EU-CIRCLE

A pan-European framework for strengthening Critical Infrastructure resilience to climate change

D5.4 Final integrated CIRP release

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Statement

This document accompanies the final integrated release of the CIRP platform and presents the adopted final system architecture and application capabilities from the user point of view. CIRP is a multi-user collaborative modelling environment where multiple scientific disciplines can work together to understand interdependencies, validate results, and present findings in a unified manner.

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Abbreviations List	
Term	Description
CEF	Chameleon Enterprise Foundation
CIRP	Critical Infrastructure Resilience Platform
CI	Critical Infrastructure
CORDEX	Coordinated Regional Climate Downscaling Experiment
DEM	Digital Elevation Model
DoA	Description of Action
ECMWF	European Center for Medium range Weather Forecasting
ESGF	Earth System Grid Federation
Grib	GRIdded Binary
GUI	Graphical User Interface
JEE	Java Enterprise Edition
NetCDF	Network Common Data Form
OpeNDAP	Open-source Project for a Network Data Access Protocol
OSGi	Open Services Gateway Initiative
PC	GEF Personal Computer
PCA	Principal Component Analysis
RCM	Reginal Climate Models
RCP	Rich Client Platform
RMI	Remote Method Invocation
SDK	Software Development Kit
THREDDS	Thematic Real-time Environmental Distributed Data Services
UI	User Interface
UML	Unified Modeling Language
WebDAV	Web Distributed Authoring and Versioning
XML	Extensible Markup Language

Executive Summary

This document accompanies the final release of the Integrated CIRP environment that constitutes an innovative modular and software platform that assesses potential impacts due to climate hazards through a multitude of extension plugins.

CIRP offers as an end-to-end collaborative modelling environment where new analyses can be added anywhere along the analysis workflow and where multiple scientific disciplines can work together to understand interdependencies, validate results, and present findings in a unified manner providing an efficient solution that integrates existing modelling tools and data into a holistic resilience model in a standardised fashion.

The final release of CIRP provides additional capabilities to the previous release (D5.3) like the ability to create custom damage curves and mapping datasets via a Graphical Editor and the ability to read and visualize grid climate data. In this respect this accompanying document is based on the accompanying document of first release and presents the additional capabilities as well as any changes occurred in this final release.

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1 Introduction

This document accompanies D5.4, a deliverable of type “OTHER”, in this case the final software release of Critical Infrastructure Resilience Platform (CIRP). CIRP’s primary goal is to provide a multi-user web based software that will be able to analyse CI’s vulnerabilities and impacts due to climate change in the form not only of physical damages but also service impacts, interdependencies, societal costs, environmental effects, and economic costs due to suspended activities.

CIRP is a user-friendly GIS based environment that provides its users with the ability to analyse what-if scenarios: leveraging model selection, climate data repositories and CI inventories in order to calculate impact for any kind of climate hazard and CI. In this way, users will be able to understand the impact of various adaptation strategies or quantify the potential impact of a catastrophic event on society.

The work package structure of EU-CIRCLE and especially the separation of Tasks in WP3, 4, 5 and 6 was based on the idea that risk model development and software development are two distinct activities and that the right approach for EU-CIRCLE is the one in which scientists and engineers develop the risk model (inputs, outputs, calibration, validation) and software developers work closely with this team to build efficient and user-friendly tools that are easily extended and adapted to suit a wide range of applications. In this respect the CIRP has been developed as an extensible platform that is able to accommodate different types of datasets (e.g. hazard, assets, interconnections, fragilities), file formats, and risk analysis algorithms and provide suitable user interface elements for scenario and data repository management, analysis workflows setup, and intuitive results visualisation and reporting.

The rest of the document is structured as follows: the methodological approach followed in order to build, test and validate CIRP is described in the following Section. Section 3 presents the CIRP System Overview and Section 4 the CIRP architecture. Finally in Section 5, the Graphical User interface is presented and Section 6 describes in more detail the functionalities offered by the platform.

2 Methodology

The overall development of the CIRP platform was based on the requirements, design specifications and design strategies that are described in D5.1. The work has been conducted in the frame of Tasks 5.4, 5.6 and factors the outcomes of the various project meetings to date and DoA descriptions. CIRP during its development stages has been presented and interacted with EU-CIRCLE partners during the project meetings where comments and suggestions have been elaborated.

The development process was based on the Agile Software Methodology [1] as the work has been divided in iterations. Each iteration included the tasks necessary to release the mini-increment of new functionality: planning, requirements analysis, design, coding, testing, and documentation.

The CIRP integrated environment first release is based on the Consequence – based Risk Management (CRM) generic approach which has been selected and extensively described in D3.4 “D3.4 Holistic CI Climate Hazard Risk Assessment Framework”, Section 3.4. CRM has been used in climate/disaster risk reduction assessments allowing for the identification of uncertainty of climate risk modeling and quantify the risk to societal systems and functions. It also enables relevant stakeholders to develop risk reduction and adaptation strategies and implement mitigation actions.

3 System Overview

The Climate Infrastructure Resilience Platform (CIRP) is a multi-user simulation environment that offers a Climate Change Risk assessment analysis toolbox to CI policy-makers, decision makers, and scientists which allows them to utilise different and diverse modelling and risk assessment solutions, in a standardised and homogenised environment, to develop risk reduction strategies and implement mitigation actions that help minimise the impact of climate change on CIs.

Various risk assessment tools and platforms exists today that lack the flexibility to easily be extended with new analysis tools [2]. This is typically due to a combination of architectural approach and closed-source licensing policies. Such software does not allow the community to actively contribute new algorithms and capabilities and, therefore, allow the software to evolve with the advancements of science. Furthermore, software-licensing fees from proprietary vendors can make such packages unaffordable for many members of the community.

CIRP aims to cover this gap by offering an extensible platform assuring that the science and engineering principles behind the forecasting of damage probability of Critical Infrastructures (including buildings, bridges, networks, pipelines, and other inventory items) from anticipated events is both pragmatic and state-of-the-art and therefore critical to minimising the impact of climate change events, reducing losses to economic resources, and the development of more stable communities.

4 Architecture

This section provides an updated (compared to D5.3 and D5.1) architectural overview of the developed CIRP platform (first release). CIRP has been developed as a fully modular, extensible, multi-user geospatial N-tier software system according the design considerations and strategies presented in D5.1. It is an enterprise application compliant with the JEE specification that is based on a set of tools and components capable of providing the underlying building blocks for impact analysis arising from a dynamic climate risk approach to critical infrastructure.

The CIRP is accessible to end users either as a Client-Server installation or as a Web start-able rich client application. The first type of installation addresses the EU-CIRCLE scientific partners that will develop in the frame of Task 5.3 and in close collaboration with the software engineering partners, new dataset types and analysis plugins and thus need to have direct access to the client part SDK (set of plugins) of CIRP.

The second type of installation addresses the policy and decision makers and CI owners that need to access the system from a browser, operate in diverse locations, and receive automatic software updates as these become available from the consortium.

The CIRP server is based on the JEE specification while the CIRP client architecture is based on the Eclipse RCP technology and two related frameworks:

- The Satways Chameleon Enterprise Foundation
- The ERGO-Core [3] from the ERGO consortium

Each of the two core frameworks provides a set of discrete functionalities that may be exploited independently or in a collaborative manner. The ERGO-Core OSGi bundles provides the functionality related to inventory, data and metadata management, and the ability to wrap new analysis types and execute them on a workflow engine. The CEF framework provides the User Management & Roles and Access Rights modules, and the 3D GIS viewer and editor modules. Both frameworks are described in detail in D5.1.

The overall aim of CIRP is to provide a multi-user geospatial application that will:

- Support new types of infrastructures and links to societal functions;
- Support risk and resilience assessment models for multiple hazards;
- Support analysis and modeling of inter-dependent physical systems and non-technical systems that are essential for the recovery of a regional area (e.g. financial, social, healthcare, public safety, education etc.);
- Link to external software for climate hazards (e.g. flood, forest fire simulators) and infrastructure operation models, and
- Support the collaborative and interactive exchange of risk analysis information and related scenarios

The following UML Deployment Diagram (updated diagram compared to D5.1) shows the physical layout of the various hardware components (nodes) of the CIRP system as well as the distribution of executable environments and software components on that hardware. The diagram depicts the actual devices (workstations, servers), along with the inter-connections, and provides an effective system topology. In that topology, as illustrated below, the location of executable components and objects illustrates where the software units are deployed and executed.

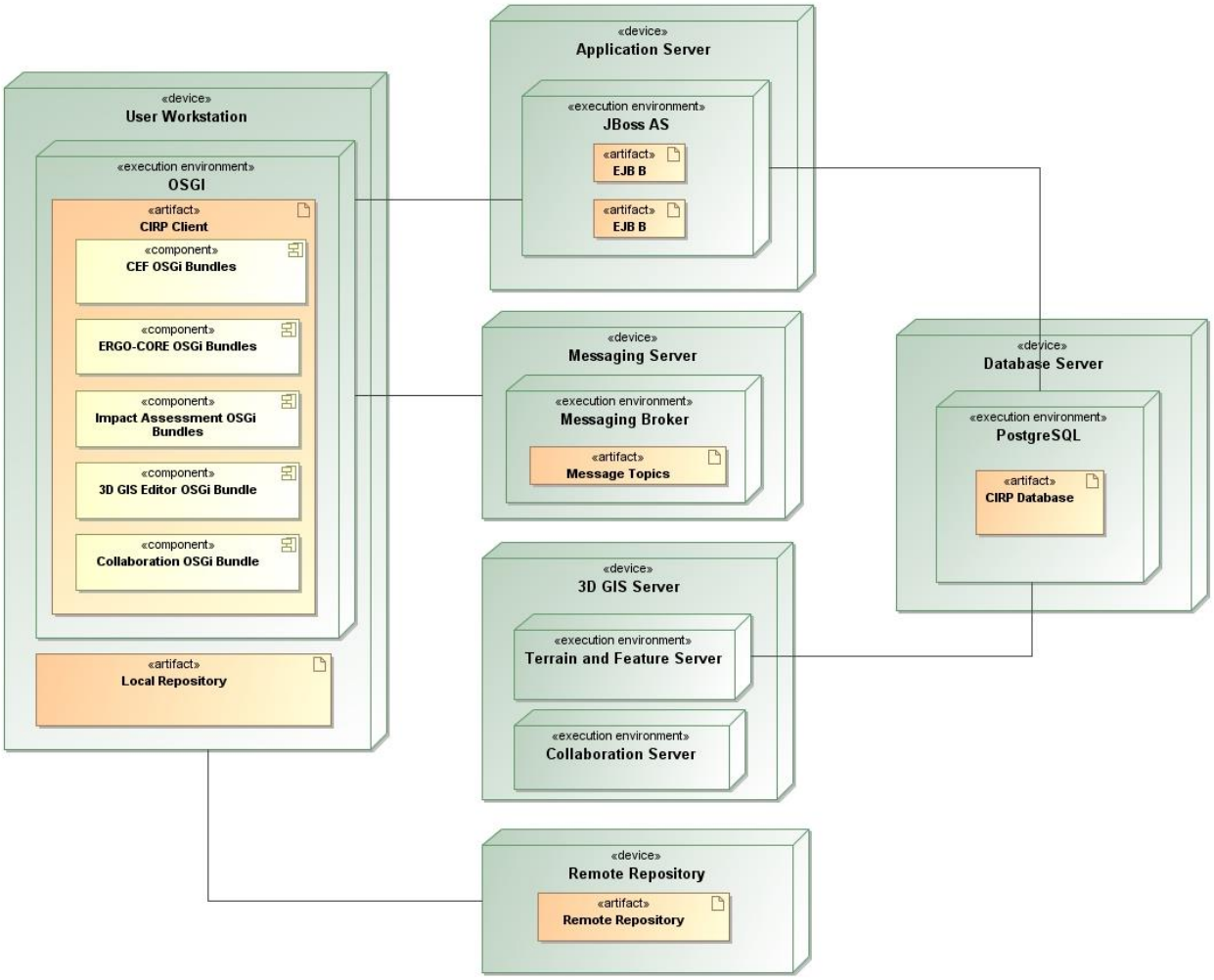

Figure 1: UML deployment diagram of the CIRP software system

The deployment diagram illustrates:

- The Application Server:
    - The core of the system running all server side Business Logic. The JBoss Application Server is the chosen execution environment. It stands between workstations and the Database, handling requests and storing and retrieving data and performing all necessary validations and actions. Communication with the Operator Workstations uses Enterprise Java Beans remote method invocations (RMI) technology.
- The Messaging Server:
    - Hosts the Message Broker that enables Event Driven based object exchanges.
- The Database Server:
    - Stores all configuration and runtime data for the system. PostgreSQL is the chosen Relational Database System. This is extended with PostGIS to support geographical data structures and spatial queries.
- The 3D GIS Server: It consists of three different services:
    - The terrain service streams 3D terrain databases
    - The feature service streams vector datasets

- The Collaboration service allows multi-user collaborative sessions.

- The User Workstation:
  - The host device for the CIRP software. The latter will be a multi-screen Rich Internet Application. The currently supported workstation operating system is Microsoft Windows (XP, Vista, 7, 8, 10) 32 and 64bit while the RIA runs on top of the Java and OSGi [4] framework, which allows the application to be fast, efficient, extensible, scalable and adaptable to the user needs.

5 The CIRP Graphical User Interface

One of the main design goals was to have a user interface for both the CIRP operator and system administrator as friendly and customizable as possible. CIRP's UI consists of one or more (in the case of using multiple workstation monitors) main application windows. Each window includes a menu, toolbars (top, left, right and below), the perspective area and the main toolbar where the users will be able to navigate between the different perspectives. A perspective groups a number of views and supporting widgets and menus as well as shortcuts to relevant content creation wizards, other related views, and other related perspectives.
The graphical interface is a rich environment employing tables, lists, drop-down lists, links, buttons, features drag-n-drop capabilities, etc. The GUI has been designed to ease the required user actions and options for processing an operation. This is accomplished by:

- Auto-save functions when entering data or changing scenario contents
- Drag-n-drop features (e.g. raster and vector data to a Map)
- Appropriate design of forms and wizards

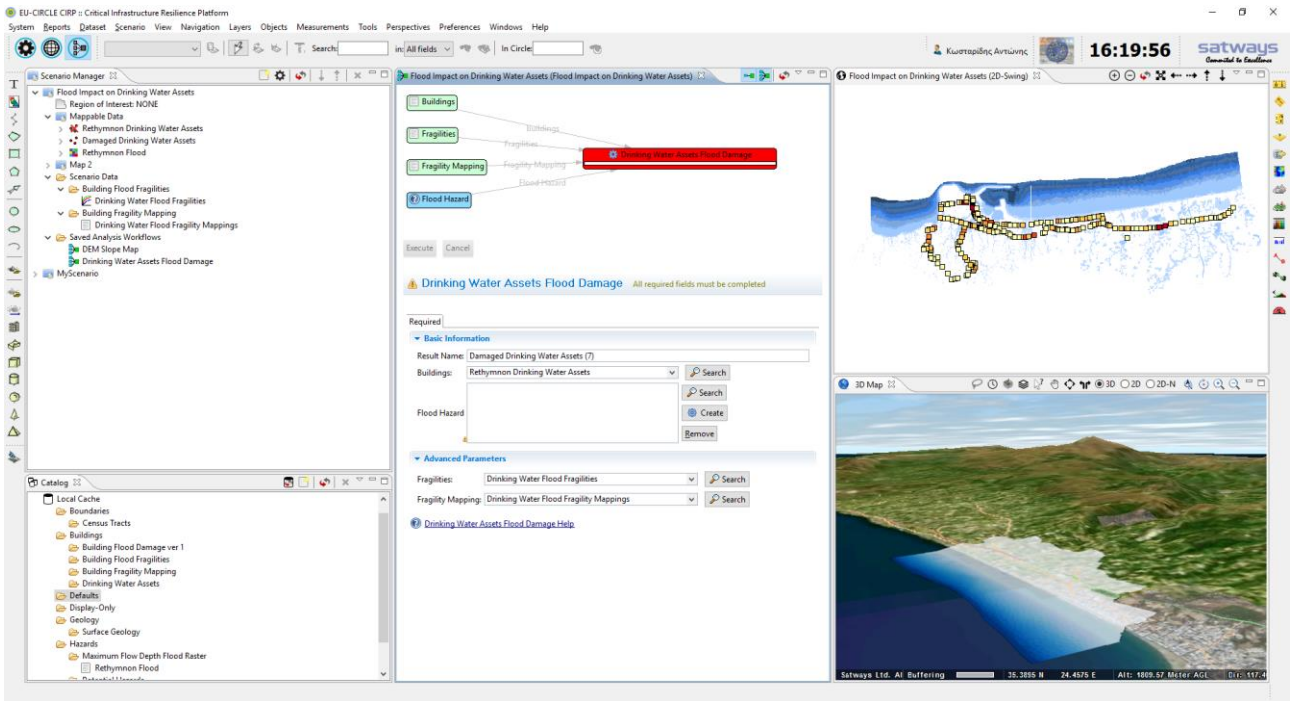

Figure 2: The CIRP Workbench System

The application defines the following window areas:

- Main menu: includes all application menus depending on the modules/plugins that are loaded
- Main toolbars area: includes window selection toolbar and toolbars contributed by other plugins
- Left toolbars area: includes toolbars that contributed by plugins and any minimized Views
- Right toolbars area: includes toolbars contributed by plugins and any minimized Views

- Status area: information and alerts (Status Region). Includes toolbars contributed by plugins and any minimized Views
- Perspective Area: includes the perspective views according to the perspective layout

User preferences are stored in the CIRP database and the GUI has been built to support multiple languages.

5.1 Perspectives and Views

CIRP software's environment provides the ability to switch between the groups of views of the Graphical User Interface (GUI) via the different perspectives. Switching between them is accomplished in the following two ways:

- Via the main toolbar of the application. Each user depending on their role will have access to one or more perspectives from which they access the application's functionalities.

Figure 3: Toolbar for perspective selection

- By pressing the Control-Tab the quick launcher popup window appears that allows the selection of a particular window.

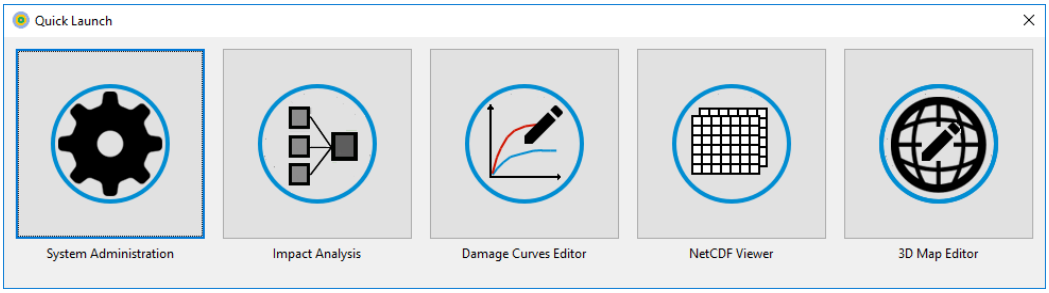

Figure 4: Quick launcher popup

A perspective comprises of one or more views. A view can be maximized occupying all available space of the perspective area, can be completely closed, can be minimized or detached from the perspective window as an independent view (the user has to drag the view outside of the window area).
In case of minimization of a view, it becomes a button in one of the sidebar tools or even in toolbars in the bottom of each window (status region) as shown in the following Figure.

Figure 5: Buttons of Minimized Views

A perspective when activated may contribute controls (buttons, combo boxes, check boxes) to main toolbar or to the left and right sidebar areas. As an example the 3D Map Editor perspective of CIRP provides a set of controls for editing shapefiles in the main toolbar.

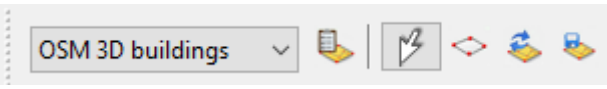

Figure 6: 3D Map Editor toolbar

A View may also provide a number of functions through the view toolbar. The View toolbar is located at the top right part of the View area. This provides easier access to functions and provides users with a better understanding of the use of tools after the allocation is done on each View individually.

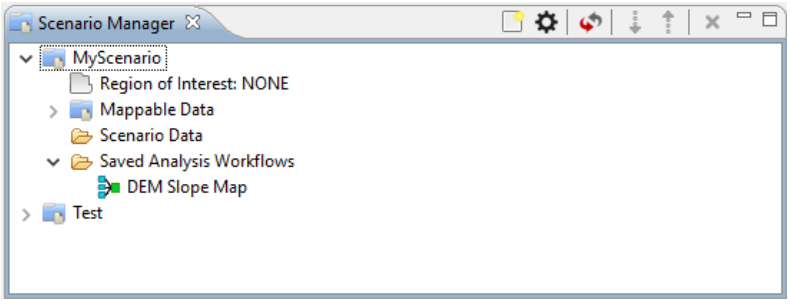

Figure 7: Additional controls on a View

5.2 Common UI elements

Some general GUI elements will be discussed in the following sections that appear often in various views.

5.2.1 Tooltips

Tooltips are evident in most fields providing the user the extra help in understanding the data displayed or providing a tip as to the nature of data input required.

5.2.2 Table Views

The most common way of presenting a list of data in the system is via tables. The tables used generally follow similar logic, but differ greatly in content.

Table: Rethymno Streets

MultiLineString	ID	ID2	USERID	FNODE	TNODE	LENGTH	WIDTH	LANES...	LANES_TF	L_AI
	1153086	87802	28951	776709	788946	444	0	1.50	1.50	0
	1153085	540472	28950	788946	788945	72	0	1.50	1.50	0
	1153084	615722	28949	788945	788942	66	0	1.50	1.50	0
	1153083	713561	28948	788942	788936	458	0	1.50	1.50	0
	1153082	164525	28947	788936	788934	138	0	1.50	1.50	0
	1153081	903698	28946	788934	788929	229	0	1.50	1.50	0
	1153080	704038	28945	788929	706805	505	0	1.50	1.50	0
	1151347	1316422	27212	432321	782330	44	0	1.50	1.50	0
	1151346	1316421	27211	782330	782329	111	0	1.50	1.50	0
	1151345	10945	27210	782329	109490	214	0	1.50	1.50	0
	1151344	1316420	27209	782327	782328	1219	0	1.50	1.50	0
	1151343	23090	27208	782328	392401	2677	0	1.50	1.50	0
	1151342	1316419	27207	333929	782327	251	0	1.50	1.50	0
	1151341	1316418	27206	782326	333929	169	0	1.50	1.50	0
	1151340	782387	27205	775843	782326	178	0	1.50	1.50	0

Figure 8: Example table depicting the attributes of a shapefile dataset

The following are common features found in a tables View:

- **Sorting**: user can sort the list based on which column values they wish. This is done by clicking the title (header) of the corresponding column. In each table the corresponding column will be sorted alphabetically (if it contains numbers based on their values) in ascending order and the sorting criterion, it will reorganize the entire table. From this point, onwards every click on the name of the column will change the order of the sort from ascending to descending and vice versa
- **Resizing columns**: Through a rolling bar, users determine the size of table columns. The result of this action appears directly in the panel.

- **Export or Publish selected rows** : The user is able to select multiple rows of a table and export the dataset filtered with only these rows.
- **Select row by filter** : displays a wizard that enables the filtering of table rows based on user selected statements that include a table attribute (columns) and a list of predefined operators (e.g. equals, greater, than etc.).
- **Configure Table View** : display a wizard from which columns can be removed and re-ordered.
- **Statistics** : displays a dialog that provides statistics for any selected attribute (column) in terms of maximum, mean, minimum, standard deviation values and a bar chart with the frequencies.

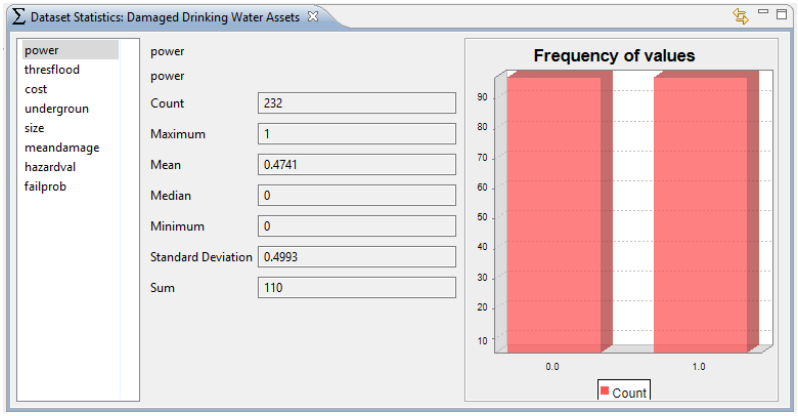

Figure 9: Statistics window of a Drinking water assets dataset

- **Copy selected cells** : copies the selected cells to the clipboard

6 CIRP Functionalities

6.1 Launching CIRP

CIRP can be launched via Java Web Start technology from a link to the main Web site accessible at: http://cloud.satways.net/cirp/.

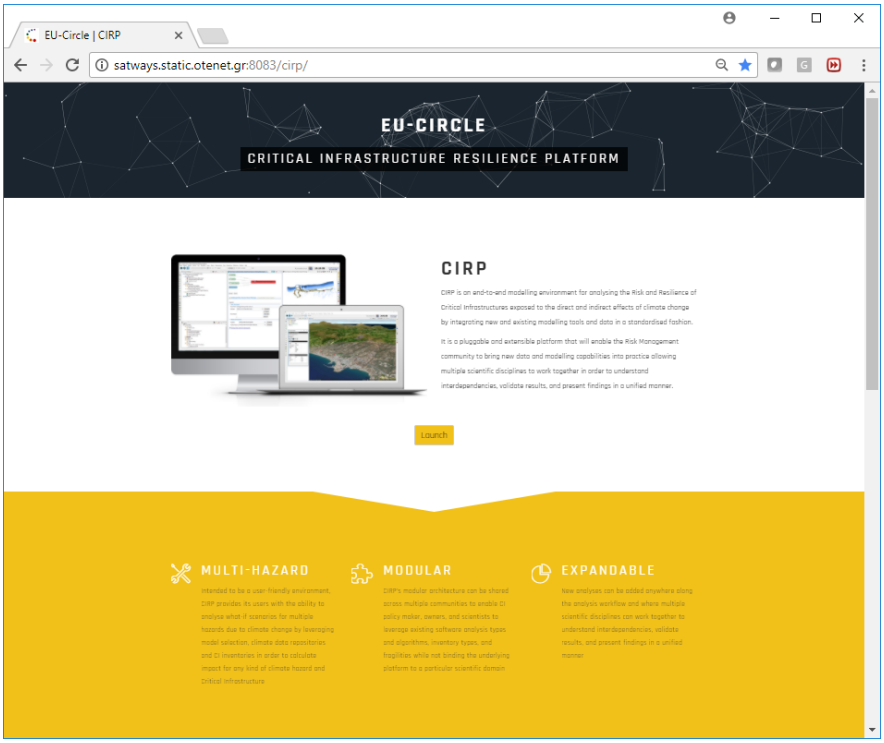

Figure 10: The CIRP home page

Clicking the Launch button the application will download once (and updated automatically as updates are available on the server). When download is completed and after some seconds the following splash screen appears that requests from the user to provide the login credentials.

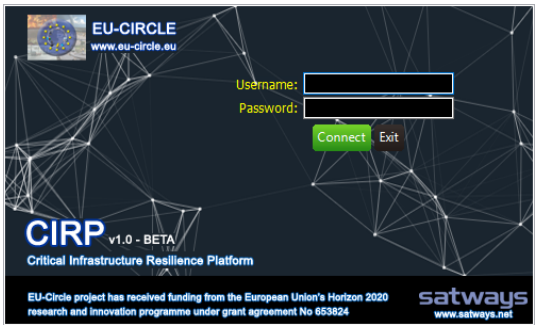

Figure 11: CIRP login screen

Upon providing the credentials and pressing the "Connect" button the user authentication and authorization takes place. The authorization refers to the Perspectives and Views that the user is able to access and any actions that is able to perform according to the appointed user role as defined by the System administrator.

The following sections presents the main Views and functionalities of the CIRP platform (first release).

6.2 The Impact Analysis Perspective

6.2.1 The Scenario Manager View

The Scenarios View shows each scenario a user is working with. A scenario is a user defined case that consists of one or more selected analysis tools from the toolbox and the associated datasets (input and output). Each scenario can be expanded to show its contents (see Figure 12).
The user defined Scenarios within CIRP provide the software basis for the baseline scenarios defined within D3.4, being the software) that will estimate the damages (and impacts) from climate hazards and their impacts on the CI operation. CIRP scenarios can be defined and implemented in sequential and/or in parallel way so that when defined together meaningful output are obtained from CIRP supporting policy questions and climate base scenarios.
Right-clicking the entries within the Scenario view the user can perform the following actions on them:

- Creates a new scenario
- Runs an analysis on your scenario
- Refreshes the view
- Moves the selected map layer down
- Moves the selected map layer up
- Removes the selected item. If the selected item is a dataset, removes it from the scenario. If the selected item is a scenario, deletes the scenario

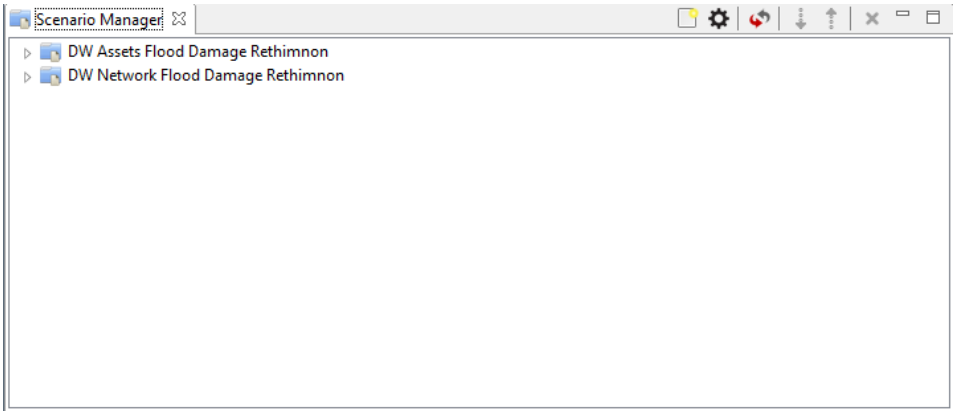

Figure 12: The Scenario Manager View with two loaded scenarios

By unfolding a scenario, the following items are exposed:

- **Region of interest item**: depicts an optionally defined geographical region for the scenario
- **Mappable Data folder**: contains a list with the loaded raster and vector datasets. The following icons denote the dataset type:
  - point vector layer
  - polyline layer
  - polygon layer
  - raster or grid layer
- **Scenario Data folder**: contains non mappable data like fragilities and fragility mapping XML documents. Fragility datasets [5-7] appear with the icon.

- **Saved Analysis Workflows**: contains a list of the analysis loaded into the scenario.

The following figure depicts an example Scenario contents.

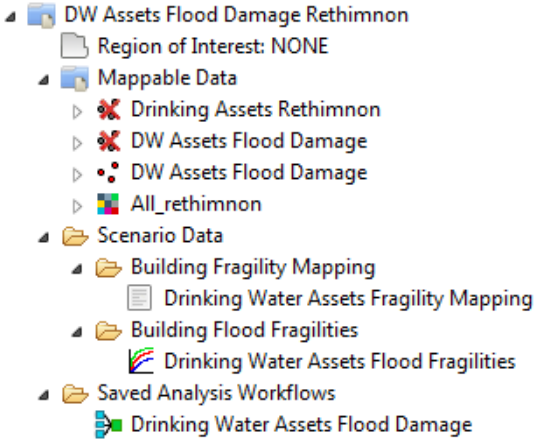

Figure 13: Sample Impact analysis scenario

Depending on the nature of a scenario item different options are provided via a mouse right click popup menu.

6.2.2 Actions on a Dataset

Right clicking a dataset item depicts the popup menu of Figure 18. It provides the following actions:

- **Compare with**: can compare the dataset with another selected from the popup wizard.

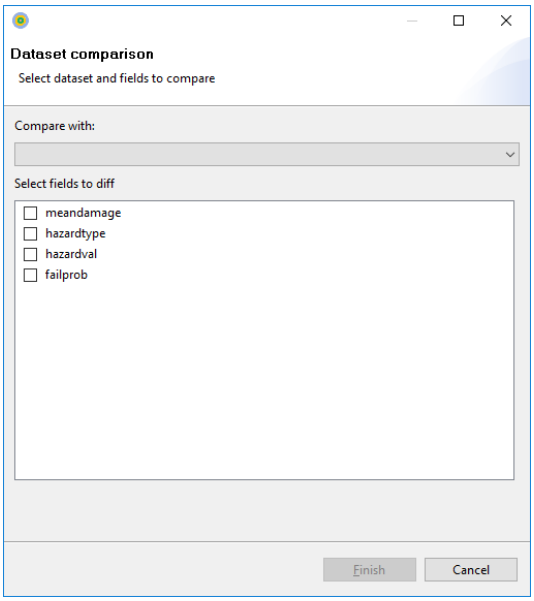

Figure 14: Dataset comparison wizard

- **Show Attribute Table**: depicts a Table View with the dataset attributes. The actions described in Section 5.2.2 are applicable in this View.
- **Properties**: depicts the Dataset properties View enlisting the repository, data type, data provenance and metadata (see Figure below):

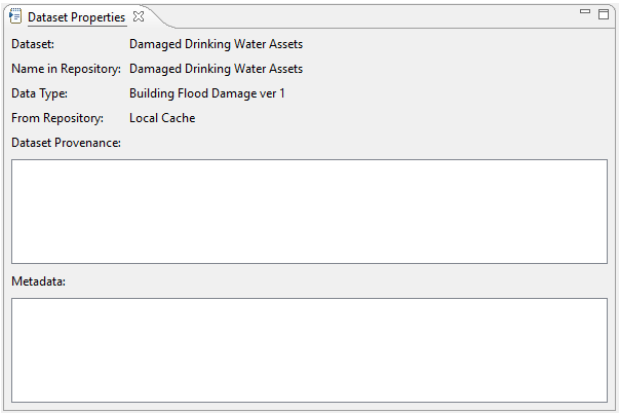

Figure 15: The Dataset Properties View for a sample dataset

- **Show Chart [8]**: depicts a wizard in order to select the fields to plot a chart for different aggregation types (mean, sum and count). This action is only valid for Feature datasets (not raster ones)

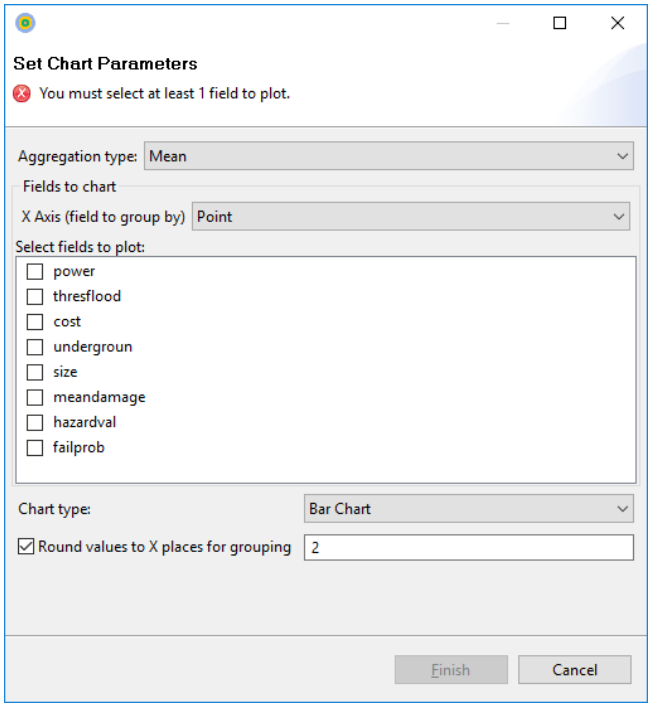

Figure 16: The Chart definition wizard for a selected dataset

- **Reports** – reserved for future release
- **Zoom to Layer**: zoom the map to the bounding box / envelope of the dataset
- **Toggle Visibility**: hides and shows the layer from the map
- **Import Style**: allows the selection of a style from the file system
- **Change Layer Style**: shows the Style Editor View (see section 6.2.7) which allows the modification of the layer appearance on the map.
- **Rename**: allows inline editing of the dataset name in the scenario tree
- **Copy & Paste**: allows copy and paste functionality
- **Delete**: deletes the dataset from the scenario tree
- **Export Dataset**: allows dataset export (as a copy) to a user selected location
- **Publish Dataset**: allows ingesting a dataset to a cache (local or remote). See section 6.2.5.
- **Filter by Region**: if a region of interest has been selected during scenario setup the this action allows geographic filtering of the dataset contents according to the ROI.

- **Clear Filter**: clears an applied filter
- **Filter**: shows a dialog where Boolean algebra filters can be applied on the dataset.

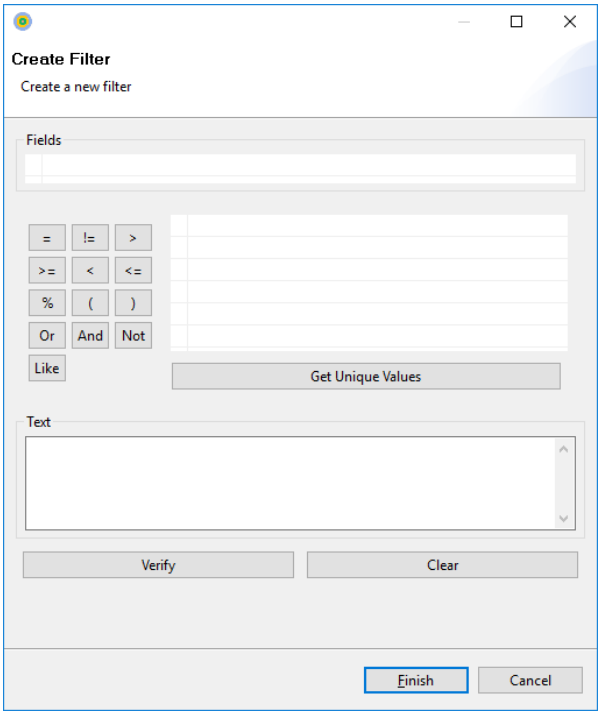

Figure 17: Boolean algebra filter dialog

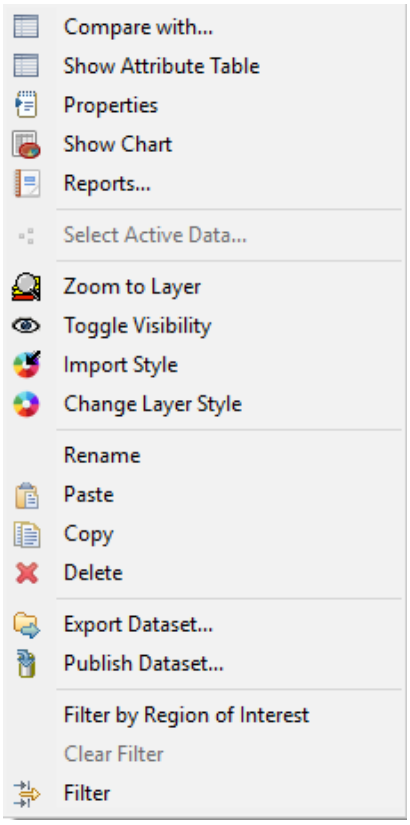

Figure 18: The available actions in the popup menu for a selected dataset

6.2.3 Executing an Analysis

A primary objective for the CIRP is that it be engineered as a pluggable and extensible platform that will enable the Risk Management community to bring new data and modelling capabilities into practice. From the CIRP policy and decision maker perspective, the platform capabilities will be offered as a toolbox that consists of a collection of diverse analyses of Risk and Resilience of Critical Infrastructures that are exposed to the direct and indirect effects of climate change.

In order to run an analysis the user should press the "Execute Analysis" button . Then a wizard is displayed that requests the selection of the scenario from a combo box (if a scenario is not yet selected in the Scenario Manager View).

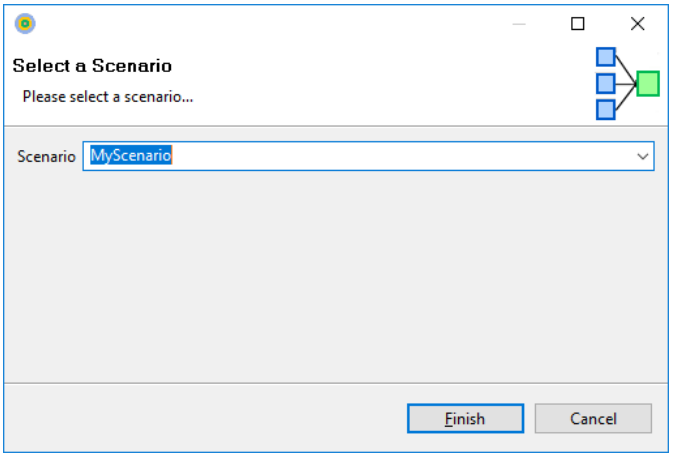

Figure 19: New scenario wizard

Upon pressing "Finish" button the analysis selection wizard appears enlisting the different analysis loaded into the system (as separated OSGi plugins) in a hierarchical manner according the category that each analysis belongs to. The following analysis categories are currently supported:

- **Building**
- **Climate Data**
- **CI Networks**
- **Decision Support**
- **GIS**
- **Hazard**
- **Socioeconomic**

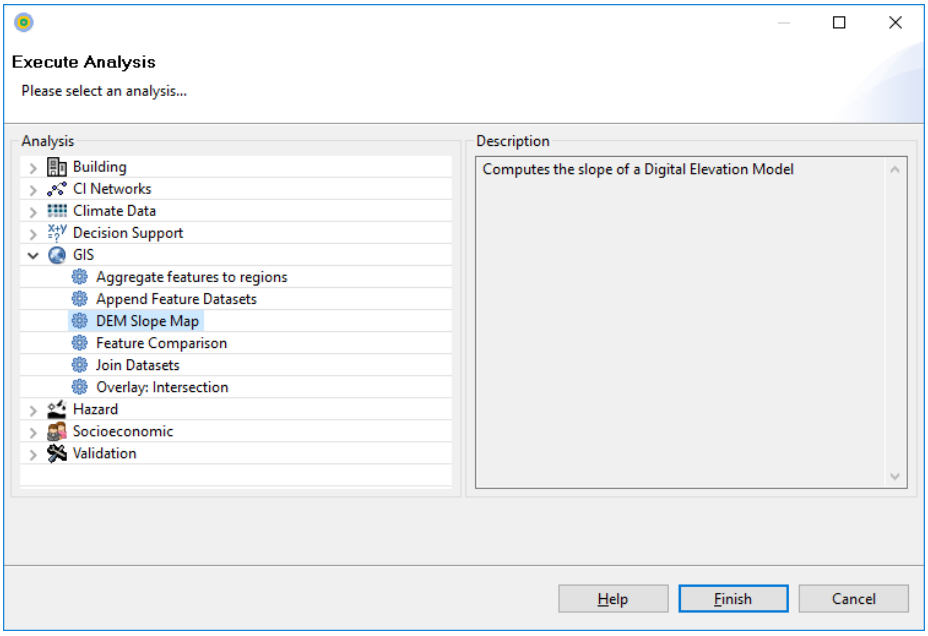

Figure 20: The available analyses categories

6.2.4 The Analysis View

An analysis View is launched upon double clicking a Saved Analysis workflow from the Scenario Manager or upon selection of an analysis from the "Execute Analysis" wizard. The view contains two parts:

- On the top the graphical part of the analysis workflow is presented
  - Light blue or green boxes denote an input node
  - Red or Green boxes denote an analysis node
- The node details part on the bottom which upon selection of a node (input or analysis) depicts widget controls that:
  - Enable the selection of a dataset (in the case of input nodes)
  - Enable the selection of all the required and optional inputs (in the case of an analysis node).

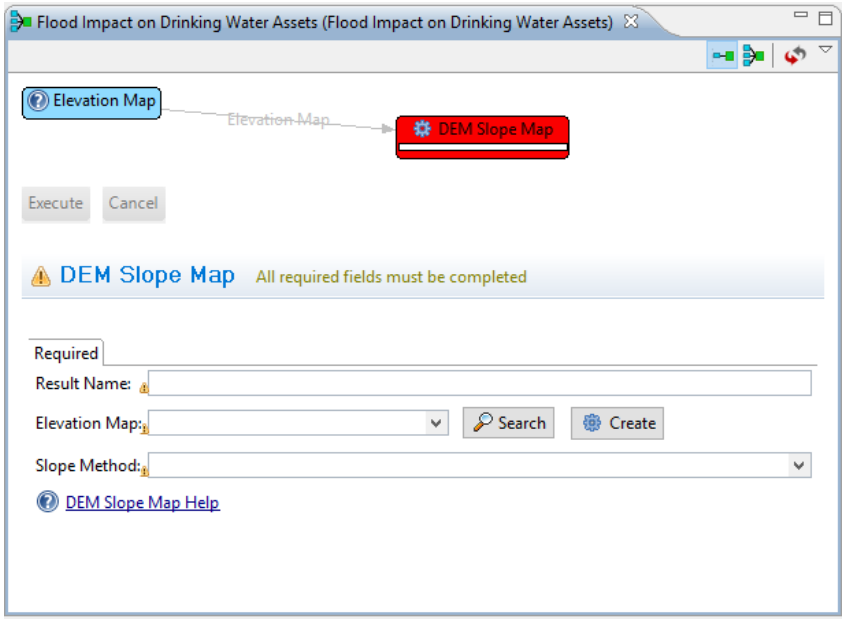

Figure 21: Example of an analysis View with only basic input fields

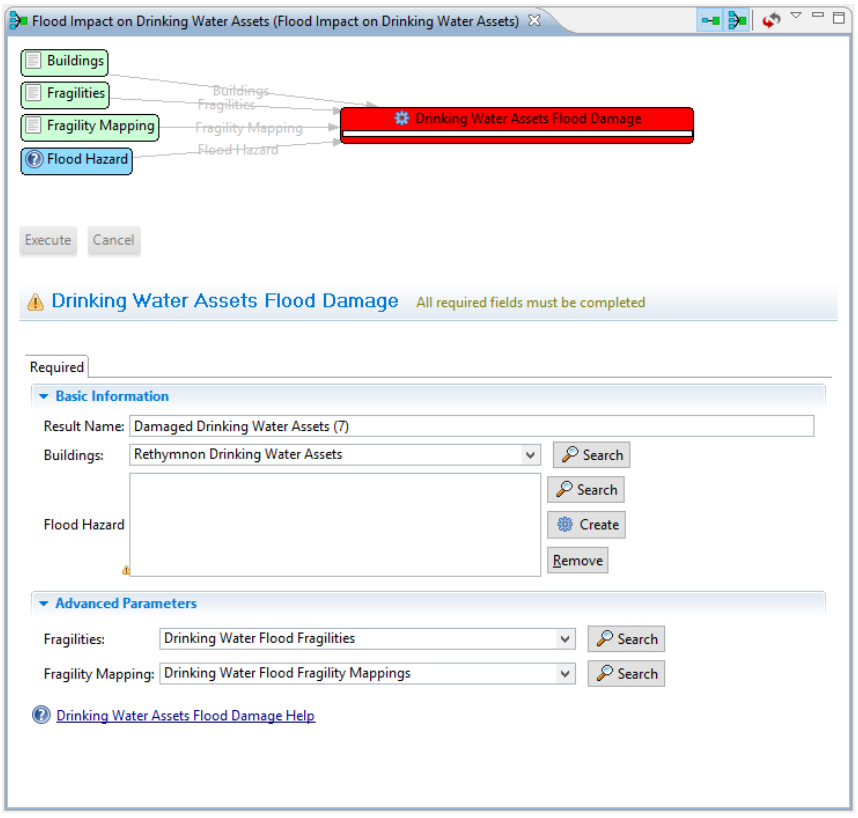

Figure 22: An analysis View with basic and advanced input parameters

In order to execute an analysis all the required fields must be filled by the user. A field may require the typing of a name (e.g. result name) or the selection of a dataset from the local or remote cache (see next section). Upon input completion the workflow nodes changes color as following:

- The light blue input node become light green
- The red analysis node becomes green.

In this state the “Execute” button is enabled.

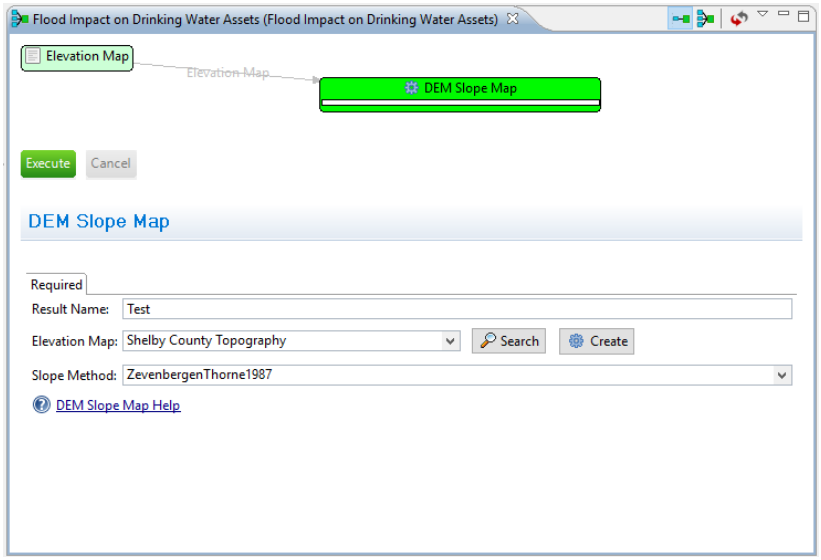

Figure 23: Analysis ready to be executed

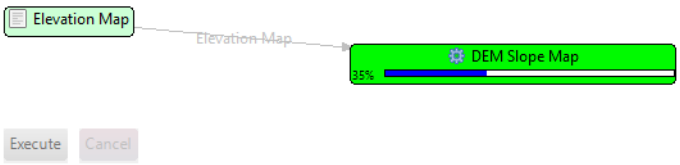

Figure 24: Progress indicator during analysis execution

6.2.5 The Catalog View

The Catalog View provides access to the local and remote file caches. A cache is a location where CIRP looks for and stores all of the data that is uses and produces.

A cache can be located locally, as a file on the local machine drive, or be remote. By default, CIRP creates a local cache on the user's system, where any remote data that is accessed is cached for local use.

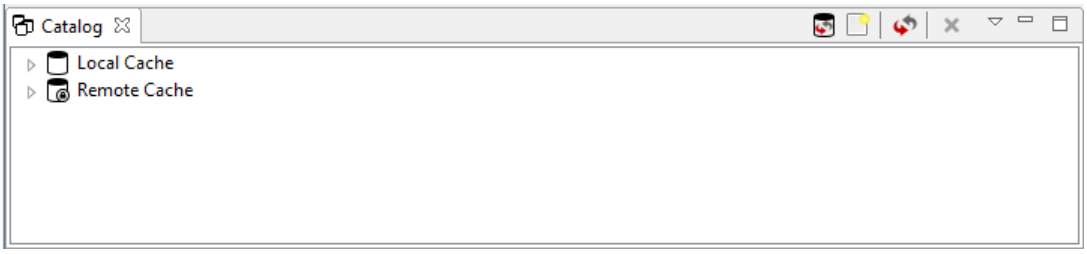

Figure 25: The Catalog View

The local cache consists of folders on the local machine's drive, which are formatted in a specific format so that CIRP recognizes and knows how to read/write them. A user can create a new local cache by using the File -> New -> Repository menu and respective wizard.

To share or publish data to other CIRP users, a Remote cache is used. The remote cache is actually a WebDAV server.

The Catalog View provides a toolbar with the following options:

- **Synchronize** : synchronizes a cache with a remote cache
- **Create new repository** : shows the cache wizard dialog
- **Refresh** : refreshes a cache
- **Delete** : deletes a selected cache

When selecting a dataset of a cache (local or remote) the following options via right mouse click:

- **Load Dataset**: loads a dataset into a selected scenario
- **Delete from Repository** (only available for local repositories): deletes the dataset from the local cache
- **Export Dataset**: shows a wizard that allows copying the dataset to a local file path
- **Publish Dataset**: copies the dataset to another cache
- **View Dataset Location**: show the absolute file path of the dataset

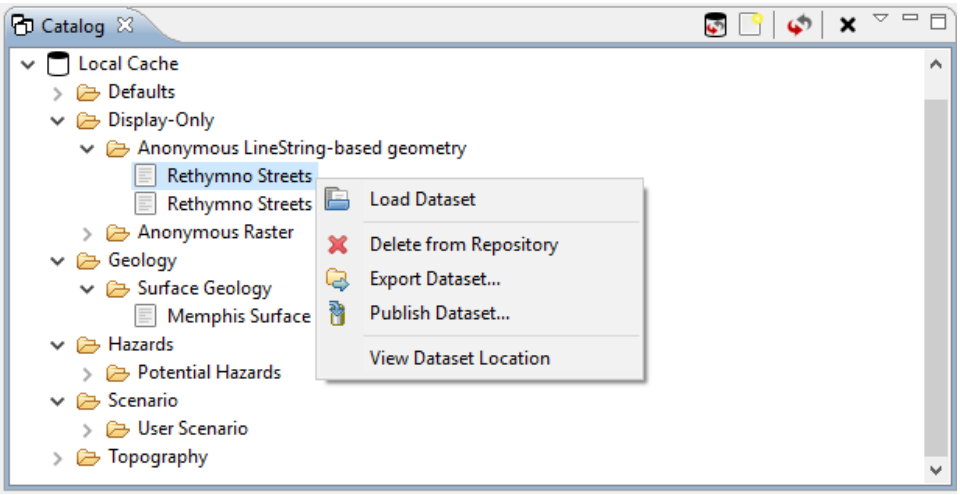

Figure 26: Available options for cache datasets

It must be noted that if the dataset belongs to a remote cache, then the Load Dataset option first downloads the dataset it into the local cache and then it loads it into the selected scenario.

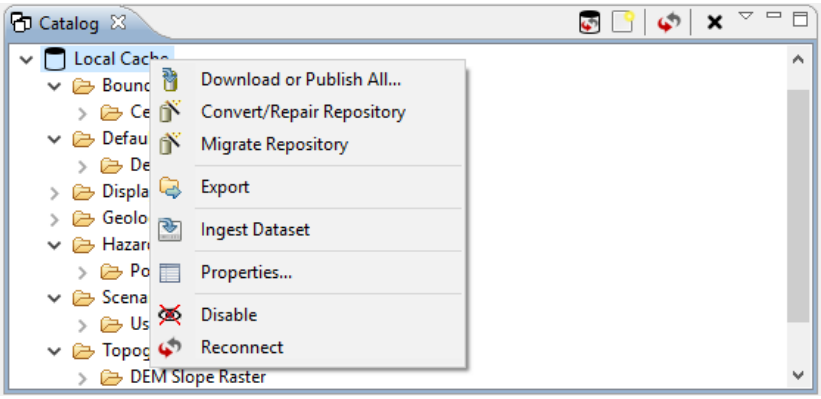

Figure 27: The popup menu of a cache / repository

In order to load a dataset into the local or remote cache the user must select the “Ingest Dataset” of the right click popup menu of a given selected cache. The user must select the appropriate file type from the list of predefined types. The following types are supported:

- Fragility
- Animated Raster
- Network
- Table
- Shapefile [9]
- Raster
- Hazard
- Mapping
- CollectionShapefile
- Text Files

6.2.6 The 2D Map View

The 2D Map View of CIRP allows the visualization of raster and vector datasets in a layered approach and according to the defined styles [10] applied via the Style Editor View. The underlying map engine is based on the Geotools [11], [12] open source library. The 2D Map View provides the following actions on its toolbar:

- Zoom in
- Zoom out
- Refresh
- Zoom Extent
- Pan left, right, top, down

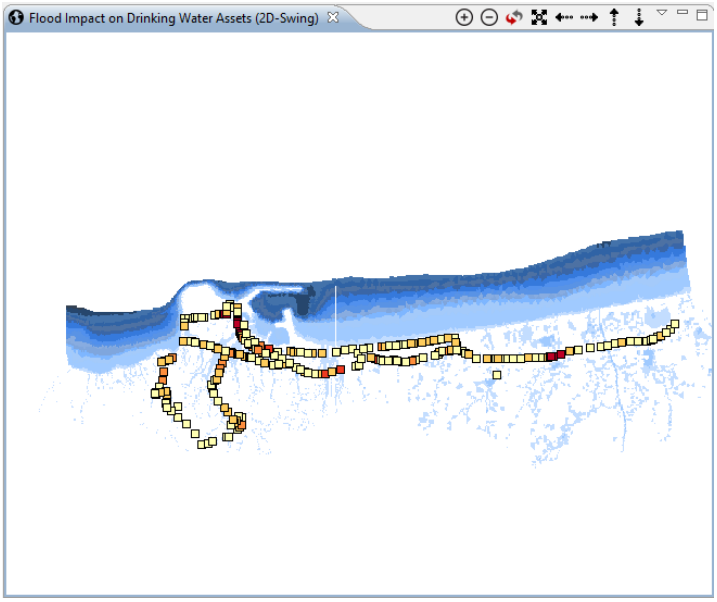

Figure 28: The 2D Map View with sample layers from a flood scenario

It must be noted that a 2D Map View can be opened multiple times in the same perspective window.

6.2.7 The Style Editor View

The Style Editor View provides the tools that allow the definition and application for Vector and raster datasets. The following styles are currently supported:

- Simple Style
- Ranged Style
- Unique Style
- Raster Style (applicable only on Raster Datasets)

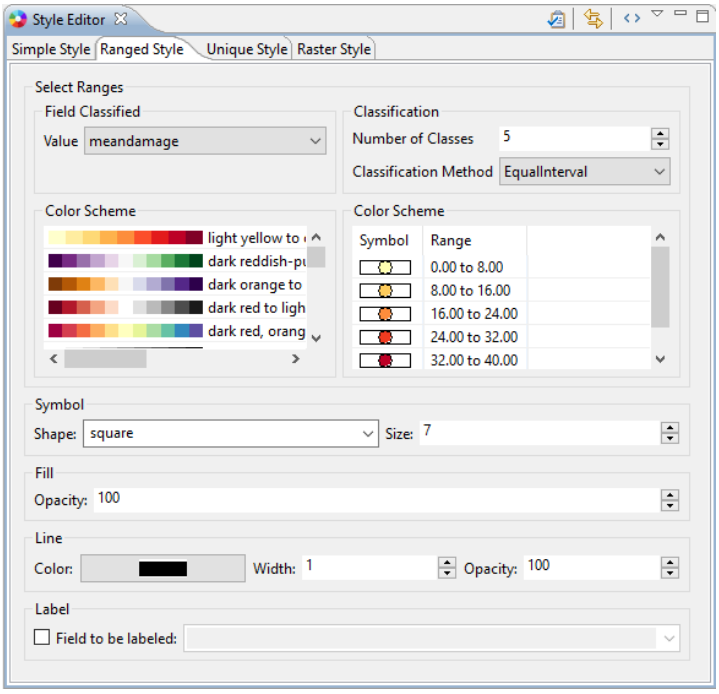

Figure 29: The Style Editor View

6.3 The Curve Editor Perspective

The Curve editor perspective provides tools for creating and editing Damage Curves consisting of a set of X, Y pairs and linear interpolation and their associated Curve's mappings. This module complements other supported curve types (e.g. logNormal) (see D5.1 section 8.5.3).
The Curve editor is capable of manipulating curves ingested in CIRP's repository, as well as raw XML files located in user's local filesystem. By loading a Curve dataset or creating a new one, user has the capability to add or edit curve's points either from a raw table view or from a chart view using drag-n-drop features. With the Curve editor, shipped within CIRP's ecosystem, there is no need for external tools in order to change curve's data or reviewing the curve in a chart.

Main features of Curve Editor

- Create or Edit a Damage Curve
- View, Create, Edit Damage Curve properties
- Create or Edit a Damage Curve's mapping
- Load DBF files containing the data which are filtered by the Damage Curve mappings.
- Create, Edit or Delete Damage Curve's points
- Drag-n-drop feature for editing Damage Curve's points (Live feed in Chart)
- Loading ingested Datasets (Damage Curves, Mappings, DBF files) from CIRP's repository
- Saving Curves & Mappings in local filesystem, Auto-ingesting is feasible if the Curve is loaded from the repository.
- Optionally, auto-loading the saved Damage Curve (loaded from the repository) in all Scenarios using the former.
- Chart additional features towards better User experience

To open the Curve Editor just click on the chart icon  from the main toolbar

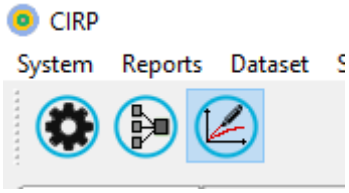

Figure 30: Main toolbar

This is how the Curve Editor perspective looks like after loading a Damage Curve. It consists of three different views, The Curve Dataset, the Table and the Chart view.

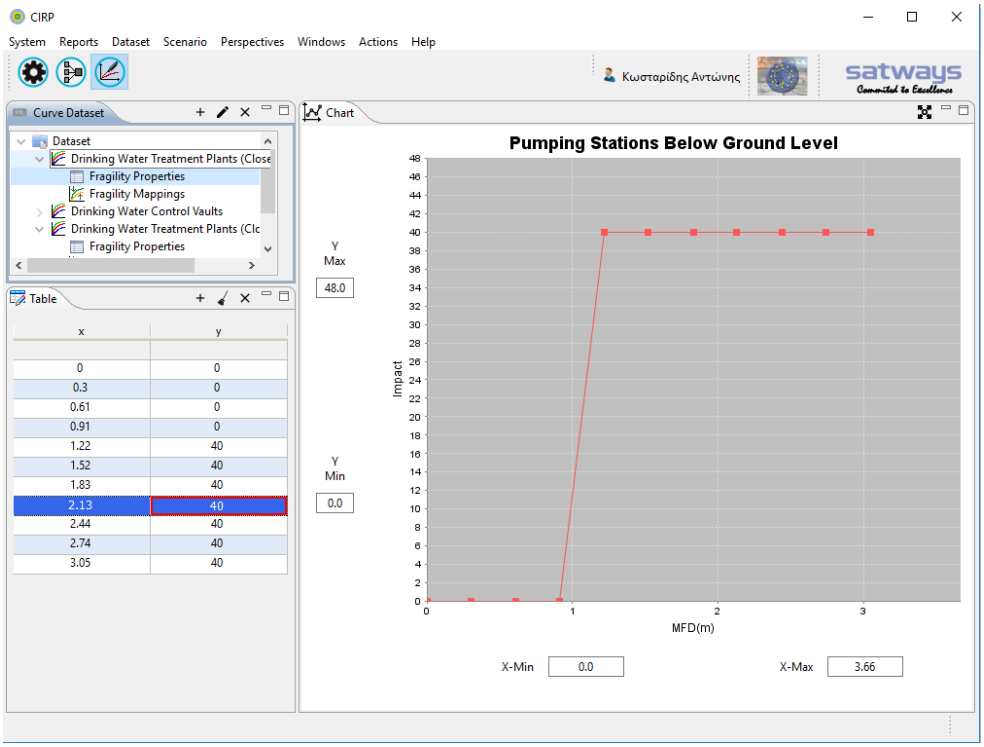

Figure 31: The curve editor perspective

6.3.1 The Curve Dataset View

In the Curve Dataset view you can view in a tree layout the damage curve series of the Curve Dataset.

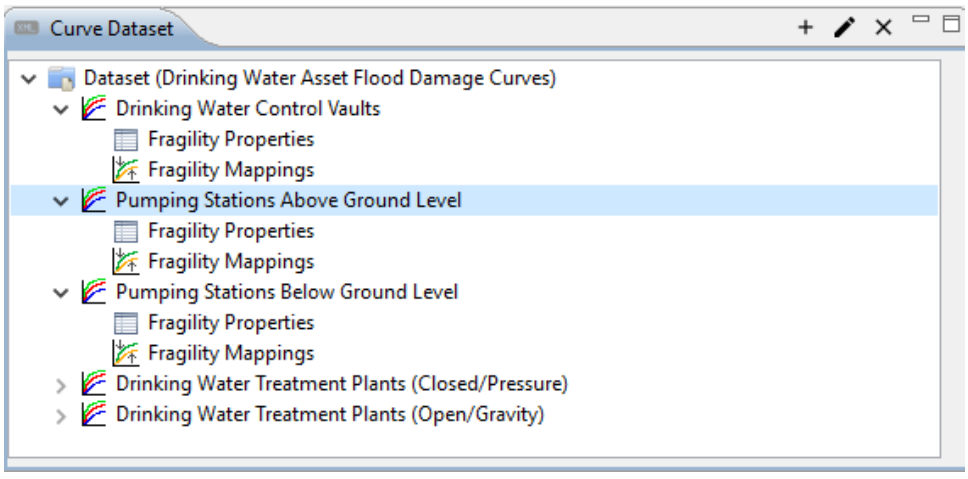

Figure 32: The Curve Dataset View

The toolbar provides the following widgets:

- A create new curve button
- An edit curve button
- A delete curve button

By clicking on a damage curve the related chart and table are loaded and shown to the user. Selecting and pressing the edit button will open the Properties/Mappings wizard, which allows you to enter all related information.

6.3.2 The Table View

The Table view gives user the capability of viewing and editing damage curve's points in a flat table-layout format.

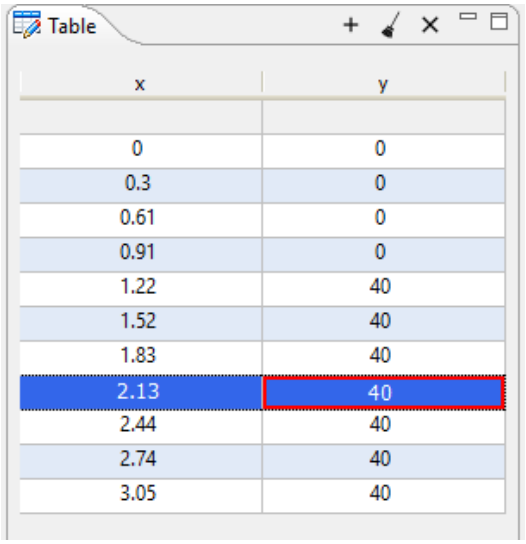

Figure 33: Curve table data

The toolbar provides the following widgets:

- A create new point button
- A clear all points buttons
- A delete point button

By clicking on the row cells, in-text editing of the x, y values is feasible, changes are then affected in the chart view.

6.3.3 The Chart View

The Chart view gives user the capability of viewing and editing damage curve's points in a chart format.

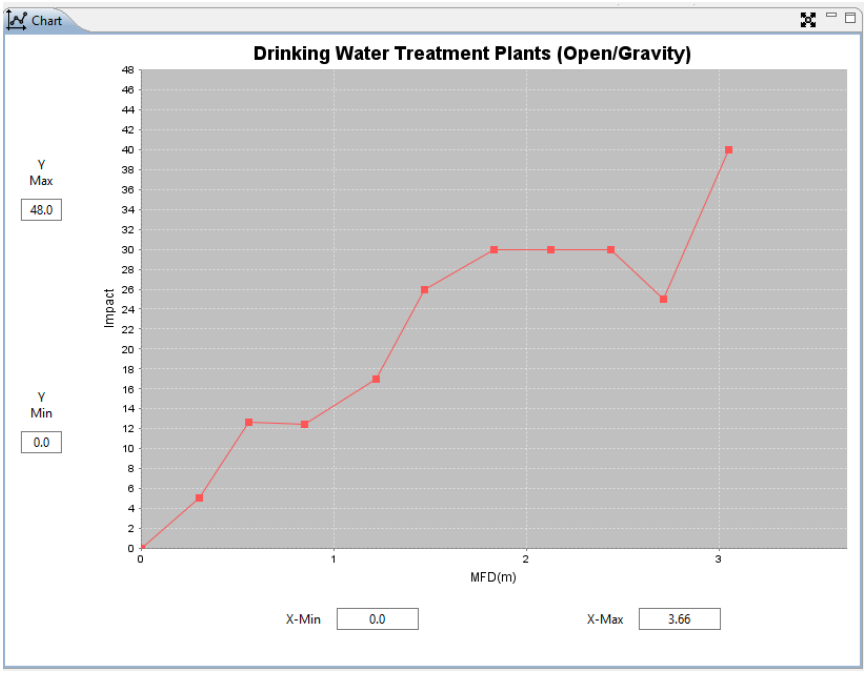

Figure 34: Chart View

The toolbar provides the following widget:

- Auto Calculate Chart ranges

Drag-n-dropping a point in the curve updates the specified point's x and y values. Changes are reflected in Table view.

Ranges of the Chart can be manipulated in order to be able to edit big data charts with large ranged X or Y axis. Clicking on Auto Calculate toolbar's button will scale the chart ranges to fit in the container.

Right clicking on chart area will give users JFree Chart extra capabilities.

6.3.4 Damage Curve Properties, Mappings & DBF related rules.

By clicking on edit curve, or double-clicking on Fragility Properties or Mappings, a wizard will popup which prompts user to provide curve's information.
First page contains basic Fragility Set properties, from which only ID is mandatory.

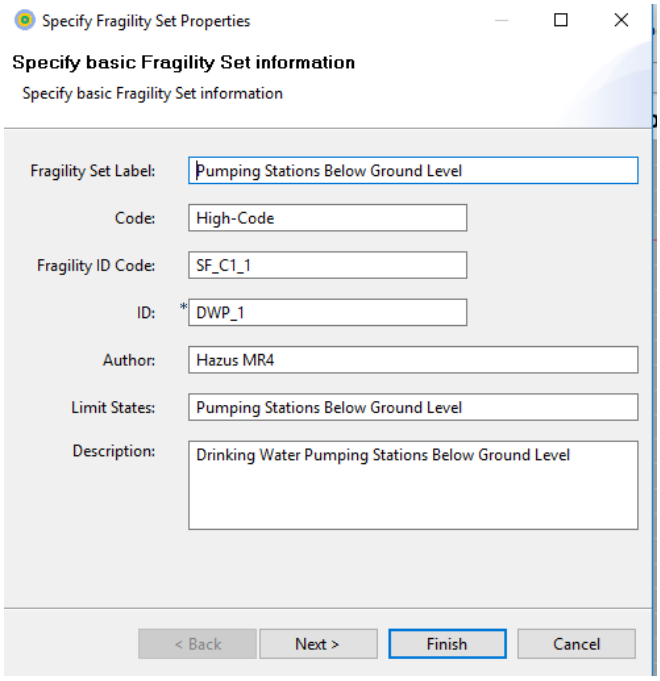

Figure 35: Damage/Fragility curve main properties wizard page

By clicking on next button user navigates to the second page containing extra fragility set properties, all of which are optional.

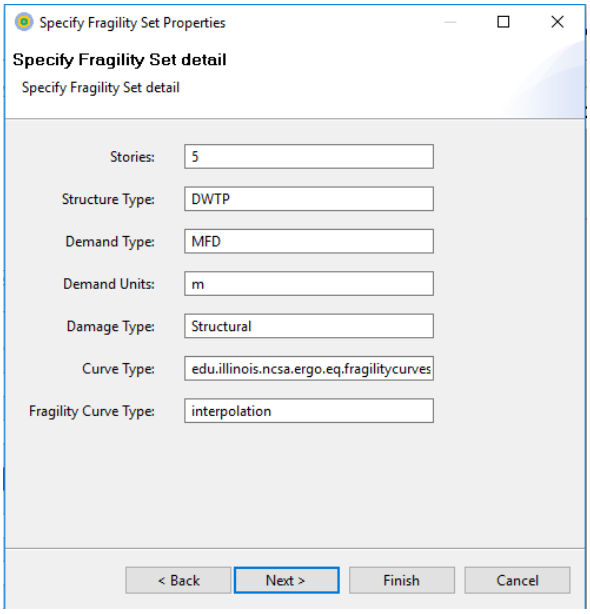

Figure 36: Damage/Fragility curve optional properties wizard page

By clicking on next button user navigates to the last page containing all damage curve's mappings. User can review the already created rules, edit or delete them. To create or edit rules a DBF file must be loaded.

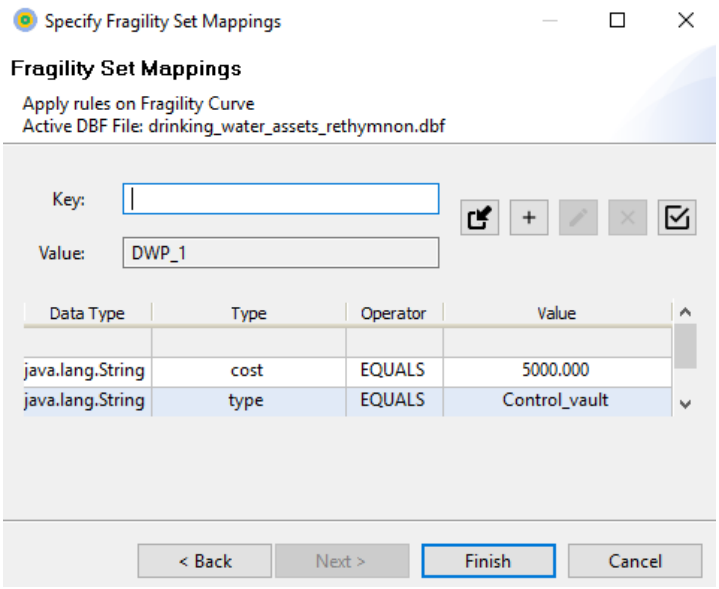

Figure 37: Curve mappings wizard page

The toolbar provides the following widget:

- Loading a DBF file
- Add a new rule
- Edit a rule
- Delete a rule
- Validate the rules

After loading a DBF file, all available rule's types and values are ingested and user can easily define rules using a set of operators. Clicking on add or edit rule button will open the following view.

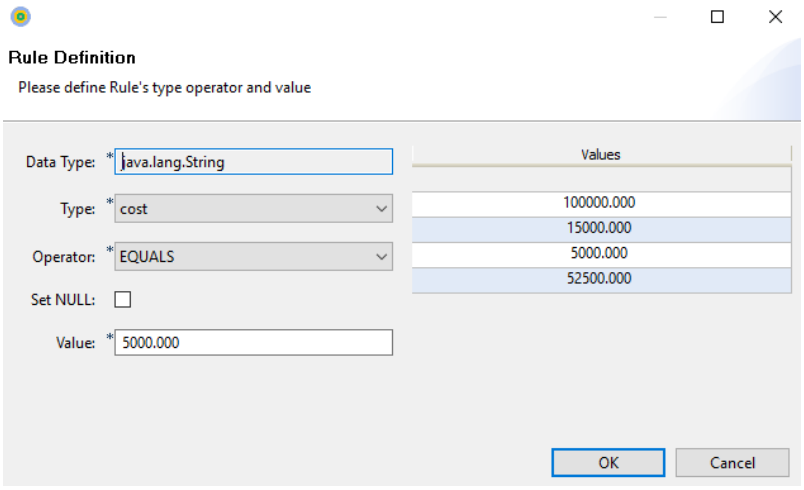

Figure 38: Mapping rule definition page

User can select the rule's type from the Type drop-down, populated with DBF's fields, then the Data Type input is auto-inserted and the distinct Values view is updated. Clicking on a value will auto-insert the corresponding value in the Value input. User must also select an Operator for the rule's evaluation. Available operators are

- EQUALS for checking for equality
- NEQUALS for checking for non equality
- GT greater than
- LT less than
- GE greater or equal
- LE less or equal
- MATCHES matches specified value string
- NMATCHES does not match specified value string

Finally user can click on the Set NULL checkbox to set rule's right Value to NULL.

6.3.5 Loading Damage Curves, Mappings & DBF files.

Loading a damage curve, mapping or DBF file can be done in two different ways. Both apply for all related file types.
First way is to use the main toolbar by clicking on "Curve Editor" menu, the following pop's up

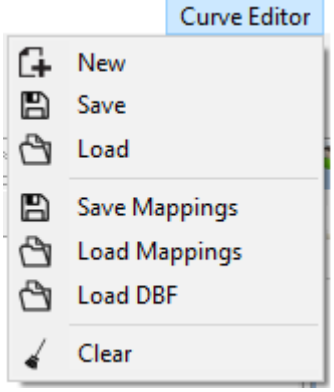

Figure 39: The Curve Editor popup menu

Options are:

- By clicking on “Load” option the standard open file wizard is shown and user selects a damage curve XML file from his file system.
- By clicking on “Load Mappings” option the standard open file wizard is shown and user selects a damage curve mapping XML file from his file system.
- By clicking on “Load DBF” option the standard open file wizard is shown and user selects a DBF file from his file system.

Second way is to right click on an already ingested dataset of the CIRP’s repository from the Dataset View. Right-clicking on a Fragility Curve file will open the following popup.

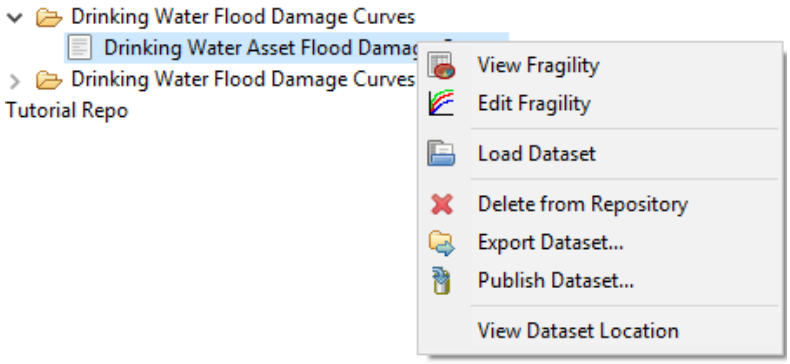

Figure 40: Edit fragility file option

Clicking on “View Fragility” option will open a Chart view rendering all damage curve’s points.
Clicking on “Edit Fragility” will load the Damage Curve in the Curve Editor.

Right-clicking on a Fragility Curve’s Mappings file will open the following popup.

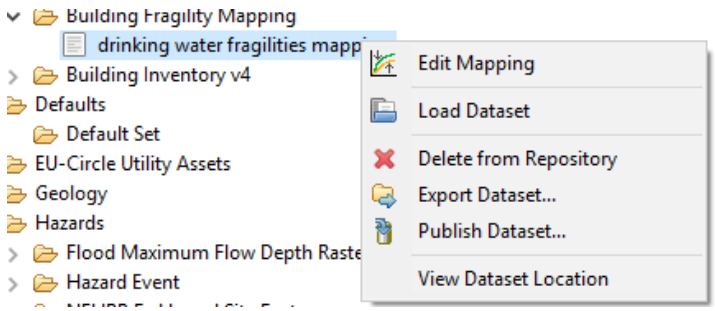

Figure 41: Edit mapping file option

Clicking on “Edit Mapping” option will load the specified damage curve’s mapping file in the Curve editor. Please mind that a damage curve must be already loaded prior to loading the mapping file.

Right-clicking on a DBF file will open the following popup.

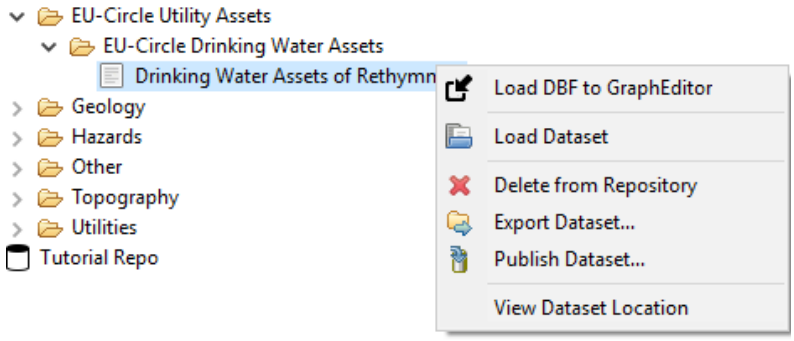

Figure 42: Load DBF file option

Clicking on "Load DBF to GraphEditor" option will load the specified DBF file in the Curve editor. Please keep in mind that a damage curve must be already loaded prior to loading the DBF file.

6.3.6 Saving Damage Curve, Mappings.

Saving a damage curve or mapping file can be done from the already presented "Actions" menu.

If the damage curve or mapping is created from the scratch or loaded from a standard XML file from the user's file system after pressing the save option the standard save file wizard is shown.

If the curve or mapping is loaded from an already ingested file then after saving the new file is auto-ingested in the repository and user has the capability of selecting to auto-load the file in all scenarios in where the original file was imported.

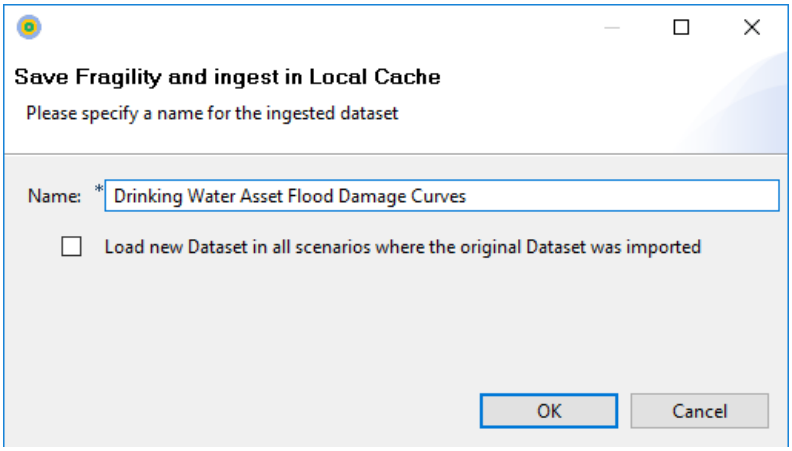

Figure 43: Saving and ingesting the curve file

6.4 The 3D Map Tools Perspective

The 3D Map Editor Perspective contains the following Views and toolbars:

- The 3D Map View
- The 3D Information Tree View
- The 3D Map Editor toolbar (in the main toolbar area)
- The Collaboration View
- The measurement and object toolbars

The following sections present the functionalities offered by each of the Views and toolbar associated actions.

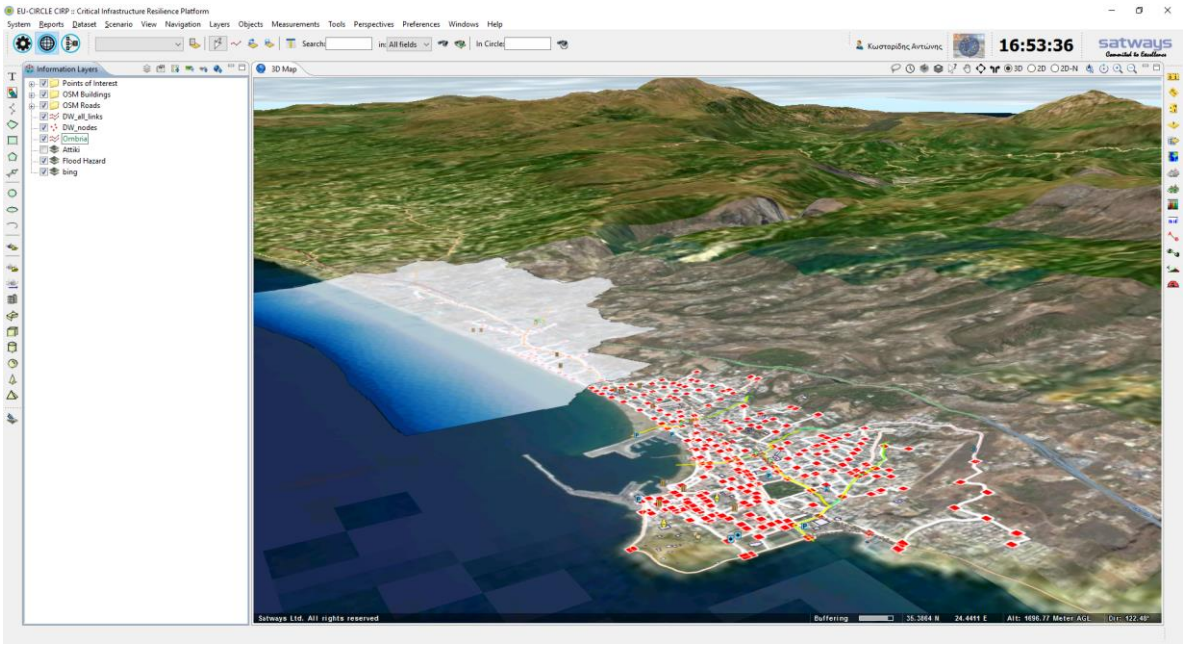

Figure 44: The 3D GIS Editor perspective

6.4.1 The 3D MapView

The 3D view is created by fusing aerial and satellite photography, terrain elevation data and other 3D and 2D information sources including geospatial dataset layers.

It provides a set of advanced tools for processing, analysis and annotation of photo-realistic, interactive and three-dimensional landscapes. The user can import vector layers, images and elevation data from a variety of sources, add information on various landmarks such as image or text labels, buildings, cloud-point models, two-dimensional and three-dimensional entities and default routes from GIS files and databases.
A basic difference from the 2D Map is the fact that feature and imagery layers can be streamed from the 3D GIS servers and that the underlying map engine (TerraExplorer [13]) is using Graphics Card acceleration (DirectX) providing maximum performance. In addition feature layers (e.g. shapefiles) can also be streamed from the local cache repository (loading only features of the 3D viewport).

The 3D GIS module can process different coordinate systems as well as a wide variety of vector formats. This makes it easy for any user to display different kind of data from disparate sources. There are various

tools available within the environment such as horizontal and vertical measuring, 2D/3D object creation, line of sight analysis etc.

6.4.2 The 3D Information Tree View

The 3D Information Tree View provides the tools that control the appearance of information in the 3D Map View. The information elements can be arranged in groups, according to function, type of information, or location. The appearance and styling of each object or layer can be changed via the Properties dialog (available as option from the right click popop menu). The View toolbar provides the following capabilities:

- Load a Feature Layer
- Load an Imagery Layer
- Load an Elevation layer
- Load a KML file

6.4.3 Editing Feature Layers

CIRP users will frequently want to assess the climate risk and related hazards to the critical infrastructure assets and networks. In this sense and in order to assess the risk for different asset and network configurations, the Editing Feature toolbar provides a set of tools for editing (or creating new) vector datasets (e.g. shapefiles) that reside in the local cache.

The feature editing toolbar is enabled when a shapefile layer is selected from the 3D Information tree View. The toolbar provides the following widgets:

- A combo box for feature layer selection
- A properties button 
- The select feature toggle button 
- The add feature button (icons depending on the type of selected dataset e.g. point, polyline or polygon)
- The refresh layer button 
- The save layer button 

In order to edit an existing dataset feature the user must click on the “select feature” button and select via mouse left click a feature on the 3D map. Upon click, the Feature Attributes window appears that contains a toolbar (similar to the editing toolbar), the geometry details and the attribute values of the selected feature. The position and layer attribute tables are editable (inline). If the user changes any of the values, then the layer becomes “dirty” and is marked with an asterisk in the 3D Information tree. By pressing the Save Layer button, the change is persisted in the original layer dataset.

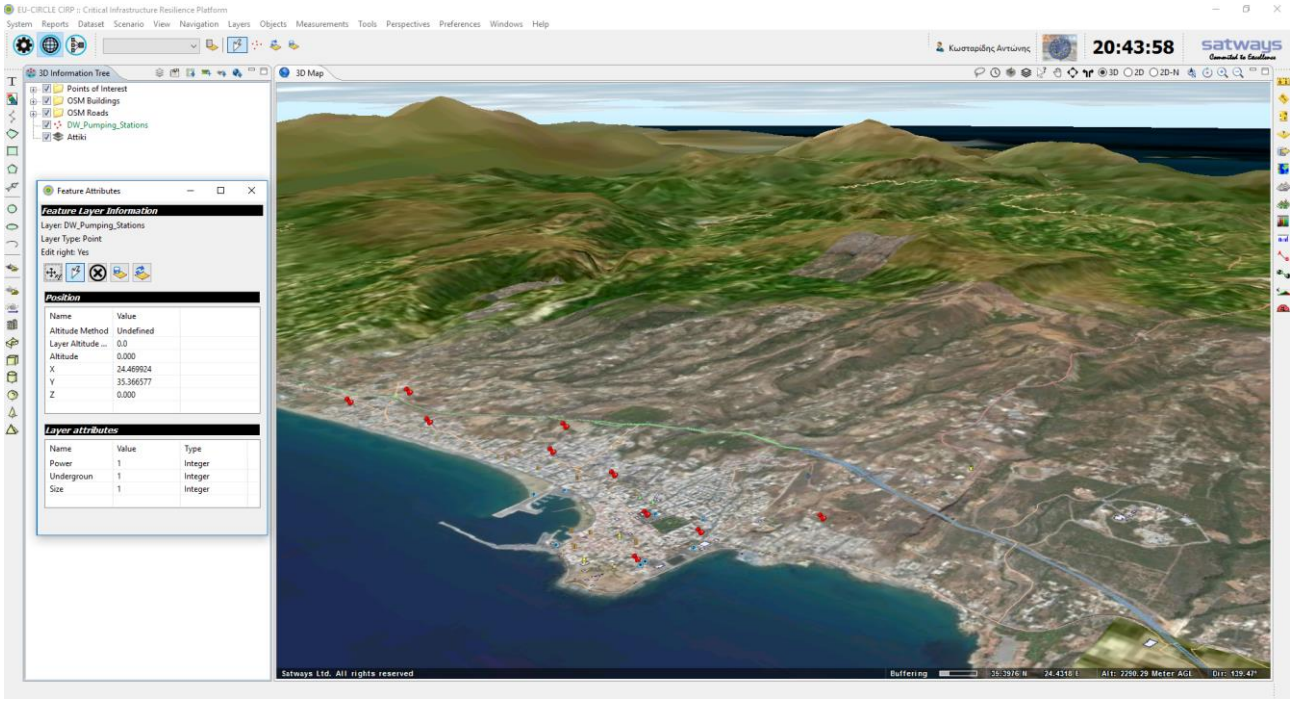

Figure 45: Editing a feature dataset

6.4.4 The Collaboration View

The Collaboration View connects CIRP users on one collaborative sessions. In these sessions, users can chat with other users, annotate the 3D terrain with text labels and freehand drawing, point using a virtual cursor and synchronize their flight. One user serves as the manager of the session, while the rest connect to the session as clients.

To join or open a Collaboration session: On the Tools menu, click Collaboration. The Collaboration View opens.

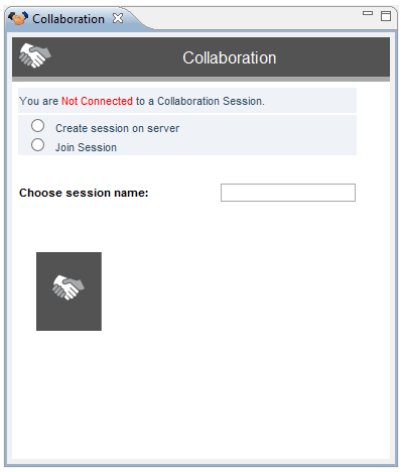

Figure 46: The Collaboration View initial contents

The Manager of the session is the only participant that has permission to give the leadership of the session to another user. The Leader of the session is the user that sets the location of the camera by navigating freely in the 3D Map and all other users can attach to this point of view. The Participants list displays all

connected users to the session. If the session manager wants to appoint another participant leader, select the required name in the list, and click Set as Leader.

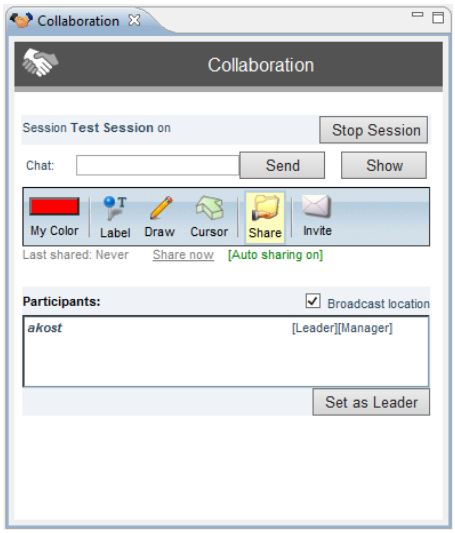

Figure 47: The collaboration session toolbox

To type a chat message:

- In the Collaboration dialog box, in the Chat field, type the message text.
- Click Send to send this chat message to all other participants in the session. The text appears in the Chat box preceded by the name of the sender.
- If the message box is not displayed, click the Show button to display it.

User may use a virtual cursor to point to an area on the 3D Window. The cursor, which is available in different colors, is visible to all the participants in the session.
To use the virtual cursor:

- In the Collaboration tool box, click the Virtual Cursor button.
- Click the Color button to set the virtual cursor's color and select a color from the color palette.
- Click and hold the mouse button to display the Virtual Cursor.
- Right-click to finish the operation.

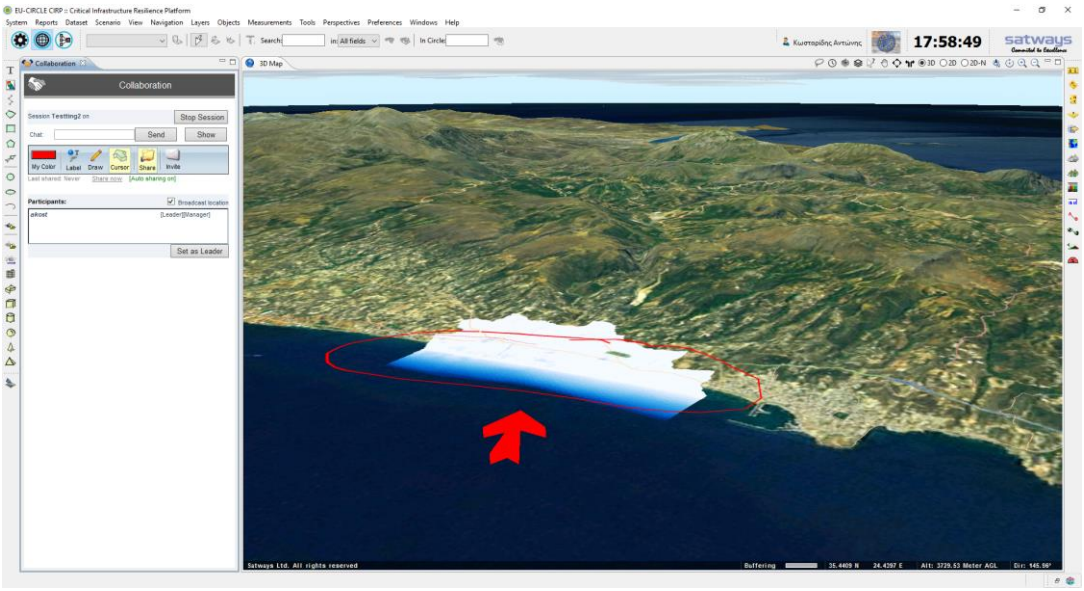

Figure 48: Collaboration session user defined map annotation symbols

User can draw freehand in the 3D Window. User drawings are visible to all participants in the session.

To draw freehand:

- In the Collaboration tool box, click the Draw button.
- Click the Color button to set the drawing tool's color and select a color from the color palette.
- Click and hold the mouse button to draw.
- Right-click to finish the operation.

To add a text label:

- In the Collaboration tool box, click the Add Text Label button. The Text Label field is displayed in the lower half of the dialog box.
- In the Text Label field, type a text string.
- Click the My Color button to set the color of the text, and select a color from the color palette.
- In the 3D Window, click the terrain location where you want to insert the text label. The label is displayed in the 3D Window at the same location, for all other participants of the session.

6.5 The Grid Data Perspective

The Grid Data Perspective provides Views for loading and visualization of grid datasets of various formats. Currently the NetCDF and Grib file formats are supported. NetCDF [15] is the commonly self-describing, machine-independent data format for large-sized climate data (as those from ESGF, ECMWF and CORDEX and output from RCM/weather prediction models).

A CIRP user is able to load a NetCDF/Grib file from the local file system or via the OpeNDAP [15] protocol (e.g. from a THREDDS [16] Server) and plot selectable variables/grids it into the 3D Map in an animated fashion.

To access a NetCDF/Grib dataset select "Open Grid Dataset" from the "Climate Data" menu. The Grid Details View will depict the information contained in the file and more specifically the variables and dimensions (e.g. coordinates, time). By selecting a time range the pressing the "Load" button.

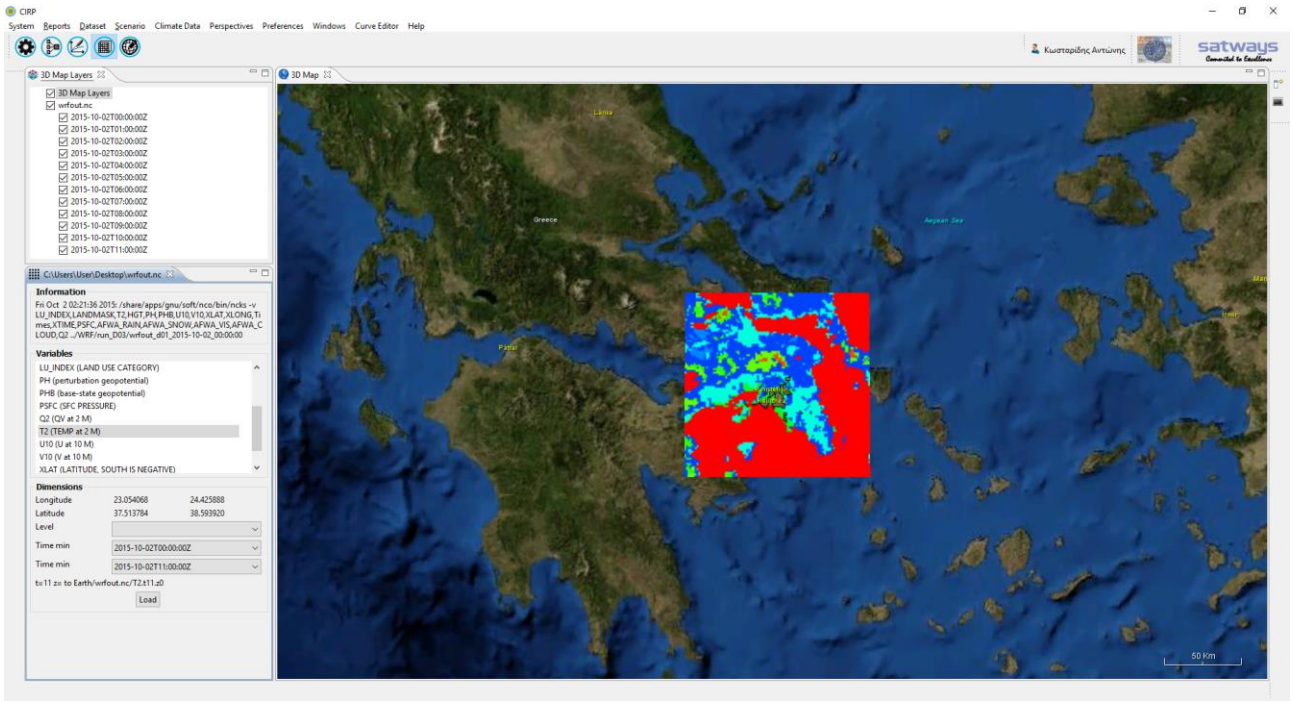

Figure 49: Time based animated view of NetCDF data

6.6 The Administrator Perspective

The administrator view provides the CIRP administration tools for User, Role and Access Rights management. Users are organized into organizations. Access in the administrator perspective is provided only to the system administrators.

It consists of three main Views:

- System administration View
- Users View

6.6.1 The System Administration View

Using the options under the User and Roles Management section, the administrator is able to create edit and delete users and user roles.

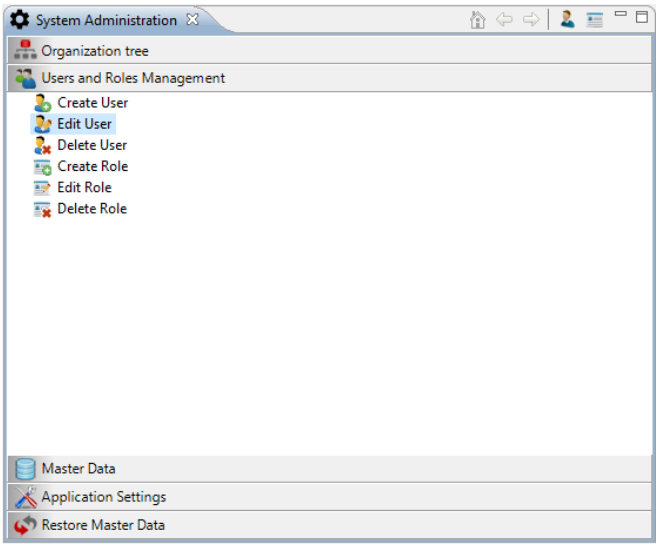

Figure 50: Managing users and roles

For a new user, the administrator must fill in the following information:

- Name
- Surname
- Username:
- Password
- Department
- Etc.

The “Create” button creates the new user. All the compulsory fields are marked with a special icon to help the administrator recognize what information is missing in order to be allowed to continue to the next page of the wizard.

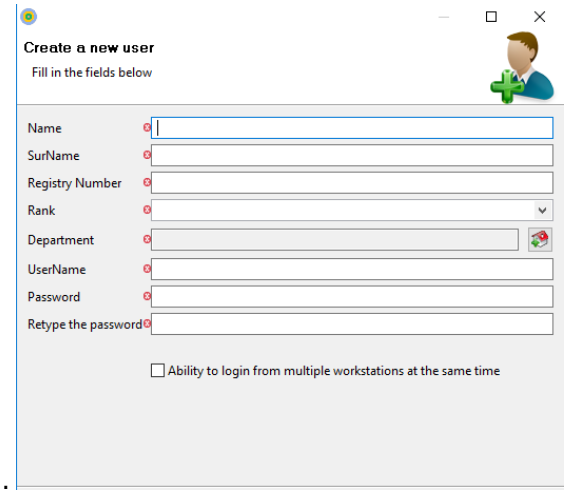

Figure 51: Create New User

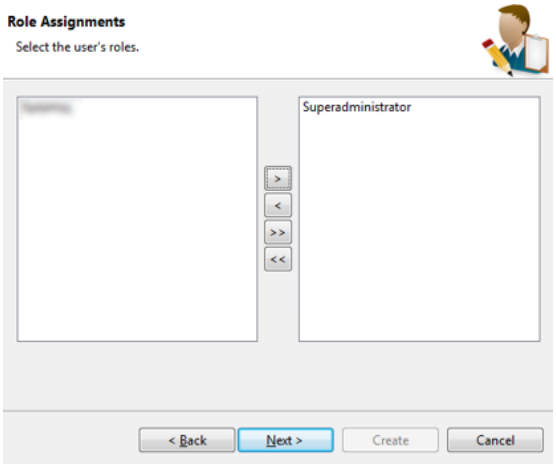

Figure 52: Assign User Roles

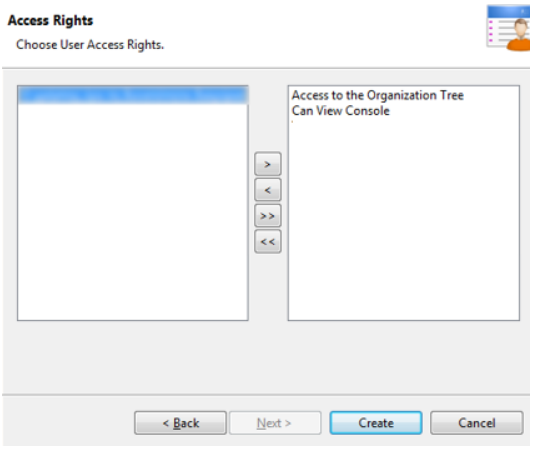

Figure 53: Assign Access Rights

Regarding User Roles the system gives the ability to manage any number of Roles by providing access to the system Perspective, Views and toolbars. A user can be assigned more than one Role.

A user who has the predefined role of Administrator can perform the following functions:

- Create or Delete an Organization's Departments
- Create or Delete Users
- Create or Delete Roles
- Parametrize the System (Application Settings)

The Administrator can perform organizational management and tune the system according to the requirements of the users and the organization. Each of these functions listed above have been discussed previously.

7 Conclusions

The document accompanies the Integrated CIRP environment final software release and describes the architecture and functionalities from the end user perspective. CIRP has been developed as a collaborative modelling environment where new scenarios with risk assessment and geospatial analyses are chained in workflow and where multiple scientific disciplines can work together to understand interdependencies, validate results, and present findings in a unified manner. CIRP's purpose it to provide an efficient, pragmatic, and effective solution that integrates existing modelling tools and data into a holistic resilience model in a standardised fashion.

CIRP offers an analysis toolbox environment for what-if scenario analyses with the selection of model chains, climate data, and CI inventories in order to calculate damages and assess the resulting risk. The CIRP platform provides a user friendly environment to enable the intuitive design and analysis of modelling scenarios created for any combination of climate hazard and CI assets. In this way, users are able to understand the impact of various adaptation strategies or to quantify the potential impact of a catastrophic event on society.

The CIRP extensible modular architecture can be shared across multiple communities to enable CI policy maker, owners, and scientists to leverage existing software analysis types and algorithms, inventory types, and fragilities while not binding the underlying platform to a particular scientific domain. This pluggable, open architecture is what will allow CIRP to support a wide variety of domain specific functionality isolated in plugins; to repackage different functionalities as a starting point for new applications, and to be extended to add new analytical capabilities in the future.

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