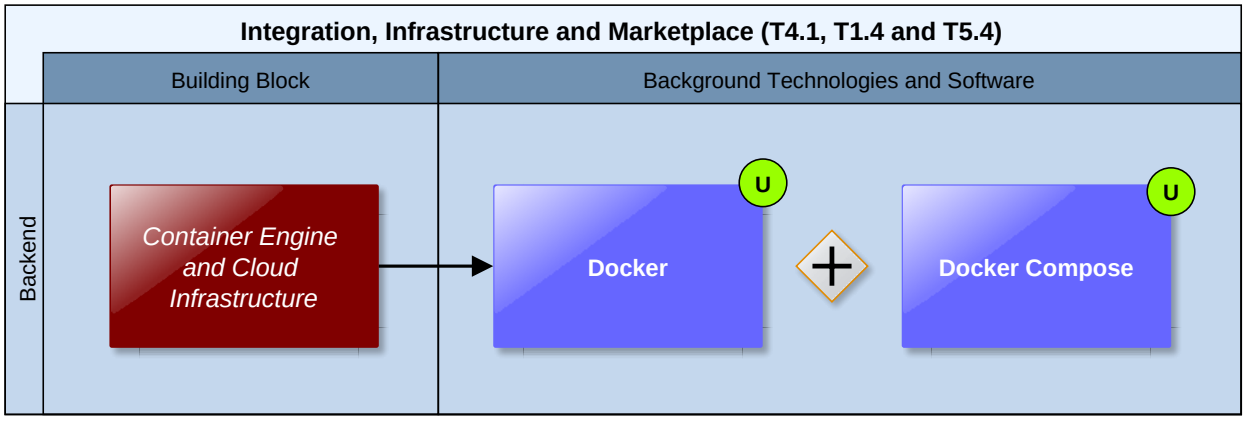


Figure 31: Container Engine and Cloud Infrastructure technology support

In accordance to the initial technology support plan, CLARITY partners AIT provided a dedicated development and deployment server (64 GB RAM, 8 cores, 8 TB hard drive) where the Docker container engine (Figure 32) is made available for deploying the CSIS components’ containers. Since such Docker containers can be installed on premise as well as in could-based environments, this option can be used unless project development requires a more powerful infrastructure.

The Docker containerisation technology is able to encapsulate lightweight runtime environments and provides good portability, performance, ease of replication, environment isolation, high availability and scalability for micro services. Additionally, so called compose files offer a lightweight automation technology to coordinate, monitor and manage the different containerised micro services.

For all micro-service based CSIS components, source code repositories for hosting the respective Docker compose files and auxiliary configuration files have been created at GitHub. This includes also several infrastructure (micro) services like proxies, load balancers, name services, etc.

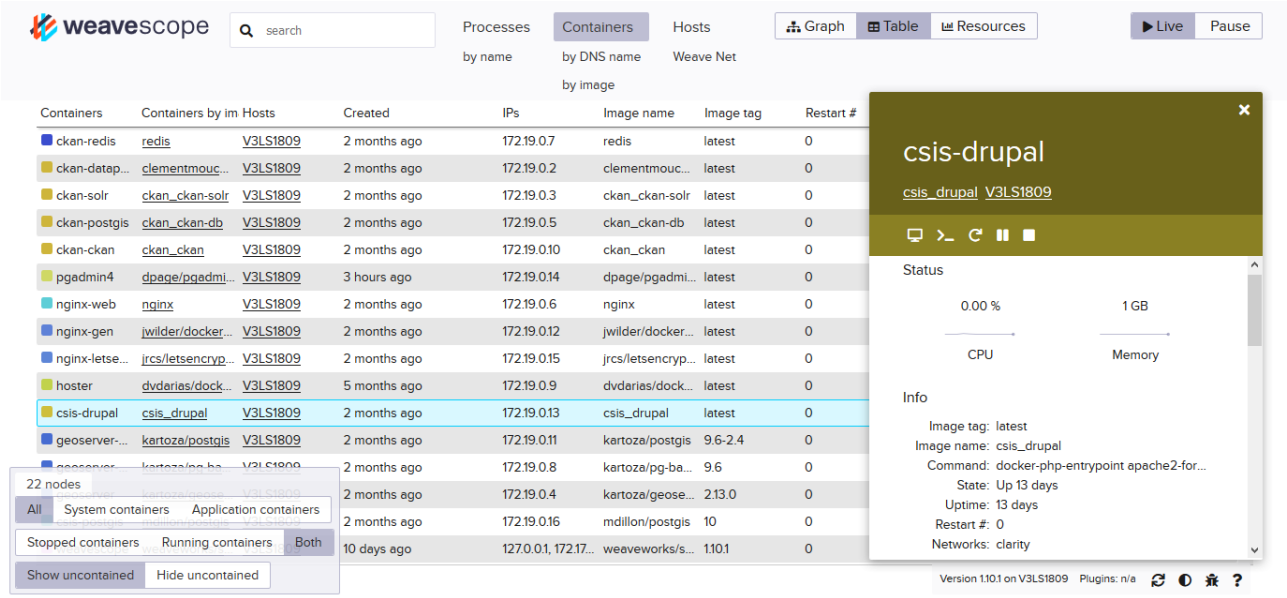


Figure 32: Container Engine and Cloud Infrastructure

**Report**

A detailed technical report of the development activities by means of implementation-level tasks (“issues”) is available on the GitHub platform. A brief summary of these activities will be provided in deliverable D1.5 ”Final Industrialisation and Support Report”.

**Detailed technology support report:**
https://github.com/search?o=desc&q=org%3Aclarity-h2020+label%3A%22BB%3A+Infrastructure%22+sort%3Acreated-asc&s=created&type=issues

# Data Dashboard

**Overview**

The Data Dashboard building block provides an overview of all the different datasets that are used, produced, ordered, collected, requested, exchanged etc. by an end user (e.g. project planner or climate resilience manager) during a CSIS screening- or expert study. Datasets are organised according to their relation to the modules of the EU-GL (e.g. hazard maps, impact scenario results, elements of risk inventory) in Data Packages. The Data Dashboard is therefore also a viewer for Data Package meta-data.

**Results**

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Data-Dashboard

**Drupal configuration repository (private):**
https://gitlab.atosresearch.eu/ari/clarity-csis-drupal

**Deployed instance:**
https://csis.myclimateservice.eu/

**Realisation**

Figure 33 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

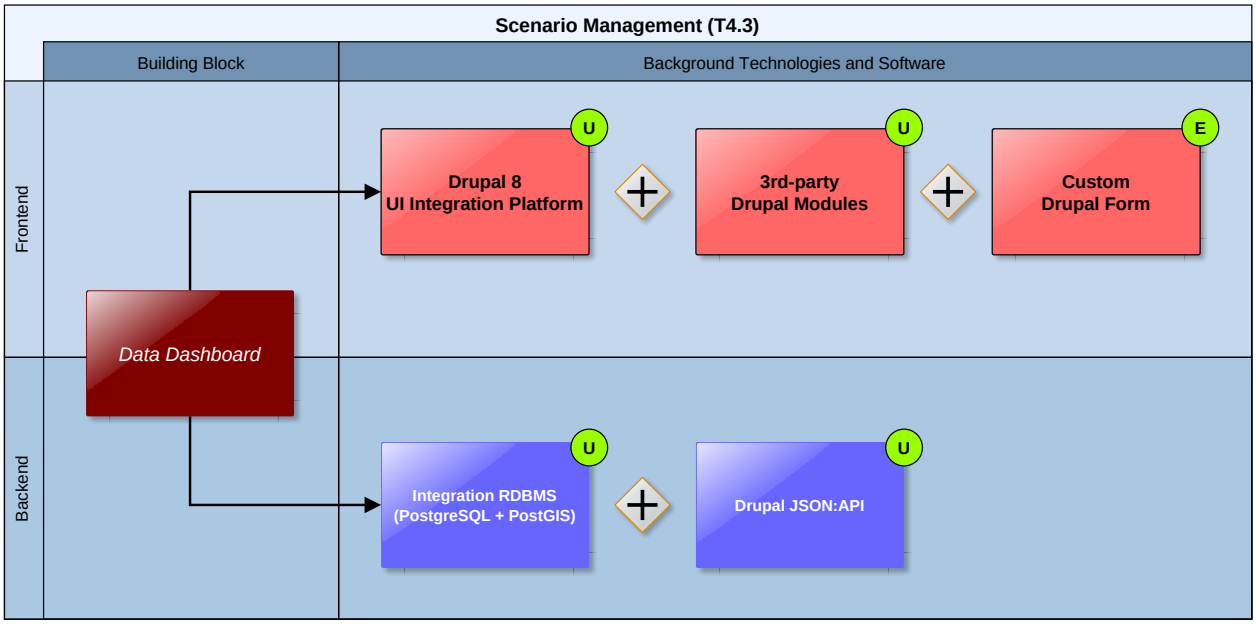


Figure 33: Data Dashboard technology support

Since the Data Dashboard is closely related to the Data Package Builder and thus to the Data Package specification (https://github.com/clarity-h2020/data-package), the same front-end technologies for both building blocks are used

Since both building blocks are realised as Drupal forms (Figure 34) with help of a serval open-source 3rd-party modules, they benefit not only from the rich functionality offered to a Drupal form and the powerful Drupal API, but are also able to reuse the respective entity types and view mode configurations in both building blocks. These configurations are stored in a common private git repository offered by Atos Research & Innovation department. Since these configurations are part of the overall CSIS Drupal configuration, they are deployed as part of the CSIS Drupal Docker container in CLARITY's cloud infrastructure.

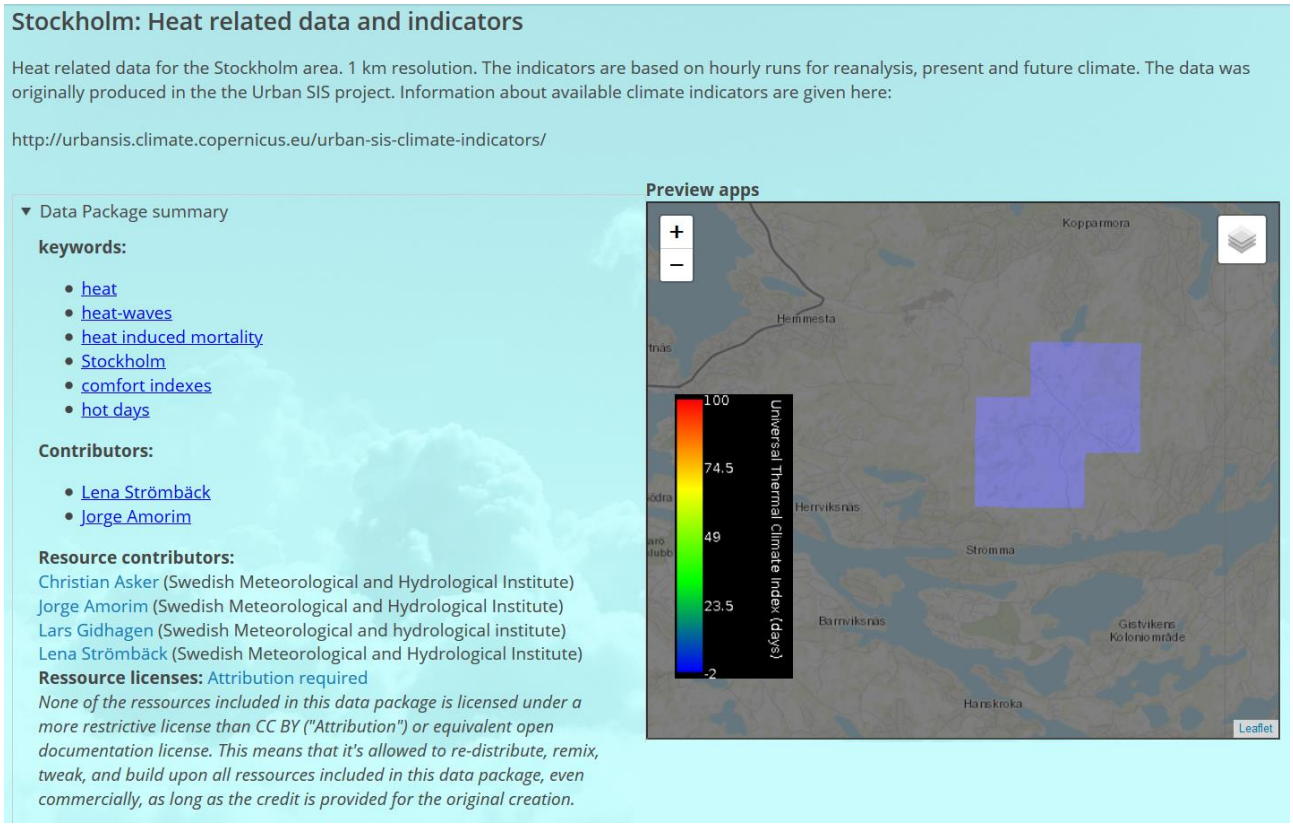


Figure 34: Data Dashboard (Data Package)

**Report**

A detailed technical report of the development activities by means of implementation-level tasks ("issues") is available on the GitHub platform. A brief summary of these activities can be found in section 3.2 of this document.

**Detailed technology support report:**
https://github.com/search?q=org%3Aclarity-h2020+sort%3Acreated-asc+label%3A%22BB%3A+Data+Dashboard%22&type=issues

# Data Package Builder

**Overview**

The Data Package Builder building block is a tool that can used be used to support experts in developing additional Data Packages for use in the Marketplace and the CSIS.

**Results**

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Data-Package-Export-and-Import-Tool

**Data Package Specification repository:**
https://github.com/clarity-h2020/data-package

**Drupal configuration repository (private):**
https://gitlab.atosresearch.eu/ari/clarity-csis-drupal

**Experimental QGIS 3 plugin repository:**
https://github.com/clarity-h2020/data-package-builder

**Deployed instance:**
https://csis.myclimateservice.eu/

**Realisation**

Figure 35 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

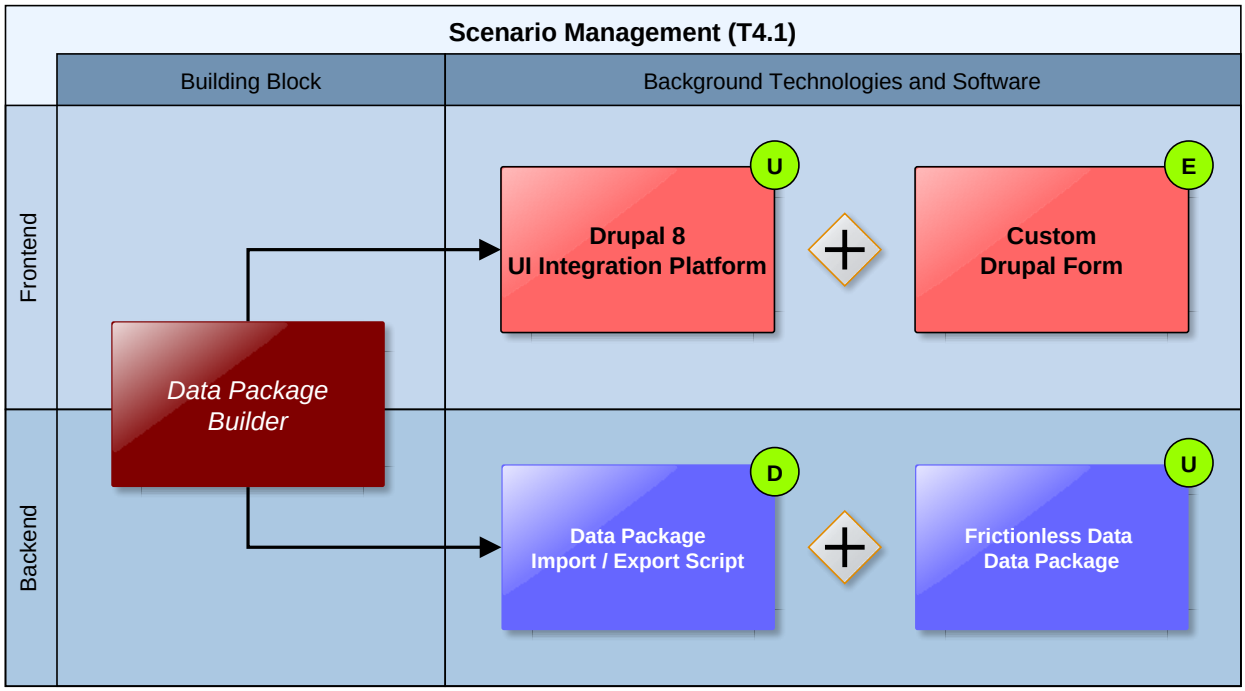


Figure 35: Data Package Builder technology support

Both this building block and the Data Dashboard are realised as **Drupal forms**. However, the Data Package Builder building blocks follow thereby a hybrid approach. Although the management of a Data Package's meta-data can easily be achieved using the standard entity forms the Drupal 8 platform, deriving such meta-data that follows CLARITY's Data Package standards from the original data sources is still a complex task. To support providers of Data Packages in the creation of such and to lower the entry hurdles for the myclimateservices.eu marketplace, self-explanatory online Data Package forms supports users creating CLARITY-compatible Data Packages with data necessary to carry out studies in the CSIS have been created.

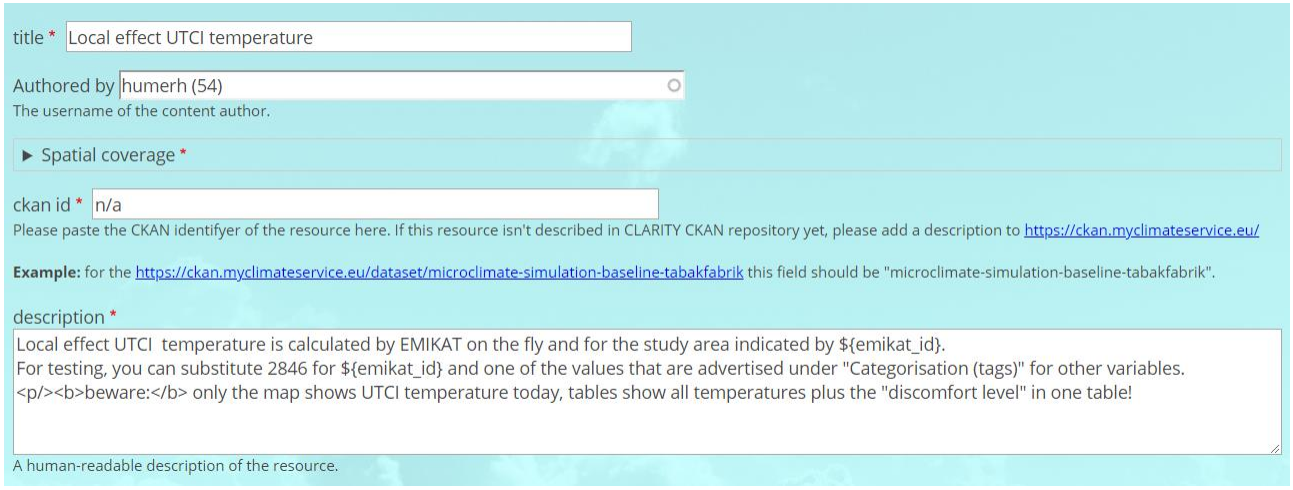


Figure 36: Data Package Builder (advanced form)

There are two versions of the online Data Package Builder, one allowing the user to describe a Data Package in full detail according to the properties defined in the specification (Figure 36) and, a simplified version (Figure 37) requesting the minimum list of properties necessary for creating a valid and usable Data Package for the CSIS.

Apart from this, the Drupal-specific configurations of this building block are stored in a common private git repository offered by Atos Research & Innovation department. Since these configurations are part of the overall CSIS Drupal configuration, they are deployed as part of the CSIS Drupal Docker container in CLARITY's cloud infrastructure. The specification of the Data Package standard is made available as open specification in a public GitHub repository.

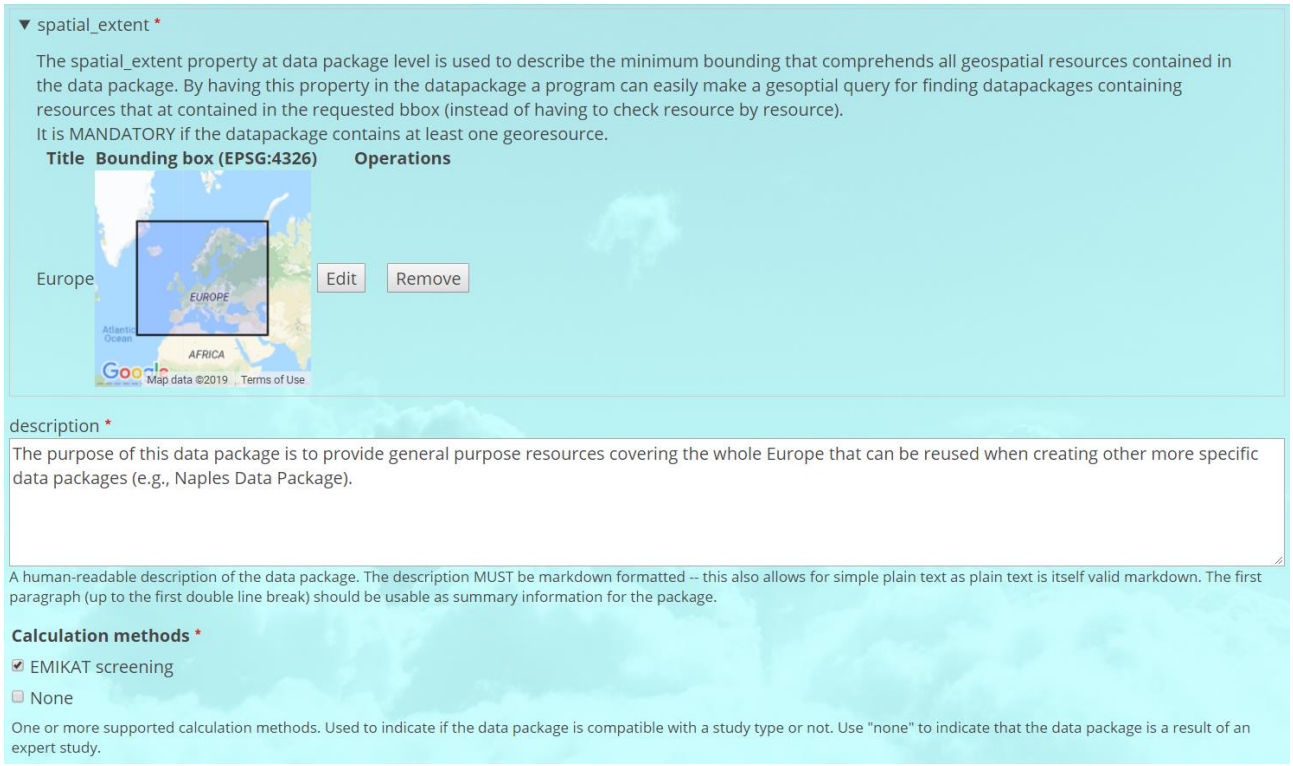


Figure 37: Data Package Builder (simple form)

**Report**

A detailed technical report of the development activities by means of implementation-level tasks ("issues") is available on the GitHub platform. A brief summary of these activities can be found in section 3.2 of this document.

**Detailed technology support report:**
https://github.com/search?o=desc&q=org%3Aclarity-h2020+sort%3Acreated-asc+label%3A%22BB%3A+Data+Package+Tool%22&s=created&type=Issues

# Data Repository

**Overview**

"This Building Block represents a set of generic data repositories that can be used to store, manage, and retrieve different types of (file-based) vector and raster datasets. Among others, this building block is used to facilitate the sharing of datasets between users and providers of Climate Services." [3]

**Results**

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Integration-RDMBS

**Source code, software releases and technical documentation:**
https://github.com/clarity-h2020/docker-geoserver
https://github.com/clarity-h2020/docker-geonode
https://github.com/clarity-h2020/thredds-docker

**Deployed instances:**
https://geoserver.myclimateservice.eu/geoserver/web/
https://service.emikat.at/geoserver/web/
https://clarity.meteogrid.com/geoserver/web/
https://service.clarity-h2020.eu:8080/geoserver/web

**Realisation**

Figure 38 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

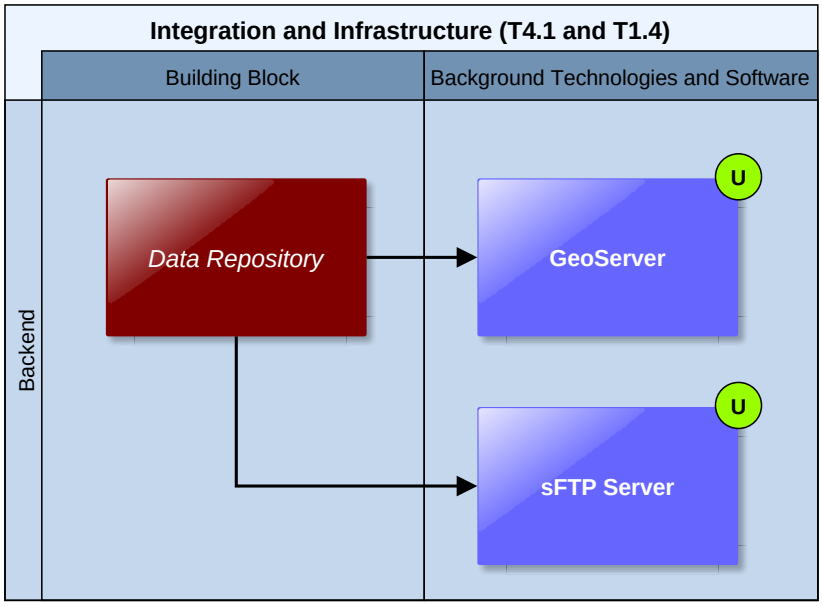


Figure 38: Data Repository technology support

The best choice for managing geospatial directly used in CSIS is **GeoServer** (Figure 39). GeoServer's Web Coverage Service for gridded data is mainly used by EMIKAT and the Table Component while the Web Map Service is mainly used by the Map Component building block.

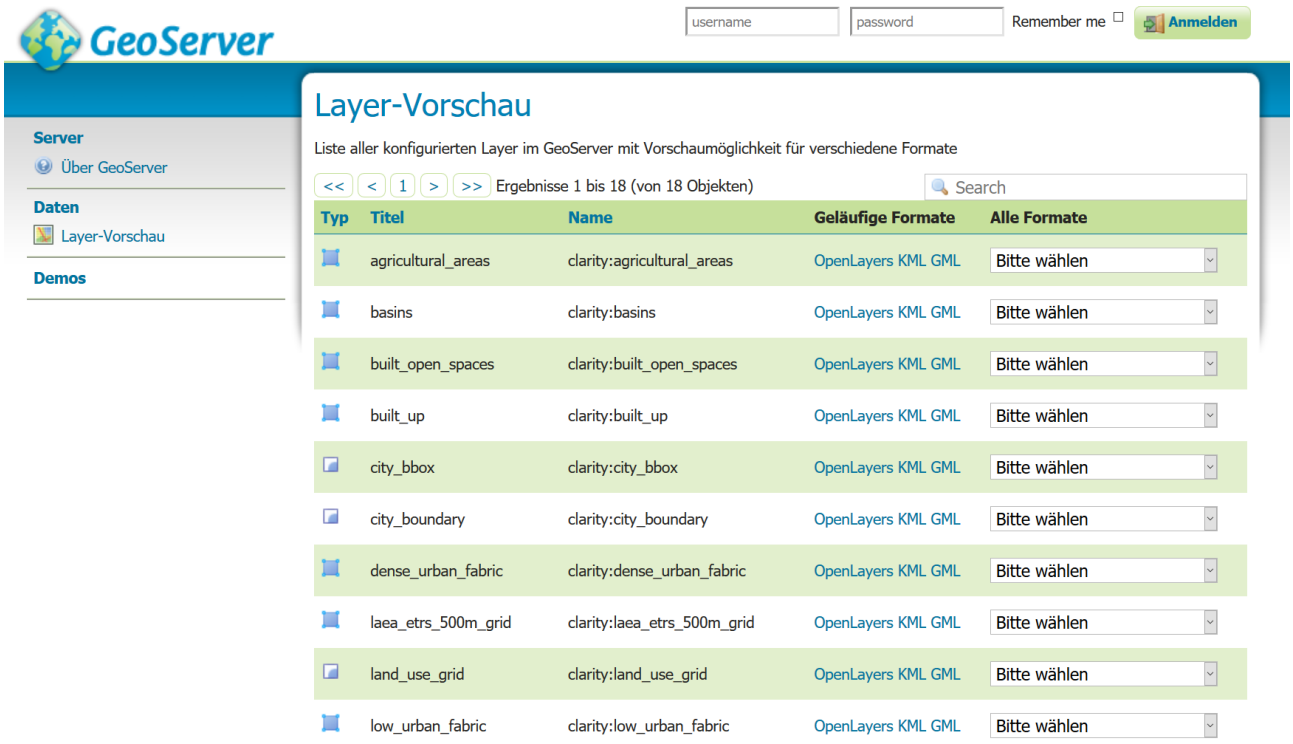


Figure 39: GeoServer Data Repository

For any *temporary* or "raw" data collected and produced in CLARITY, including for example data that serves as input for local models or intermediate output data in NetCDF Format, CLARITY provides a secure FTP Server (Figure 40). The CLARITY Data Management Plan (D7.10) will report also on such data that is not directly used within in the CSIS but may be needed for an intermediate process step and that is not meant for publication.

Thus, some of the datasets used and produced in CLARITY and described in the DMP link to the CLARITY sFTP.

Such data that is temporarily stored on the CLARITY sFTP and that is eligible for publication under an open licence (open data) will, after undergoing a verification and quality control process, be made available on Zenodo research data repository (https://zenodo.org/communities/clarity/), the DRMKC Risk Data Hub (https://drmkc.jrc.ec.europa.eu/risk-data-hub) and the Climate Change Centre Austria's (CCCA) Data Server (https://data.ccca.ac.at/organization/zamg).

The actual live version of the CLARITY DMP is realised with help of the Catalogue of Data Sources building block and available at https://ckan.myclimateservice.eu/. The sFTP service itself is hosted at ATOS premises.

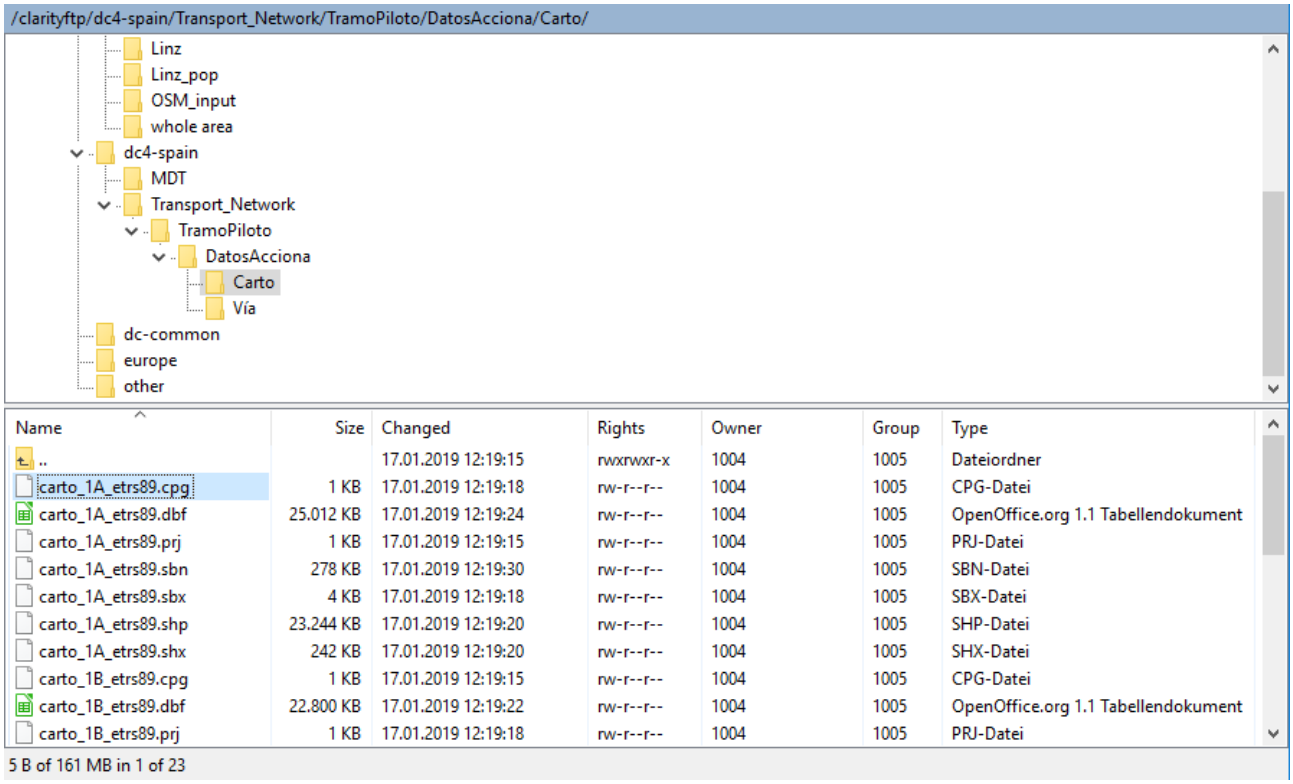


Figure 40: sFTP Data Repository

**Report**

A detailed technical report of the development activities by means of implementation-level tasks ("issues") is available on the GitHub platform. A brief summary of these activities will be provided in deliverable D1.5 "Final Industrialisation and Support Report".

**Detailed technology support report:**
https://github.com/search?q=org%3Aclarity-h2020+label%3A%22BB%3A+Data+Repository%22&type=Issues

# Integration and Development Platform

**Overview**

"The purpose of this building block is to provide a continuous integration platform allowing every consortium partner to be equipped with the tools and measures for best practices in software engineering. One of the most important factors on a successful IT project is to develop high quality software. Thereby, an appropriate development infrastructure and best practices are crucial in development in a distributed environment." [3]

**Results**

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Integration-and-Development-Platform

**Continuous integration system configurations:**
https://github.com/clarity-h2020/csis-helpers-js/blob/dev/Jenkinsfile
https://github.com/clarity-h2020/simple-table-component/blob/dev/Jenkinsfile
https://github.com/clarity-h2020/map-component/blob/dev/Jenkinsfile

**Deployed instance (protected):**
http://ci.clarity-h2020.eu/

**Realisation**

Figure 41: Integration and Development Platform technology support gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

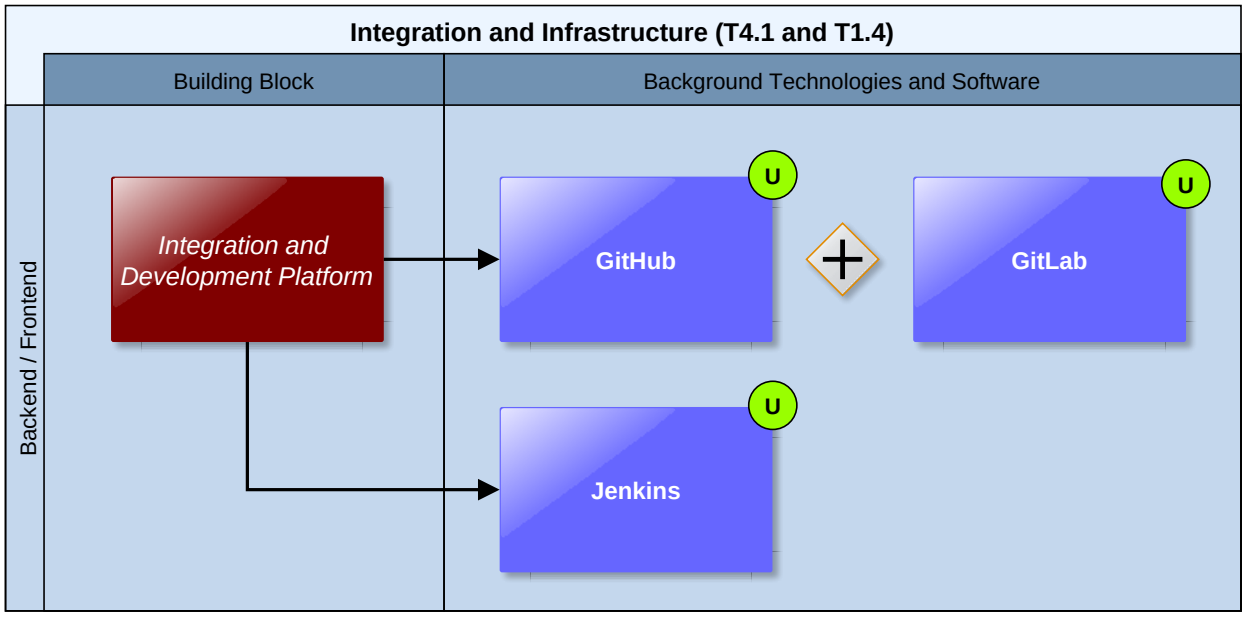


Figure 41: Integration and Development Platform technology support

The technology stack of the Integration and Development Platform is composed of **GitHub, GitLab and Jenkins**[9]. A private Jenkins CI installation hosted at ATOS servers is used for the developments (Figure 42).

[9] Jenkins is an open source automation server. It is Java based and runs under servlets containers to automatize software development processes, providing integration services. Its functionality can be easily extended by specific plugin, allowing its integration with many other different tools. https://jenkins.io/

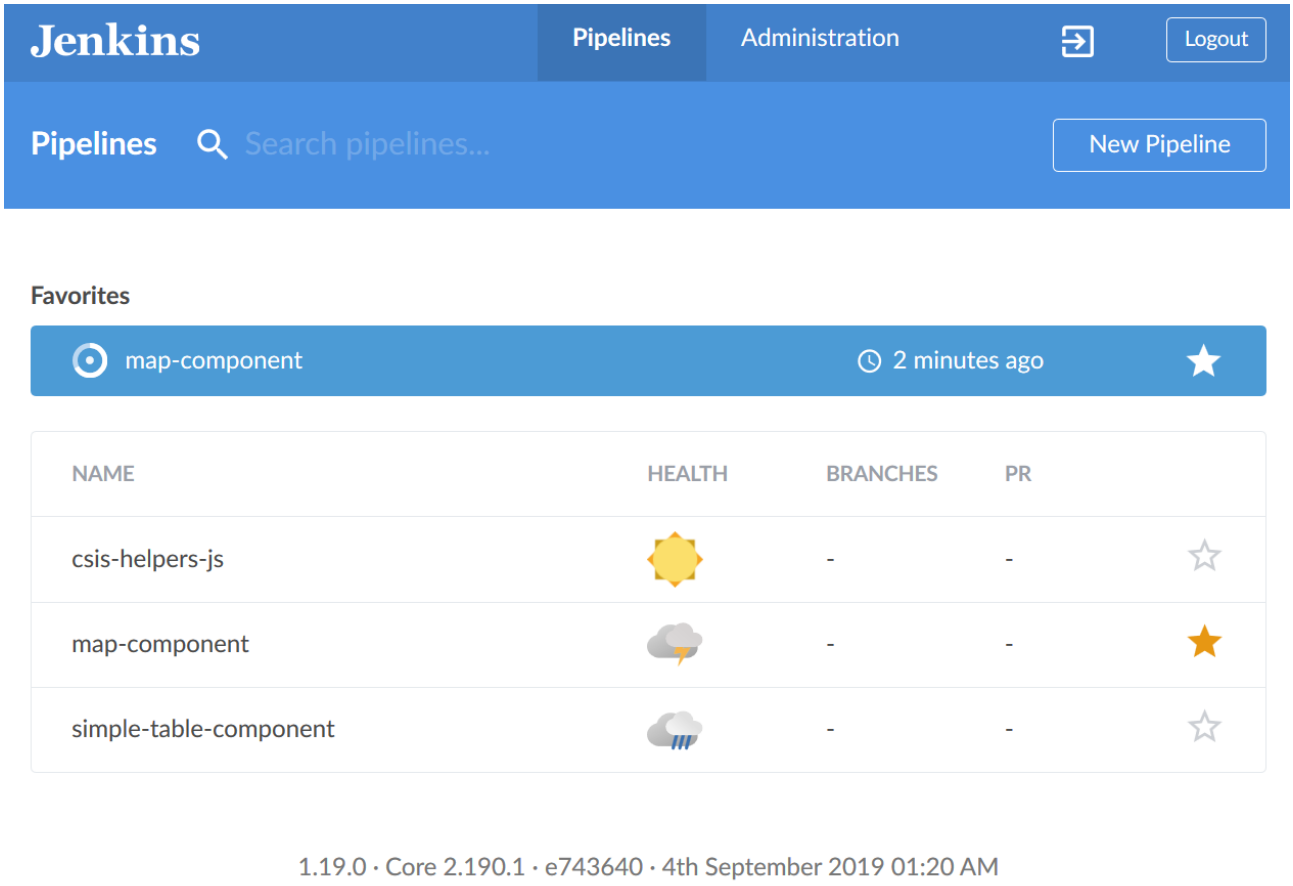


Figure 42: Integration and Development Platform

Software components supported by the continuous integration system include a Jenkins pipeline file in their public GitHub repositories. The Jenkins CI server will run the build, test and deployment steps according to the declarative definitions in this file. The Jenkins CI system is notified via GitLab and GitHub web hooks (Figure 43) and automatically creates and tests development or releases of the supported building blocks (Map Component, Table Components, etc.)

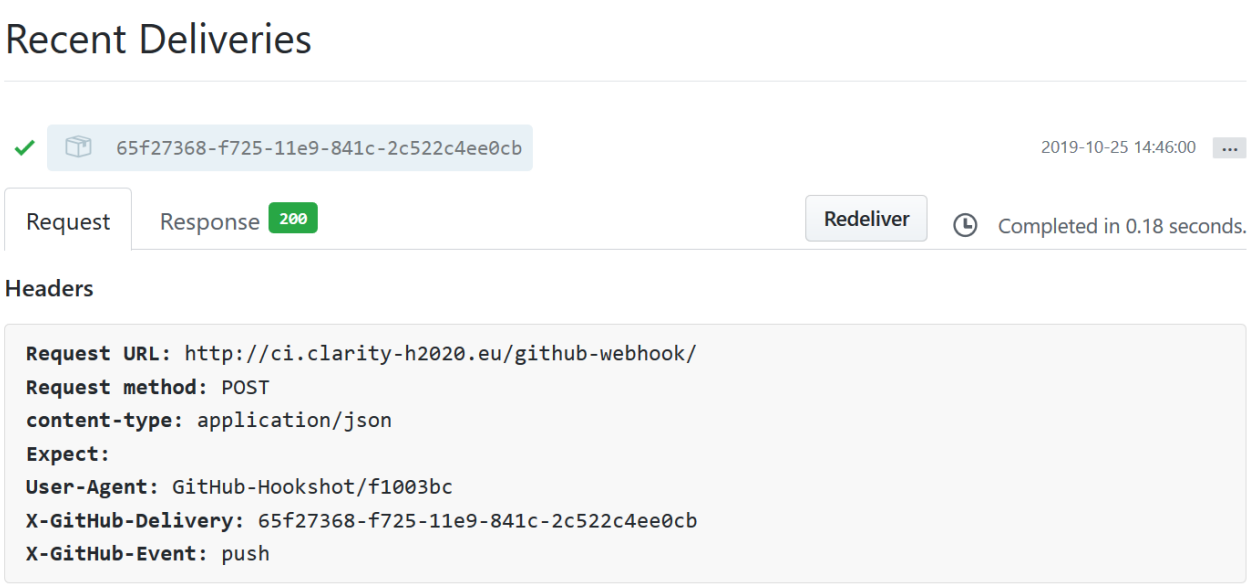


Figure 43: GitHub web hooks

**Report**

A detailed technical report of the development activities by means of implementation-level tasks (“issues”) is available on the GitHub platform. A brief summary of these activities will be provided in deliverable D1.5 ”Final Industrialisation and Support Report”.

**Detailed technology support report:**
https://github.com/search?o=desc&q=org%3Aclarity-h2020+label%3A%22bb%3A+infrastructure%22+sort%3Acreated-asc&s=&type=issues

# Integration RDMBS

**Overview**

“The Integration RDMBS is the central relational database management system for management and integration of common and shared information stored as relations (in tabular form). It stores, among others, the individual infrastructure project configurations and the associated assessment and adaptation planning information created by end users. Thereby, it is important to highlight, that the actual datasets generated during the EU-GL/CLARITY adaptation planning process (hazards maps, model outputs, etc.) are not stored in this Integration RDMBS but in general in a separate Data repository” [3]

**Results**

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Integration-RDMBS

**Source code, software releases and technical documentation:**
https://github.com/clarity-h2020/docker-pgadmin
https://github.com/clarity-h2020/docker-duplicity
https://github.com/clarity-h2020/docker-drupal/ttps://github.com/clarity-h2020/map-component

**Deployed instance:**
https://ckan.myclimateservice.eu/

**Realisation**

Figure 44 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

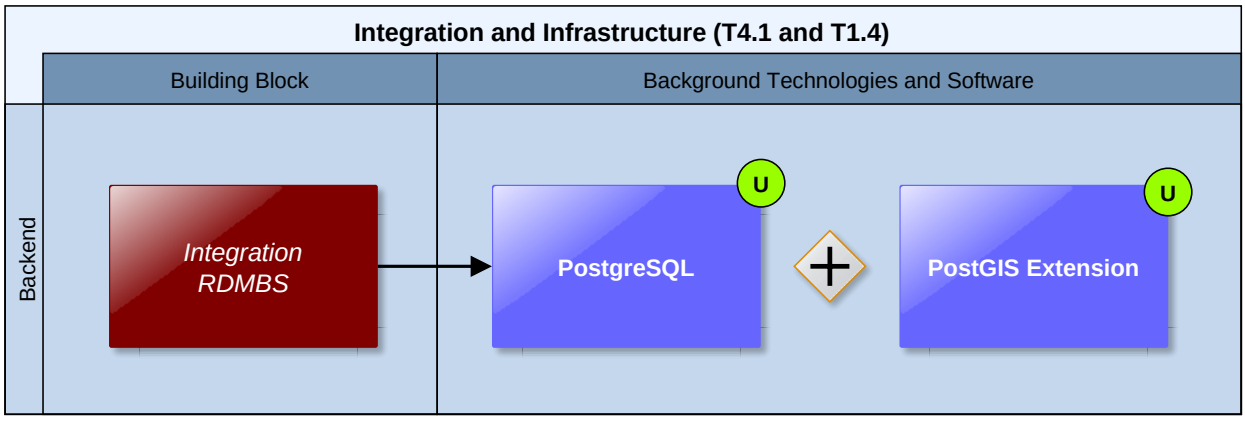


Figure 44: Integration RDMBS technology support

The integration RDBMS is realised as **PostgreSQL + PostGIS** database container that is used by all Drupal 8 based components as backend storage. It is deployed together with the overall Drupal Instance in CLARITY Container Infrastructure (Figure 45).

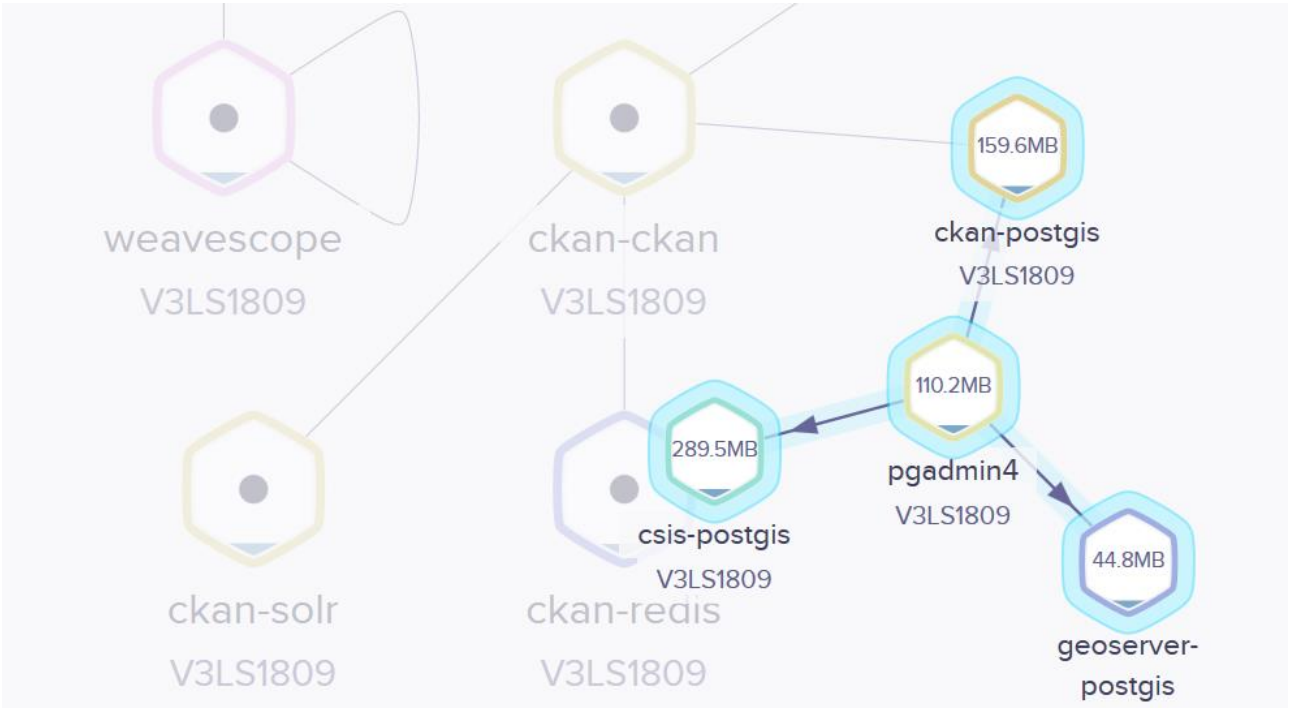


Figure 45: PostgreSQL Docker container in Container Infrastructure

The deployment configuration (Docker Compose) is therefore shared with the UI Integration Platform. Thus, actually no development is required for this building block and the activities are limited to installation, configuration and maintenance (e.g. backups).

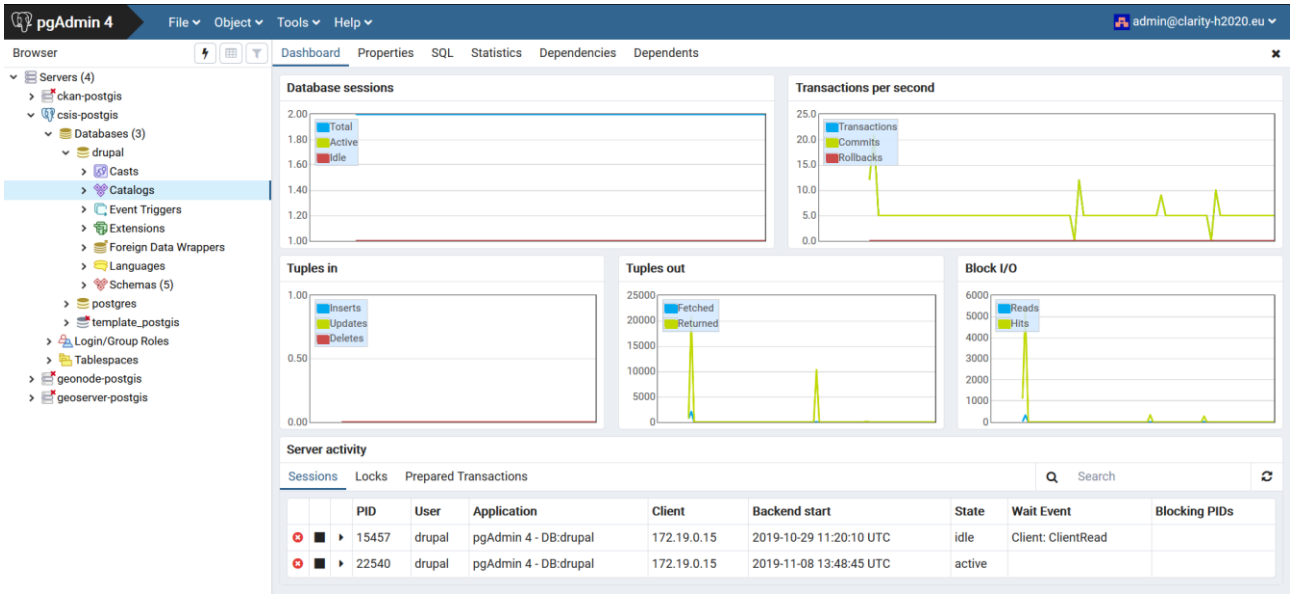


Figure 46: Integration RDMBS (pgAdmin)

Management task are carried out via the **PGAdmin 4** Web Interface (Figure 46). Incremental database backups with help of the duplicity tool in addition to complete server backups performed with “Veeam Backup & Replication”. Both management tools are deployed as separate containers and their runtime configuration is maintained in dedicated repositories.

### Report

A detailed technical report of the development activities by means of implementation-level tasks (“issues”) is available on the GitHub platform. A brief summary of these activities will be provided in deliverable D1.5 ”Final Industrialisation and Support Report”.

**Detailed technology support report:**
https://github.com/search?q=org%3Aclarity-h2020+label%3A%22BB%3A+Integration+RDMBS%22&type=Issues

# Map Component

### Overview

“The Map Component (Figure 47) is understood as a reusable, flexible and highly configurable building block meant to be used throughout CSIS. It is envisioned as an embeddable component that can be easily adapted to different parts of the common CSIS UI. The core functionalities of this component are a clear and easy visualization of different maps and layers. It is also a key feature of the map component to allow for a degree of interactivity meant to enable users to better define locations, elements at risk, hazards, scenario results, etc.” [3]


Figure 47: Map Component

**Results**

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Map-Component

**Source code, software releases and technical documentation:**
https://github.com/clarity-h2020/map-component

**Deployed instance:**
https://csis.myclimateservice.eu/

**Realisation**

Figure 48 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

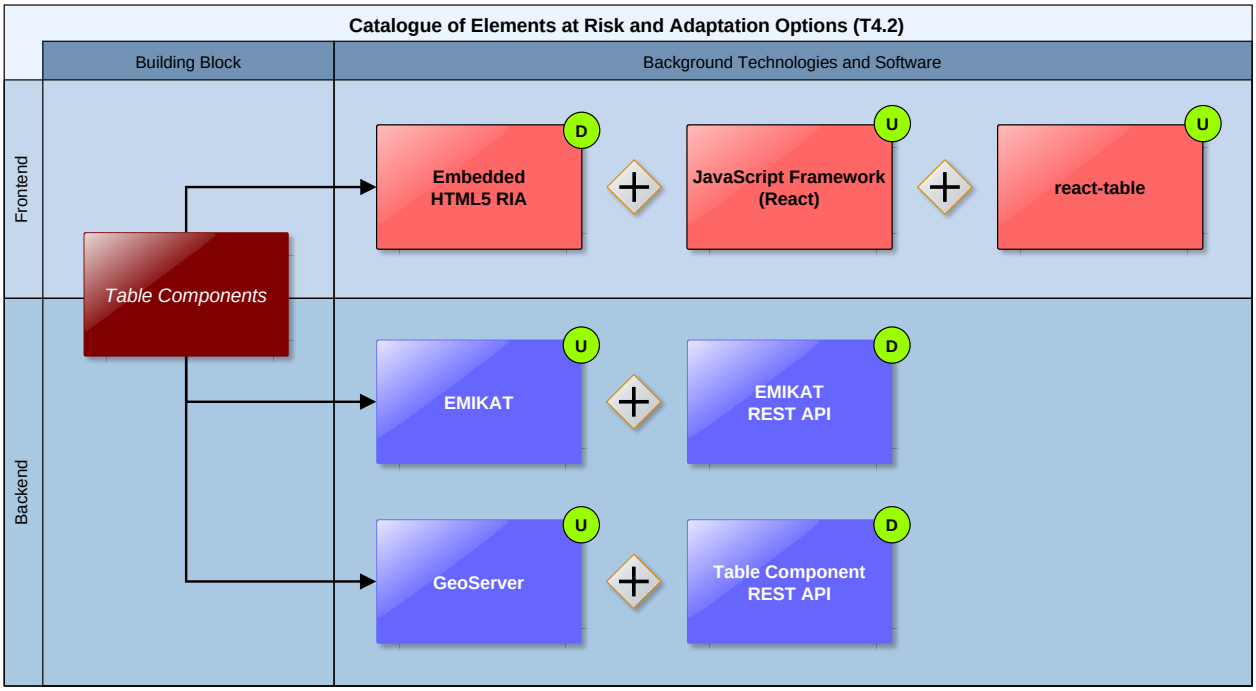


Figure 48: Realisation of the Map Component

Following the initial technology support plan, the Map Component is implemented as RIA on basis of the **ReactJS** JavaScript framework and the **LeafletJS** map visualisation library. Integration into the CSIS Drupal 8 system is performed in the same manner as for the Table Components: It is loosely embedded as **HTML5 iFrame** in the UI Integration Platform (Drupal 8) and relies as backend on **EMIKAT-GeoServer-Bridge**, the Data Repository building block and various **OGC Services**, respectively. Accordingly, it is deployed together with the CSIS Docker container in CLARITY's cloud infrastructure. The source code of this building block is released under on an open source license and maintained in a dedicated GitHub repository.

In sum, the Map Component uses 28 open sources libraries (https://github.com/clarity-h2020/map-component/network/dependencies) to implement the requested features, e.g. the ability to define a study area via a user defined bounding box (Figure 49).

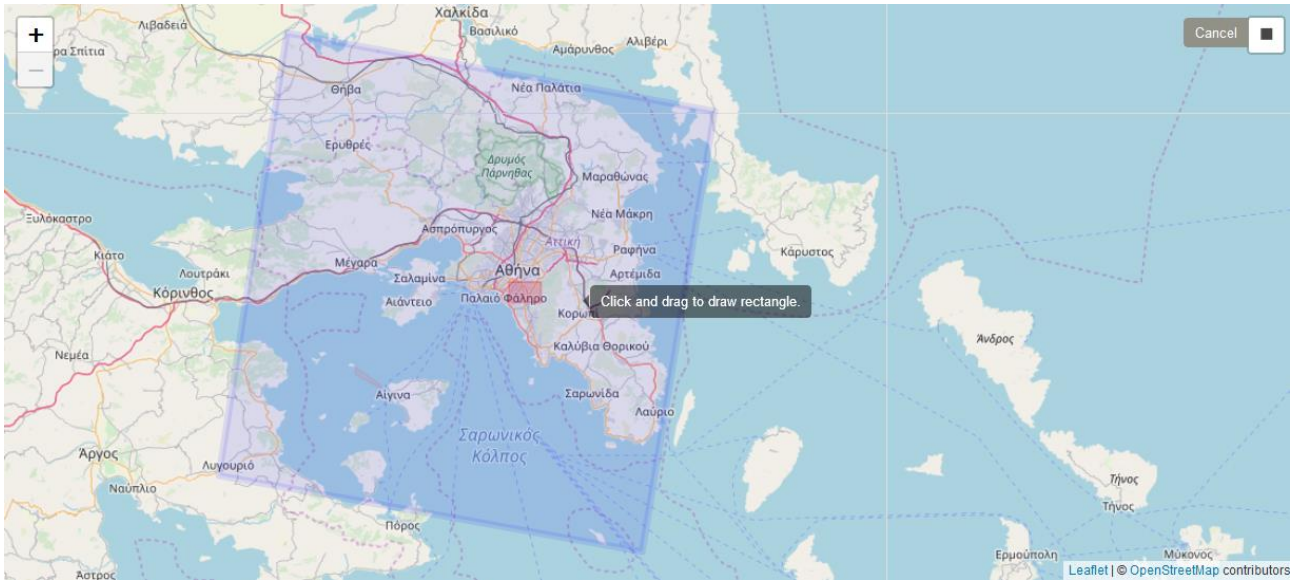


Figure 49: Map Component study area editor

### Report

A detailed technical report of the development activities by means of implementation-level tasks ("issues") is available on the GitHub platform. A brief summary of these activities can be found in section 3.1 of this document.

**Detailed technology support report:**
https://github.com/clarity-h2020/map-component/issues?q=%20

## Multi Criteria Decision Analysis Tool

### Overview

"The Multi Criteria Decision Analysis Tool supports the analysis and comparison of (adaptation) scenarios regarding performance indicators that can be defined by the end user and thus leverages what-if decision support to investigate the effects of adaptation measures and risk reduction options in the specific project context, and allows the comparison of alternative strategies. Thereby the tool provides multi-criteria ranking functions to compare and rank different scenarios and corresponding adaptation plans according to different criteria and their relative weight and level of importance." [3]

### Results

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Multi-Criteria-Decision-Analysis-Tool

**Source code, software releases and technical documentation:**
https://github.com/clarity-h2020/scenario-analysis

**Deployed instance:**
https://csis.myclimateservice.eu/apps/scenario-analysis/app/index.html

### Realisation

Figure 50 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

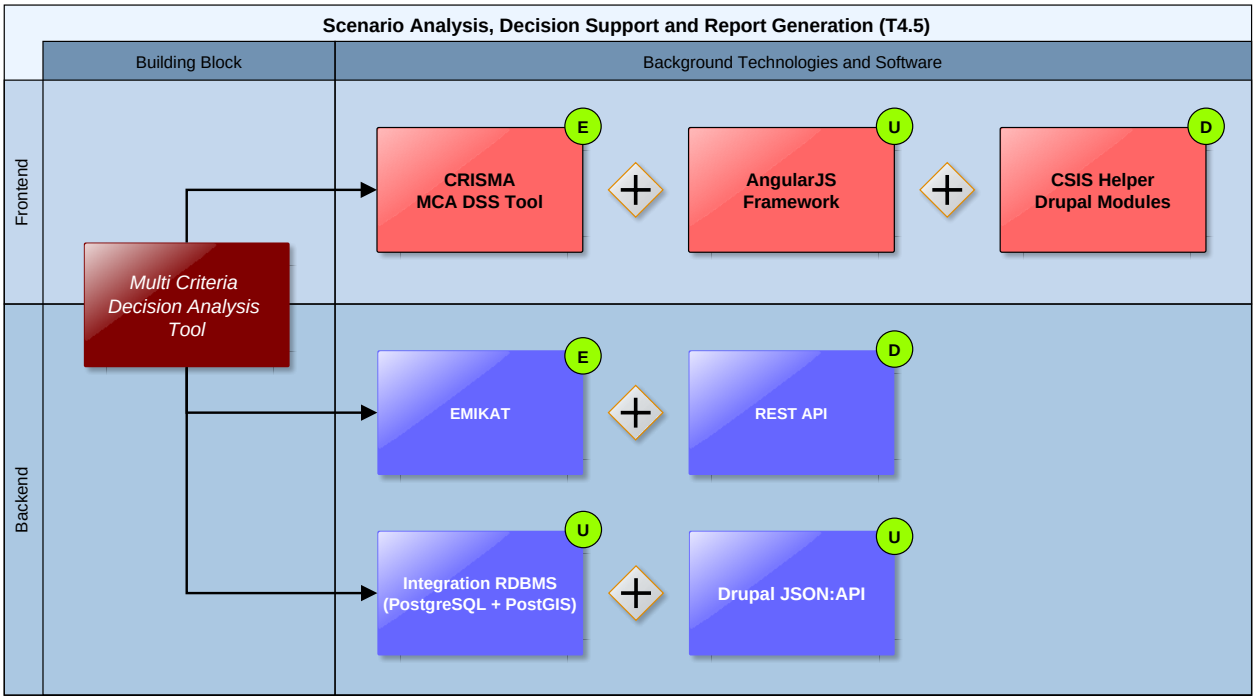


Figure 50: Multi Criteria Decision Analysis Tool technology support

This building block is being developed on basis of the **CRISMA Multi Criteria Decision Analysis** (MCDA) tools. To satisfy the functional requirements of this building block, some extension of the original software have to be made (Figure 50). This concerns mainly the support for report generation and the communication with the back-end services (**EMIKAT REST API** and **Drupal JSON:API**).

Analysis tools | Edit criteria functions | Edit decision strategies

**Criteria function**: CLARITY Criteria Function #1

**Decision strategy**: CLARTIY Decision Strategy #1

Indicator table — Change Mode | Include in Report

| Indicators | BASELINE (1971-2000) | RCP26 (2011-2040) | RCP26 (2071-2100) | RCP45 (2041-2070) | RCP45 (2071-2100) | RCP85 (2011-2040) | RCP85 (2041-2070) | RCP85 (2071-2100) |
|---|---|---|---|---|---|---|---|---|
| **Mortality Rate following Heat Wave Events** | | | | | | | | |
| Frequent | 0.690 ‰ | 0.778 ‰ | 0.825 ‰ | 0.930 ‰ | 0.930 ‰ | 0.825 ‰ | 1.042 ‰ | 1.306 ‰ |
| Occasional | 0.930 ‰ | 1.105 ‰ | 1.306 ‰ | 1.306 ‰ | 1.457 ‰ | 1.042 ‰ | 1.380 ‰ | 1.801 ‰ |
| Rare | 1.105 ‰ | 1.168 ‰ | 1.457 ‰ | 1.709 ‰ | 1.538 ‰ | 1.105 ‰ | 1.538 ‰ | 2.097 ‰ |

Figure 51: Multi Criteria Decision Analysis Tool (excerpt)

Although the CRISMA tools have been implemented on basis of the AngularJS 1.0 JavaScript framework, which has been superseded by Angular 5.0 in 2017, the existing tools could successfully be integrated into CSIS Drupal platform. For supporting the seamless communication between Drupal's JavaScript API and the MCDA tools, which are embedded as iFrame, WP4 developed a dedicated Drupal module and a JavaScript Module. These modules offers common helper functions and are used by other building blocks that are realised by independent RIAs and integrated into the Drupal 8 platform following the CLARITY's user interface integration concept.

The open source code of this building block is maintained in a dedicated GitHub repository that was forked from the original CRISMA repository. Since it is directly integrated into the CSIS Drupal Platform, it is deployed together with the CSIS Docker container in CLARITY's cloud infrastructure.

**Report**

A detailed technical report of the development activities by means of implementation-level tasks ("issues") is available on the GitHub platform. A brief summary of these activities can be found in section 3.1 of this document.

**Detailed technology support report:**
https://github.com/clarity-h2020/scenario-analysis/issues?q=%20

# Report Generation

**Overview**

The result of a climate adaptation study is a report that is (semi-)automatically generated. Report Generation enables the user to easily access and download draft and final report at the end of the project assessment process. Such report includes automatically generated documentation (with embedded supporting tables, graphs and maps of the area under study).

**Results**

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Report-Generation

**Drupal configuration repository (private):**
https://gitlab.atosresearch.eu/ari/clarity-csis-drupal

**CSIS Helpers module repositories:**
https://github.com/clarity-h2020/csis-helpers-module
https://github.com/clarity-h2020/csis-helpers-js

**Deployed instance:**
https://csis.myclimateservice.eu/

**Realisation**

Figure 52 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

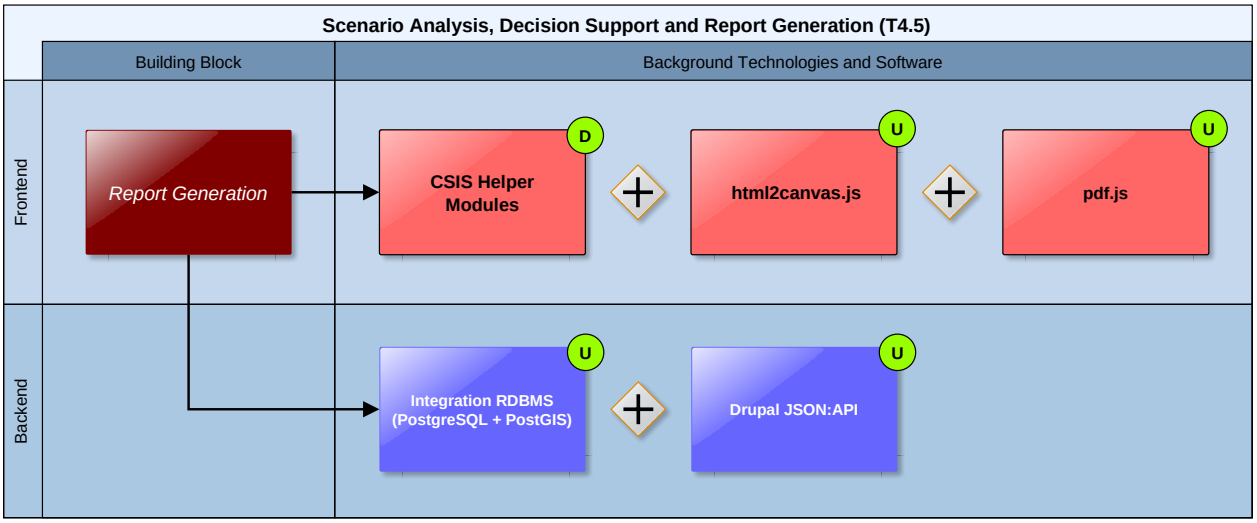


Figure 52: Report Generation technology support

The report generation building blocks is realised with help of the **Drupal 8** platform and the **html2canvas** and **pdf.js** JavaScript Libraries. Support for report generation will implemented in the **CSIS Helpers Drupal** (Figure 59) and **JavaScript** (Figure 54) **modules** and thus is available to any other component that intends to add graphs, maps, tables etc. to a PDF Report. Report Generation allows to take screenshots of embedded RIAs like the Map Component or the MCDA Tools and to save them to the respective study entity, which represents the user's scenario. With help of the **pdf.js** library, the study entity can then be exported and visualised as PDF document. Interestingly, report generation also works for external components that integrated as iFrame following the UI integration concept.

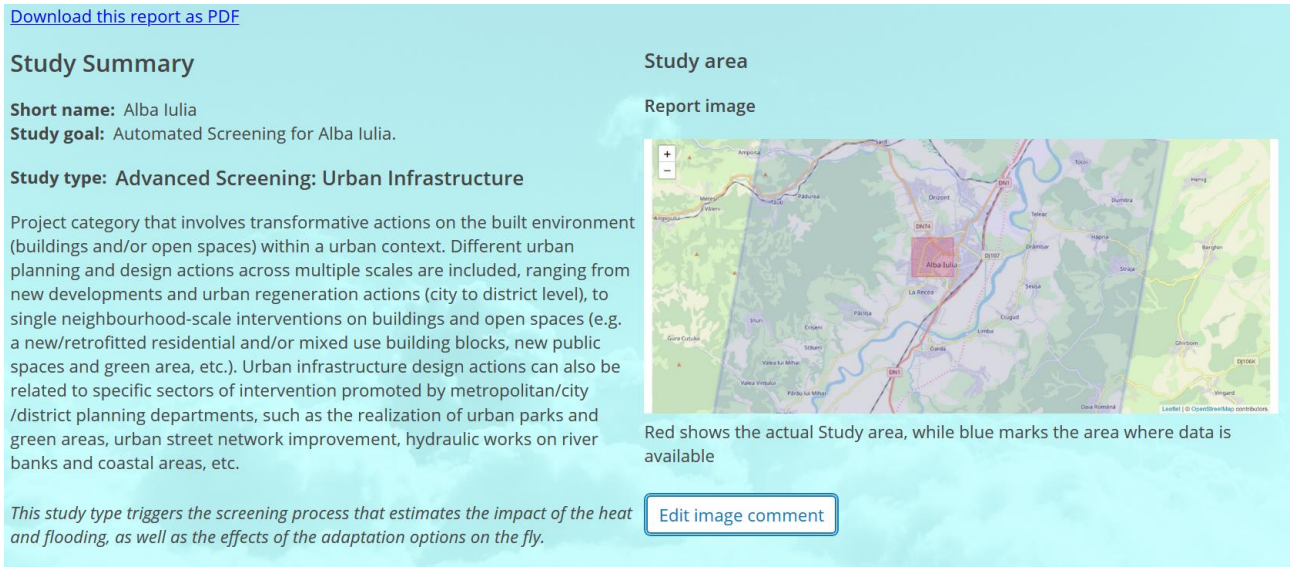


Figure 53: Report Generation

Apart from the CSIS Helpers modules there is no dedicated source code repository needed for this building block. As the modules are added to the CSIS Drupal Platform, they are deployed together with the CSIS Docker container in CLARITY's cloud infrastructure.

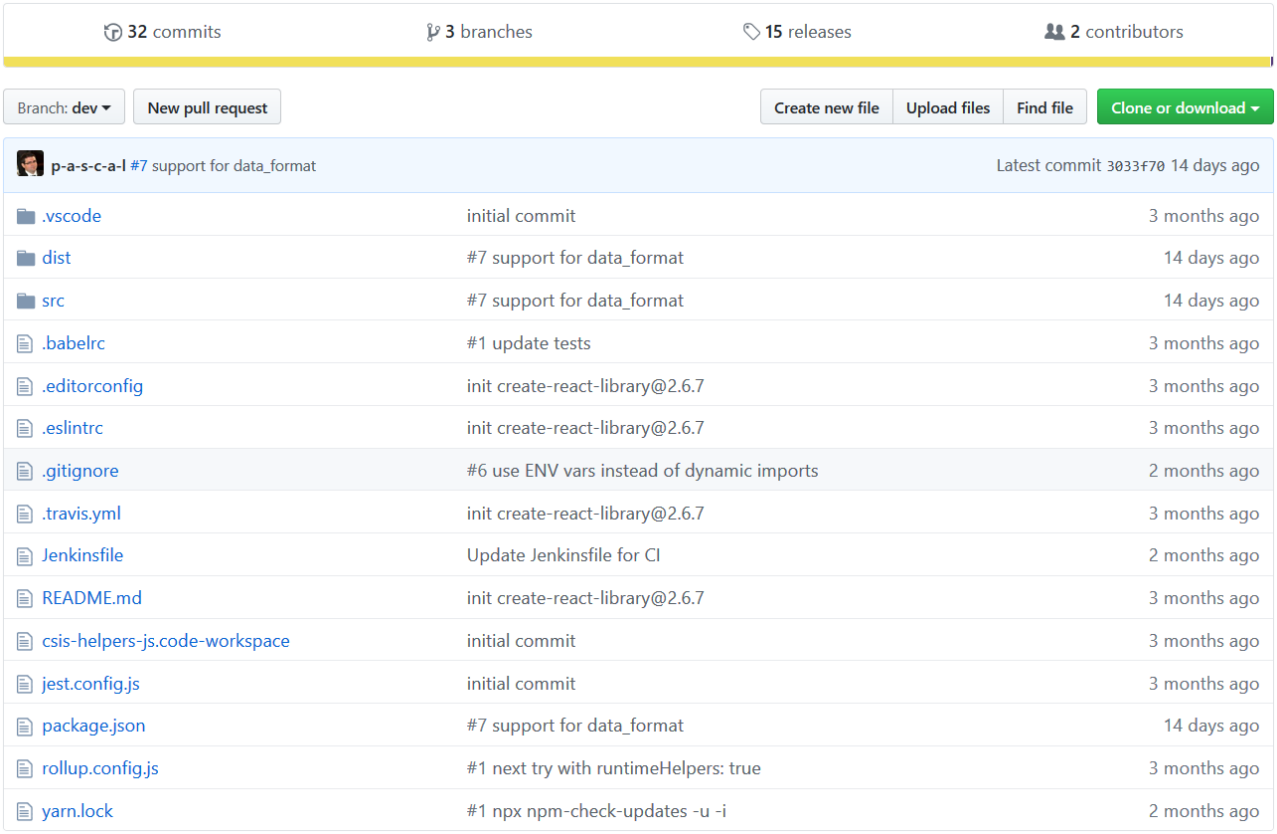


Figure 54: CSIS Helpers JavaScript module repository

**Report**

A detailed technical report of the development activities by means of implementation-level tasks ("issues") is available on the GitHub platform. A brief summary of these activities can be found in section 3.4 of this document.

**Detailed technology support report:**
https://github.com/search?q=org%3Aclarity-h2020+label%3A%22BB%3A+Report+Generation%22+sort%3Acreated-asc&type=issues

# Scenario Management

**Overview**

"The Scenario Management building block supports and enforces first and foremost the standardised workflows of the EU-GL [1] for each of the distinct planning steps and provides respective user interfaces that guide the user through the process of co-creating a climate adaptation study. Basically, the end user is presented with the list of recommended and required steps for performing a complete climate adaptation study for the respective (infrastructure) project under assessment and is asked to provide the information that is needed to complete the current step and advance to the next step." [3]

**Results**

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Scenario-Management

**Drupal configuration repository (private):**
https://gitlab.atosresearch.eu/ari/clarity-csis-drupal

**CSIS Helpers module repositories:**
https://github.com/clarity-h2020/csis-helpers-module
https://github.com/clarity-h2020/csis-helpers-js

**Help Widget Drupal module repository:**
https://github.com/clarity-h2020/csis-helpers-module

**Deployed instance:**
https://csis.myclimateservice.eu/

### Realisation

Figure 55 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

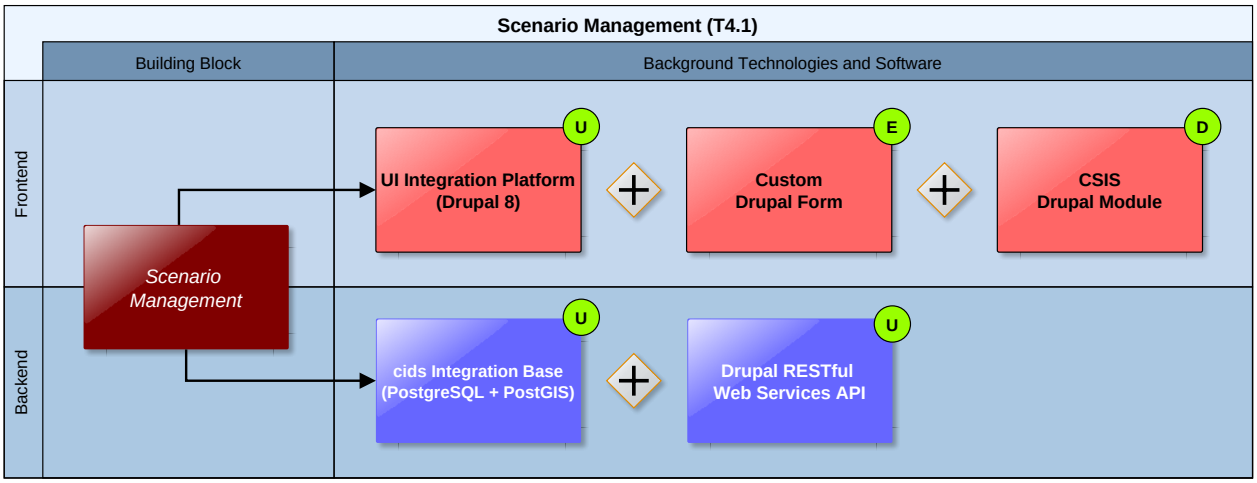


Figure 55: Scenario Management technology support

The Scenario Management building block represents the overall workflow tool that guides the user through the different steps of the EU-GL methodology (Figure 56). Thus, it is tightly coupled with the overall UI Integration Platform and needs to integrate and interact with nearly all other building blocks of the CSIS. The fronted part of this building block is realised by Drupal forms and custom Drupal modules. An example of such user interface that communicates with the EMIKAT REST API to switch between different scenarios is shown in Figure 58.

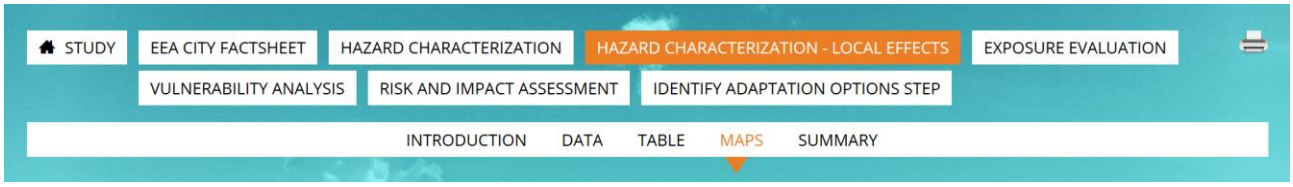


Figure 56: Scenario Management (EU-GL workflow)

The creation of the respective view forms, editor forms and the related entity types in Drupal can be considered an administrative task. The resulting configuration is rather complex and exhaustive and thus managed in a decided version controlled code repository (Figure 57).

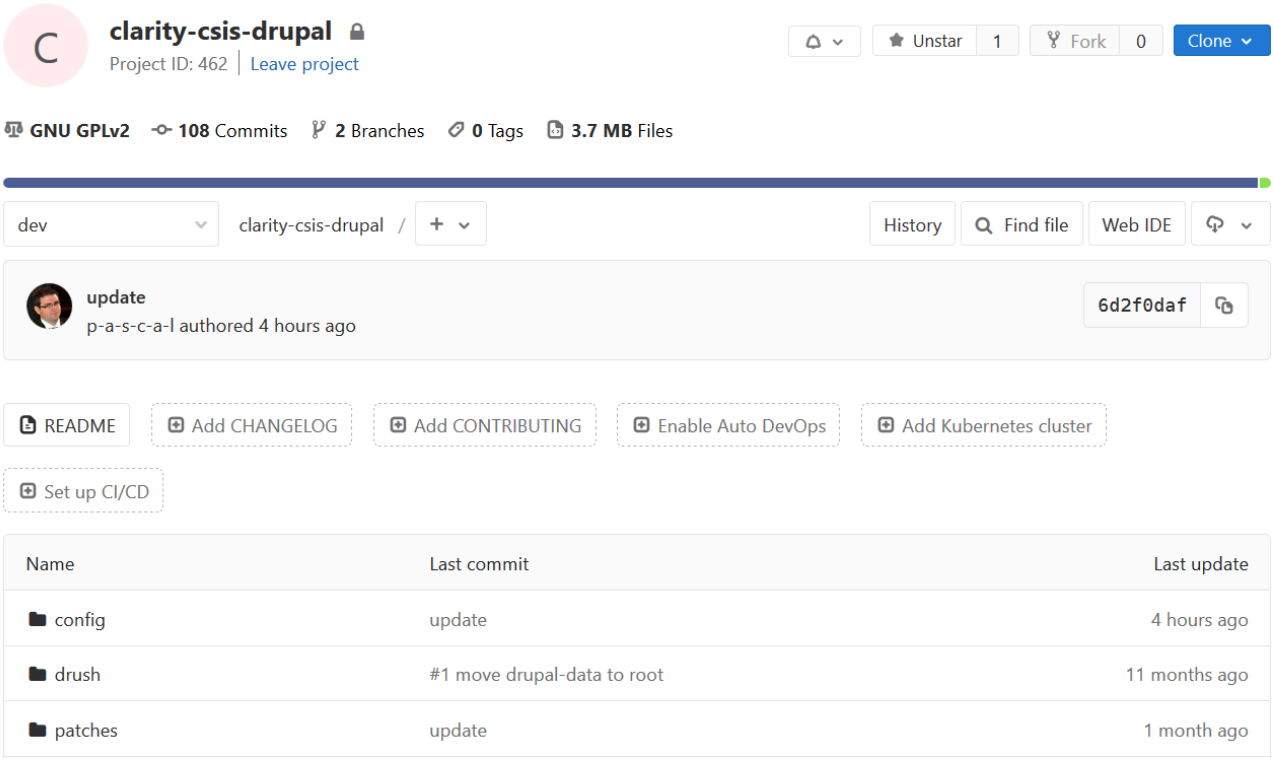


Figure 57: Private CSIS configuration GitLab repository

This applies also to the other building blocks like the Data Dashboard that are realised as Drupal components. Thus, a common git repository operated by Atos Research & Innovation department is used for the management of the overall CSIS Drupal Configuration and the configurations of all related Drupal-based building blocks. Since these configurations may include also sensitive data like API keys and credentials for accessing the connected data repositories and services, the repository is private and only accessible by authorised users.

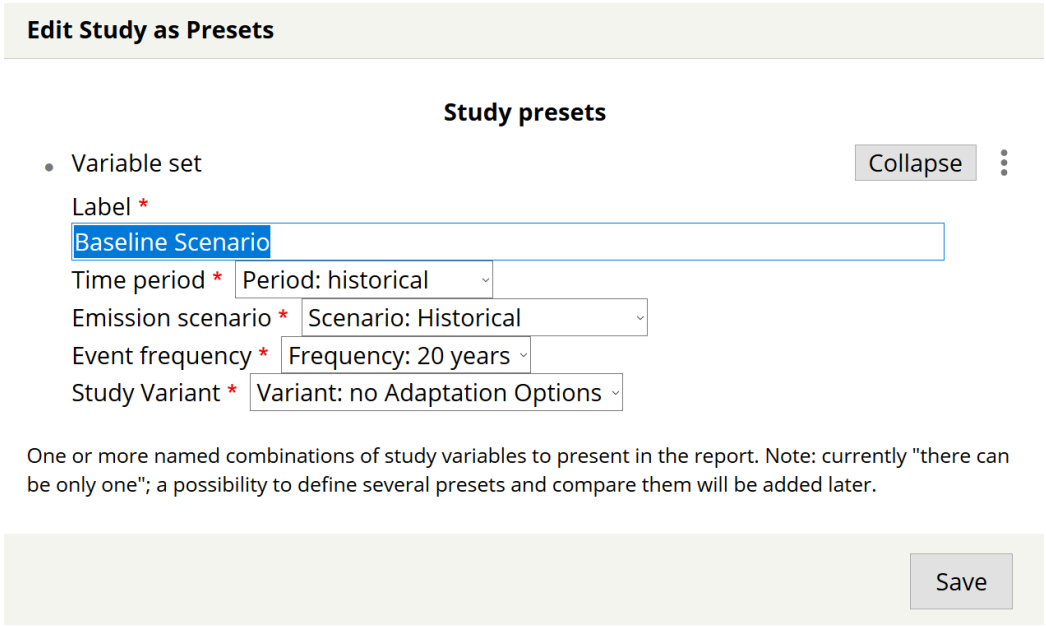


Figure 58: Scenario Management (scenario selection)

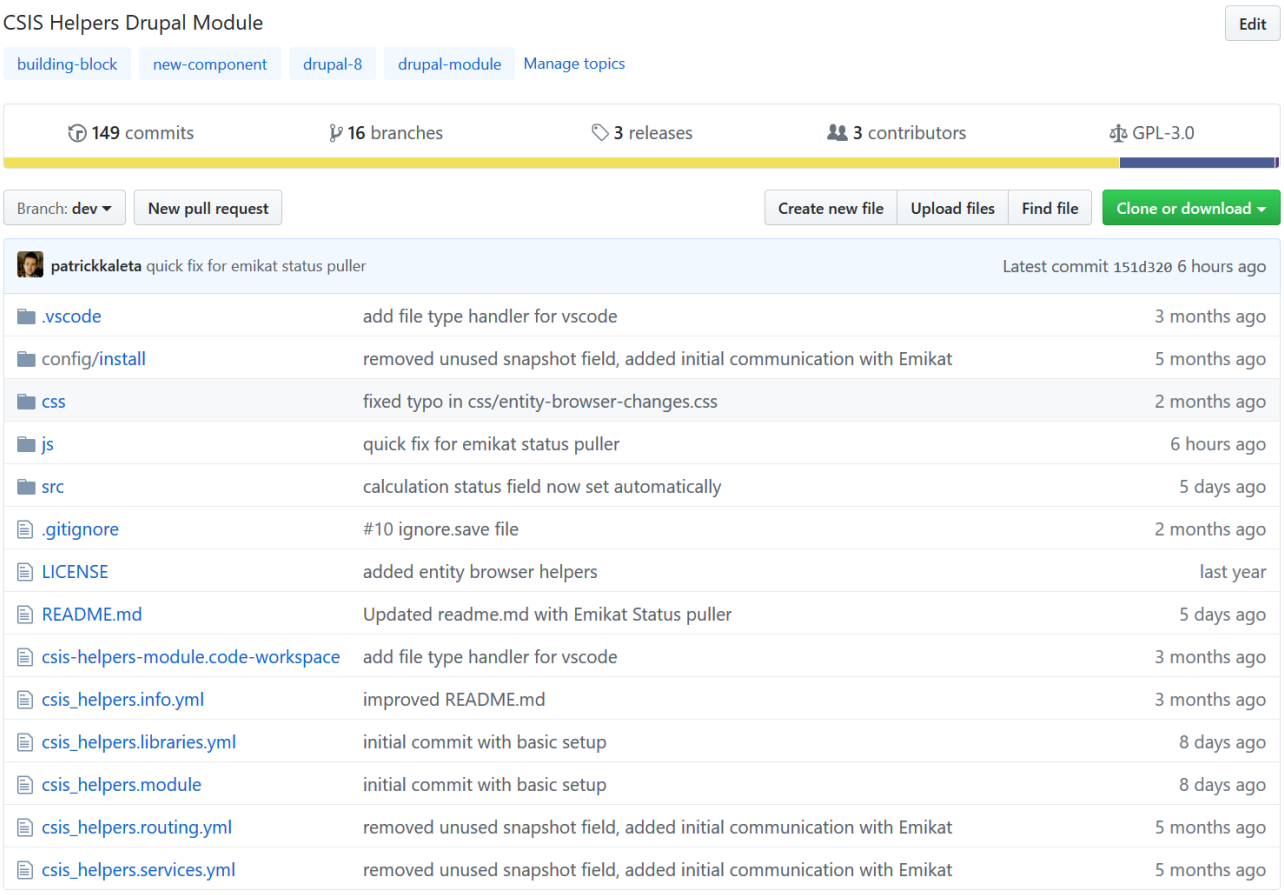


Figure 59: CSIS Helpers module GitHub repository

While a large part of the functionally offered by the Drupal 8 platform meets the functional requirements of this building block, there is still the need to extend the Drupal platform. Therefore, **Drupal modules** are developed for this purpose. WP4 is providing the “CSIS Helpers” and “Help Widget” modules, which are released as open source software and maintained in dedicated GitHub repositories (Figure 59).

Both the configurations and the modules are deployed as part of the CSIS Drupal Docker container in CLARITY's cloud infrastructure.

**Report**

A detailed technical report of the development activities by means of implementation-level tasks ("issues") is available on the GitHub platform. A brief summary of these activities can be found in section 3.1 of this document.

**Detailed technology support report:**
https://github.com/search?o=desc&q=org%3Aclarity-h2020+label%3A%22BB%3A+Scenario+Management%22&type=issues

# Scenario Transferability Component

**Overview**

The Scenario Transferability Component can be used for discovery and matchmaking of related entities (so-called "climate twins") like showcases, projects, elements at risk and adaptation options. For example, applied to the Catalogue of Elements at Risk and Adaptation Options, infrastructure projects being assessed by end users can be matched to other projects that share the same elements at risk (covering a variety of sectors). Additionally, the user can also decide to perform the matchmaking based on geographical proximity to the location of interest. This enables the user to discover what other hazards, elements at risk, etc. are of interest to projects in the nearby area. It can also be used for (visual) scenario analysis and comparison. Thereby, it allows the side-by-side comparison not only of different climate scenarios (Climate Twins Concepts), but also the comparison of alternate adaptation scenarios resulting from impact scenarios.

As a secondary way of visualisation, the twins are listed in two tables, separating the selected twins from the overall available ones. Users have to ability to add twins to or remove them from their study. This impacts the final study report, since only selected twins are exported in the final study report.

Different filter options allow users to limit the shown twins based on hazards or elements at risk (depending on the type of the twin) selected by the users. Additionally, a proximity filter can further restrict the shown twins based on the location of the user.

Throughout the study, the user can view twins at multiple stages. Currently, different twins are available for hazards ("hazard twins"), elements at risk ("exposure twins") and adaptation options ("adaptation twins"). Twins can reflect past or predicted future hazard events, measurements and adaptation options.

For this purpose, the initial hazard twins concept of the TATTOO project was extended to take also other artefacts into account to create links between marketplace concepts like solution offers and showcases and CSIS concepts like projects and studies (Figure 60).

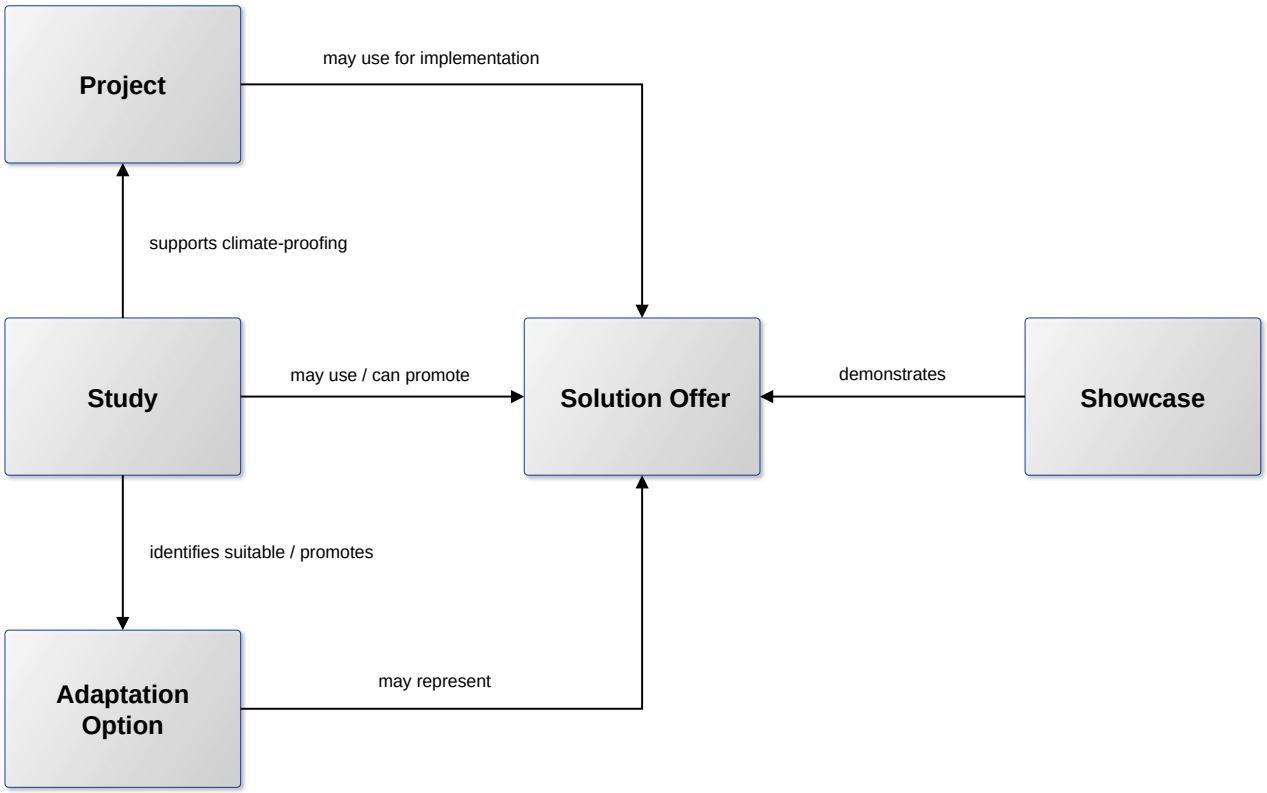


Figure 60: Artefacts supported by extended scenario transferability concept

- **Project**
  Real-world infrastructure or development activity that is in need of tailored climate advice or concrete climate change adaptation measures in from of Climate Services or Solution Offers, respectively. By means of studies, the CSIS supports planners and managers in the task of climate-proofing large-scale infrastructure projects and developing a tailored adaptation strategy.
- **Study**
  A study in the context of the CSIS consists of one or more comparable what-if scenarios that assess the effects of climate change (HxExV), possible adaptation options, their costs and benefits, etc. in relation to a specific project. Thus, a study can be considered a decision aid for project managers, financiers, etc.
  A study can for example be used to select the most effective / cost efficient / easy to implement / etc. Adaptation Options to minimise the effects of climate change on a specific project and it's Elements at Risk, respectively.
  Such a study is usually conducted in the planning phase of a project. A Study may make use of "virtual" Solution Offers (e.g. a service for creating a tailored Data Package) as well as propose the use of physical Solution Offers (e.g. Adaptation Options) for project implementation.
- **Solution Offer**
  A Solution Offer is a (generic) product or service that can be advertised in the Marketplace and the CSIS and thus gives Solution Providers the possibility to promote their products and services.
  A Solution Offer can apply to one or more (Economic) Sectors and EU-GL step/modules. Solution Offers can consist of different Climate Services (advice, software) or represent a distinct Climate Service on their own. The screening tool part of the CSIS is an example of a Solution Offer. Another example would be a service for creating tailored Data Packages.
  Additionally, Solution Offers also represent physical products and services like novel reflective

materials, CO2-absorbant paint, climate-change-aware construction services, etc. Interestingly, such a physical Solution Offer could be used as Adaptation Option.

- **Showcase**
  A Showcase is a concrete application of one or more Solution Offers, e.g. a concrete application of an Expert Service in a specific location or an implementation / usage of a tailored or generic Tool or Product (Climate Service) in a specific location.
  The CSIS Screening Study "Adaptation Scenarios for Metropolitan Resilience Planning in the Naples metropolitan area" is a Showcase of the CSIS Screening Tool used in conjunction with a tailored Data Package (Heat Wave and Pluvial Flood Hazards, Population and Urban Infrastructure Elements at Risk, . etc.). The usage of a specific physical product, e.g. painting a 1.000m² wall building with C02-absorbant paint in the city of Rome is another Showcase (of the Solution Offer "C02-absorbant paint product"). More specifically, this particular Showcases demonstrates how the product is actually used as Adaptation Option.
- **Adaption Options**
  Adaptation Options are physical measures, technologies, processes and activities that are applied to reduce the vulnerability of Elements at Risk to climate change and climate variability, thus preventing or alleviating negative effects caused by climate change hazards.
  Simplified IT abstractions of real-world Adaptation Options ("models") are used in CSIS studies to simulate the effects of concrete Adaptation Options. In consequence, Adaptation Option are selected in studies (by means of scenario analysis) and implemented in projects (by means of the respective concrete Solution Offers). Accordingly, a study in CSIS can be used to promote Solution Offers that qualify as Adaptation Options.

**Results**

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Scenario-Transferability-Component

**Source code, software releases and technical documentation[10]:**
https://github.com/clarity-h2020/docker-drupal/
https://gitlab.atosresearch.eu/ari/clarity-csis-drupal

**Deployed instance:**
https://csis.myclimateservice.eu/

**Realisation**

Figure 61 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

[10] For the Geofield Module no source code will be available since the Scenario Transferability Component will be configured within the CSIS platform in a first step

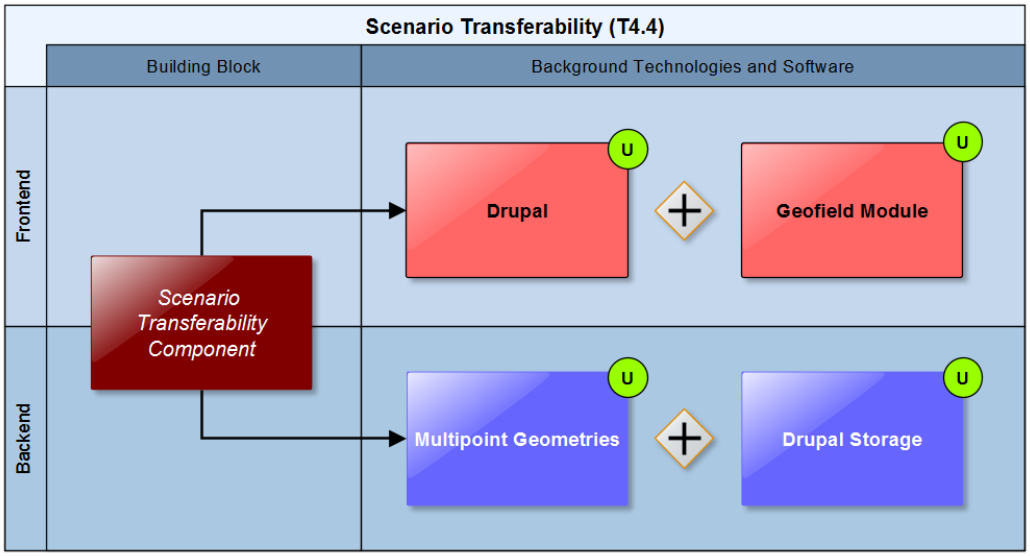


Figure 61: Scenario Transferability Component technology support

Twins are currently realized in three separate **Drupal "views"**, one focusing on the involved hazards, another one focusing on the targeted elements at risk and the last one focusing on adaptation options. "views" is a built-in feature of Drupal allowing to manipulate content (change its representation) in multiple "displays" before showing it in the frontend (user interface) to the users. Those displays are configured to be able to show different types of entities in the same map. These different entities can be for example showcases, past hazard events or measurements. Each of these views offers different filtering options for the users, which enable them to limit the number of displayed twins based on their needs. Additionally, all views offer the possibility to filter twins based on geographical proximity to the user's current position.


Figure 62: Scenario Transferability Component: Geofield Map example

The map is generated using the Drupal module "**Geofield Map**" (Figure 62). It extends the default functionality of "views" and allows to display customized maps (e.g. allowing to select custom icons for items on the map).

The selected filters don't apply only to the displayed map, but also to the table listing all available twins. Two tables under the map offer an alternative way of displaying twins, allowing to sort the twins into "included twins", which were selected by the user, and those that are available for selection (excluding those already selected by the user). The user can choose to include a twin into the study or remove it from the study. The selected twins are added to the study and later shown in the final study report.

**Report**

A detailed technical report of the development activities by means of implementation-level tasks ("issues") is available on the GitHub platform. A brief summary of these activities can be found in section 3.3 of this document.

**Detailed technology support report:**
https://github.com/search?o=desc&q=org%3Aclarity-h2020+label%3A%22BB%3A+Scenario+Transferability%22+sort%3Acreated-asc&s=created&type=Issues

# Table Components

**Overview**

This building block effectively consist of several software components for the visualisation of tabular data from arbitrary Data Package resources.

The advanced Table Component is a reusable and configurable building block for the tabular visualisation of hazard, exposure, vulnerability and impact (Figure 63) Data. The table shows aggregated and normalised values for respective hazards, elements at risk, etc. relative to the selected study area. Aggregation and normalisation of data is not performed by the Table Component itself, but by separate web services that transform the original data to standardised JSON format supported by the Table Component.

| | | | | Damage Classes | | | |
|---|---|---|---|---|---|---|---|
| Hazards | Element at risk (... | Vulnerability clas... | Unit | D1 | D2 | D3 | D4 |
| HW | Population | Age group 0-14 | pop/km2 | 1 | 3 | 2 | 3 |
| HW | Population | Age group 15-64 | pop/km2 | 1 | 3 | 2 | 3 |
| HW | Population | >65 | pop/km2 | 1 | 3 | 2 | 3 |
| FL | Population | Age group 0-14 | pop/km2 | 1 | 3 | 2 | 3 |
| FL | Population | Age group 15-64 | pop/km2 | 1 | 3 | 2 | 3 |

Previous Page 1 of 3 5 rows Next

Figure 63: Advanced Table Component (impact)

The *simple* Table Component is able to visualise any tabular data is given that the format of the data is either JSON or CSV. It visualises the data "as-is", which means, it does not perform any aggregation or modification of the data.

| GRID_ID | MULTIPOLYGON | STUDY_VARIANT | TIME_PERIOD | EMISSIONS_SCEN... | EVENT_FREQUENCY | T_MRT | T_UTCI | T_A | DISCOMFORT_LEV... | SZM_SZENARIO_R... |
|---|---|---|---|---|---|---|---|---|---|---|
| 500mE53635N264... | POLYGON ((53635... | BASELINE | Baseline | Baseline | Frequent | 89.32166617501755 | 51.881057712436... | 35.66683732210476 | 5 | 3209 |
| 500mE53635N264... | POLYGON ((53635... | BASELINE | Baseline | Baseline | Frequent | 78.76484510175362 | 49.285135410521... | 33.80815695393319 | 4 | 3209 |
| 500mE53635N264... | POLYGON ((53635... | BASELINE | Baseline | Baseline | Frequent | 76.5168658457453 | 48.73235731146877 | 33.412367835011... | 4 | 3209 |
| 500mE53635N264... | POLYGON ((53635... | BASELINE | Baseline | Baseline | Frequent | 75.46570678297016 | 48.47387729793236 | 33.22729614531957 | 4 | 3209 |
| 500mE53635N264... | POLYGON ((53635... | BASELINE | Baseline | Baseline | Frequent | 81.4074831441159 | 49.9349601051381 | 34.27343143527888 | 4 | 3209 |
| 500mE53640N264... | POLYGON ((53640... | BASELINE | Baseline | Baseline | Frequent | 93.310136450225 | 52.86182255311033 | 36.369064948026... | 5 | 3209 |
| 500mE53640N264... | POLYGON ((53640... | BASELINE | Baseline | Baseline | Frequent | 94.70505379051907 | 53.20483272708864 | 36.61466023259547 | 5 | 3209 |
| 500mE53640N264... | POLYGON ((53640... | BASELINE | Baseline | Baseline | Frequent | 91.33552812835164 | 52.37626636676167 | 36.021406718601... | 5 | 3209 |
| 500mE53640N264... | POLYGON ((53640... | BASELINE | Baseline | Baseline | Frequent | 88.84602000170317 | 51.76409631841881 | 35.583092963987... | 5 | 3209 |
| 500mE53640N264... | POLYGON ((53640... | BASELINE | Baseline | Baseline | Frequent | 86.01148796543335 | 51.06708489070006 | 35.08403278174124 | 5 | 3209 |
| 500mE53645N264... | POLYGON ((53645... | BASELINE | Baseline | Baseline | Frequent | 93.10311103151895 | 52.81091500265051 | 36.33261514189776 | 5 | 3209 |
| 500mE53645N264... | POLYGON ((53645... | BASELINE | Baseline | Baseline | Frequent | 97.1487621808419 | 53.80574062026903 | 37.04491028411262 | 5 | 3209 |
| 500mE53645N264... | POLYGON ((53645... | BASELINE | Baseline | Baseline | Frequent | 96.47125326902535 | 53.639141178853... | 36.925625084058... | 5 | 3209 |
| 500mE53645N264... | POLYGON ((53645... | BASELINE | Baseline | Baseline | Frequent | 95.94081227453536 | 53.508705738308... | 36.8322333086287 | 5 | 3209 |
| 500mE53645N264... | POLYGON ((53645... | BASELINE | Baseline | Baseline | Frequent | 88.99966452544574 | 51.80187750680711 | 35.61014429487389 | 5 | 3209 |

Previous Page 1 of 2 5 rows Next

Data Format: JSON Download

Figure 64: Simple Table Component (local effects)

**Results**

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/Table-Component

**Source code, software releases and technical documentation:**
https://github.com/clarity-h2020/table-components
https://github.com/clarity-h2020/simple-table-component
https://github.com/clarity-h2020/table-state-rest-api/

**Deployed instance:**
https://csis.myclimateservice.eu/
https://clarity.meteogrid.com/api/

The open source code of this building block is maintained in a dedicated GitHub repository. Since it is directly integrated into the CSIS Drupal Platform as explain in UI Integration Concept (chapter of D4.2 “CLARITY CSIS Architecture” [3]) it is deployed together with the CSIS Docker container in CLARITY’s cloud infrastructure.

**Realisation**

Figure 65 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

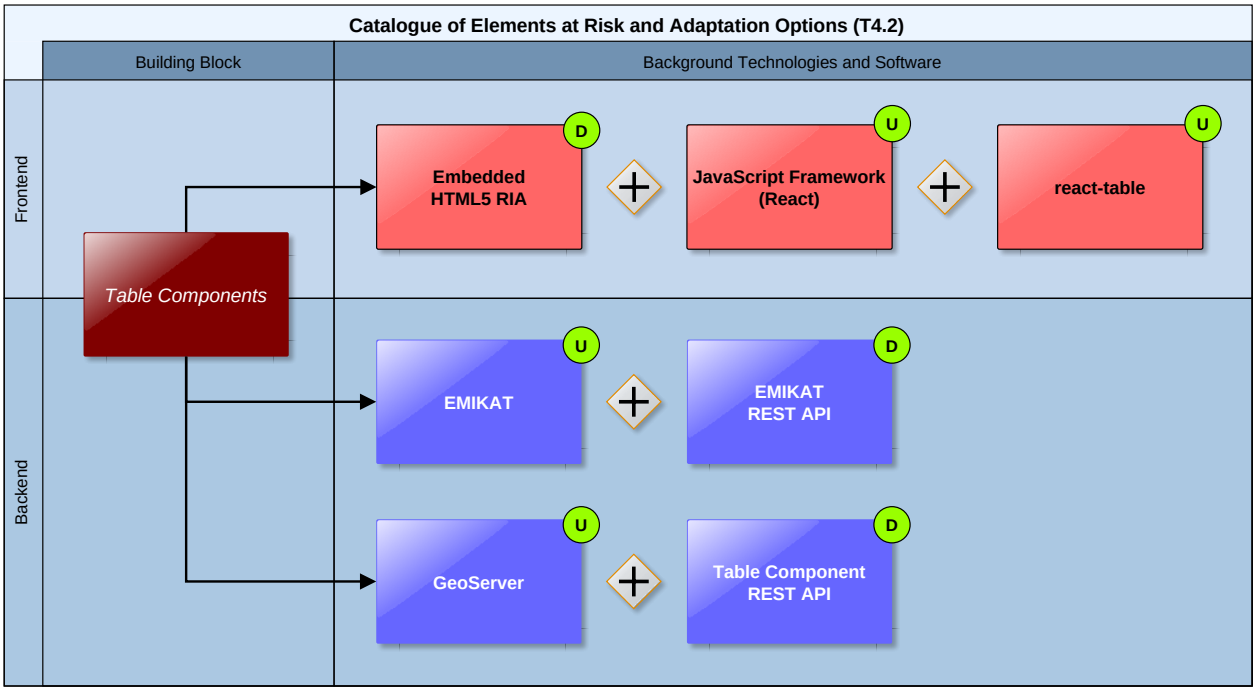


Figure 65: Realisation of the Table Component

The high interactivity and flexibility expected from this component required an approach based on responsive and highly adaptable technologies. This approach was achieved using client-side rendering along with libraries and tools that have already proved their usability and popularity, meaning that a big and active community is supporting their development and use. To ensure this high interactivity approach of this web application a good approach was to use the **React JavaScript Framework**. React allows rich site interactions, fast website rendering after the initial load, and a good selection of open-source JavaScript libraries. It is also designed to build encapsulated components that can be composed to make complex UIs. In consequence, the Table Component is developed as independent **HTML5/AJAX RIA** that is loosely embedded as iFrame in the UI Integration Platform (Drupal 8) and relies as backend on two REST APIs:

- The **EMIKAT REST API**, which offers access to data European-level screening input and output data managed in EMIKAT. It is mainly used by the *simple* table component but also by the Multi Criteria Decision Analysis Tool.
- The **Table Component REST API**, which offers additional aggregation and normalisation of arbitrary data exposed via on of the Data Repository components, in particular **GeoServer**. This API is exclusively used by the *advanced* table component.

In terms of an open-source solution for the tables itself, **react-table** (https://react-table.js.org/), a lightweight, fast and extendable data grid built for React, was used for the implementation.

**Report**

A detailed technical report of the development activities by means of implementation-level tasks (“issues”) is available on the GitHub platform. A brief summary of these activities can be found in section 3.1 of this document.

**Detailed technology support report:**
https://github.com/search?o=desc&q=org%3Aclarity-h2020+label%3A%22BB%3A+Table+Component%22&s=updated&type=Issues

# UI Integration Platform

### Overview

"CLARITY's common User Interface Integration Platform (Figure 67) is the unified entry point to the CLARITY ecosystem. It integrates the different frontends (user interfaces) of CLARITY building blocks and ICT climate services, respectively, with the CLARITY Marketplace and the CSIS." [3] It is therefore the central component for integrating all building blocks of the CSIS Architecture.

### Results

The following links provide access to the results produced by the CLARITY project, including online documentation and downloads of source code and binaries.

**Specification:**
https://clarity-h2020.github.io/csis-architecture/docs/building-blocks/UI-Integration-Platform

**Source code, software releases and technical documentation:**
https://gitlab.atosresearch.eu/ari/clarity-csis-drupal/
https://github.com/clarity-h2020/docker-drupal/

**Deployed instance:**
https://csis.myclimateservice.eu/

### Realisation

Figure 66 gives an overview on the technologies and the related software components that have been selected for the realisation of this building block.

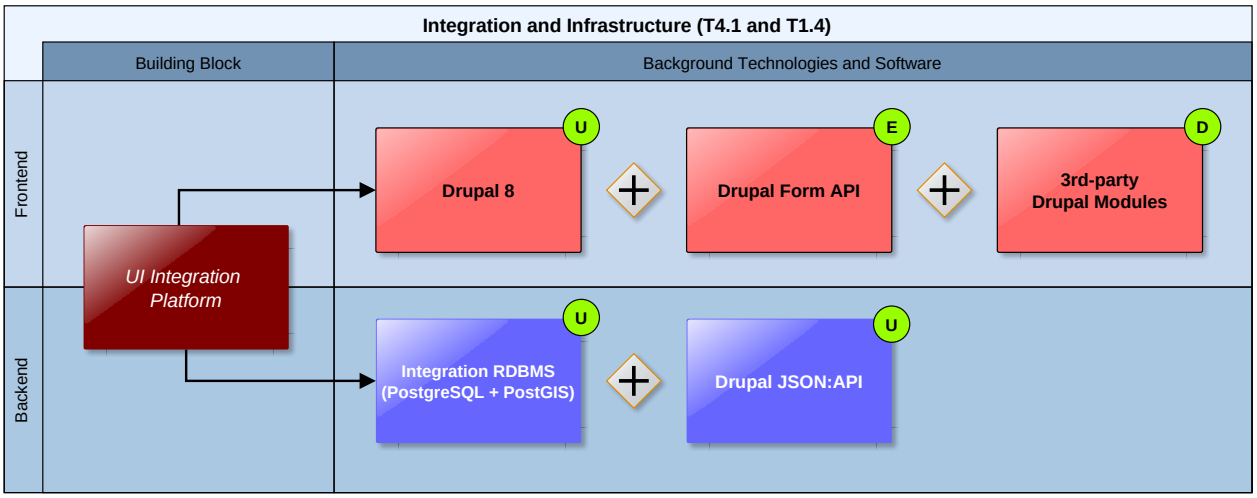


Figure 66: UI Integration Platform technology support

With the selection of the **Drupal 8** and the possibility to integrate arbitrary RIAs via iFrame (Figure 68), WP4 technology support team implemented a content management system based approach. Additional user-interface centred building blocks like the Map Component and the MCDA Tools are independently developed following a JavaScript Framework-based approach. They can communicate with the platform via Drupal 8's **JSON:API** and the **seamless.js** JavaScript library.

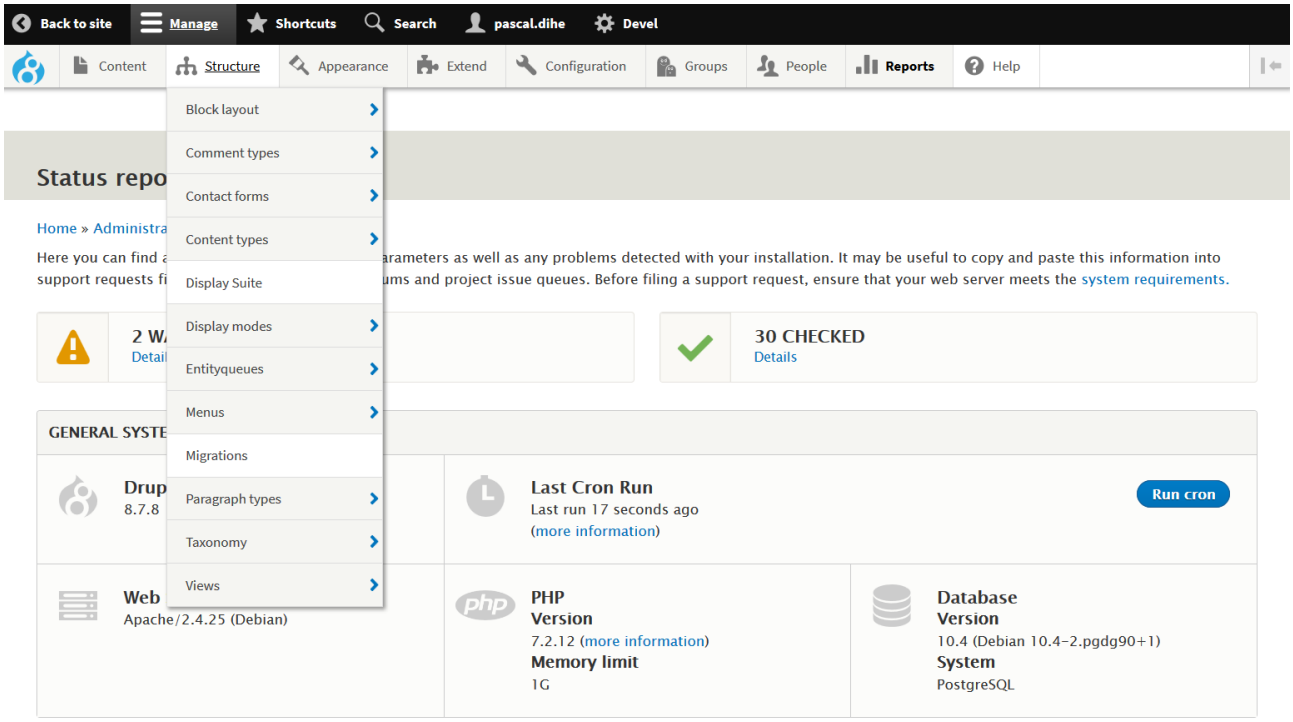


Figure 67: Drupal UI Integration Platform

The Docker-based container configuration (e.g. compose file) as well as the Drupal-specific configurations are stored in dedicated git repositories. The respective Drupal Docker container is deployed in CLARITY's container engine. As backed storage of the Drupal platform, a dedicated **PostgreSQL** with **PostGIS** extension container is used. External applications and building blocks like for example AIT EMIKAT can communicate with the Drupal Platform via a built-in **JSON:API**.

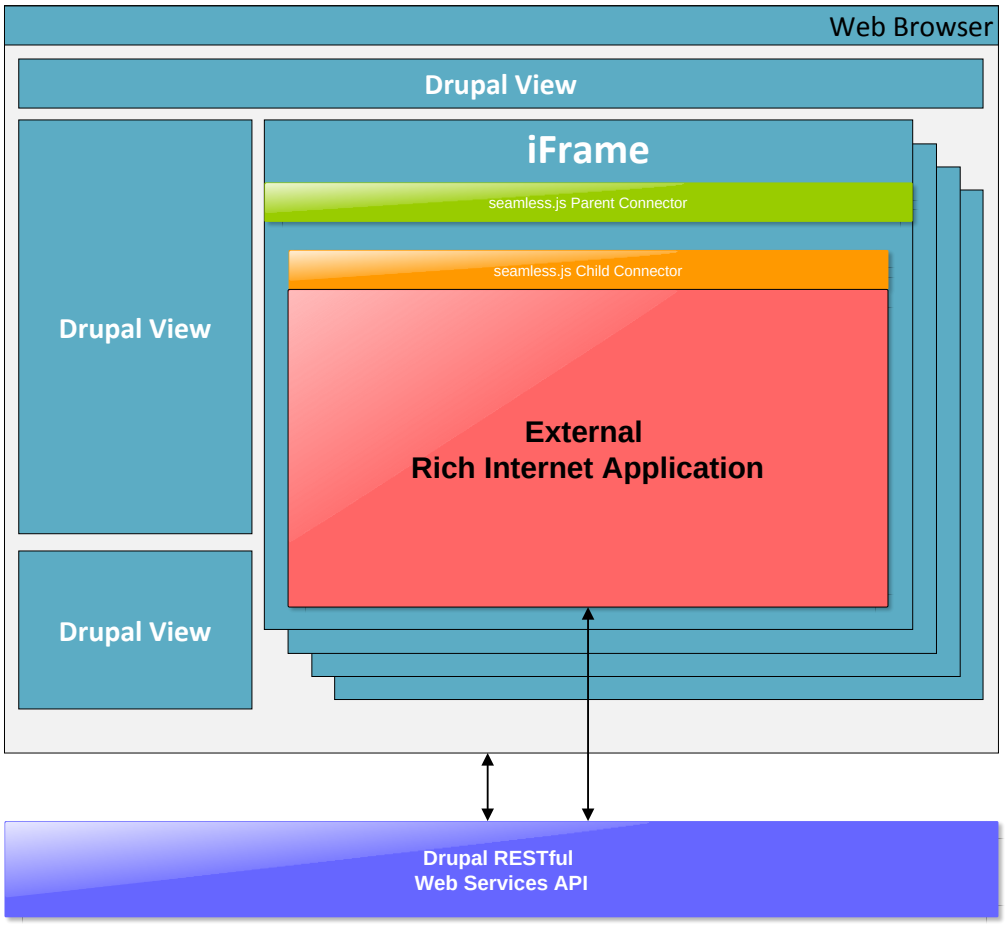


Figure 68: UI Integration Platform iFrame integration

**Report**

A detailed technical report of the development activities by means of implementation-level tasks (“issues”) is available on the GitHub platform. A brief summary of these activities will be provided in deliverable D1.5 ”Final Industrialisation and Support Report”.

**Detailed technology support report:**
https://github.com/search?o=desc&q=org%3Aclarity-h2020+label%3A%22BB%3A+Table+Component%22&s=updated&type=Issues