

## **ISESS 2017**

**An Integrated Decision-Support Information System on the  
Impact of Extreme Natural Hazards on Critical Infrastructure**

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**University of Southampton IT Innovation Centre, UK.**



ISESS 2017 Conference, 10<sup>th</sup> – 12<sup>th</sup> May 2017, Zadar, Croatia.

# **IDST Design, Architecture**

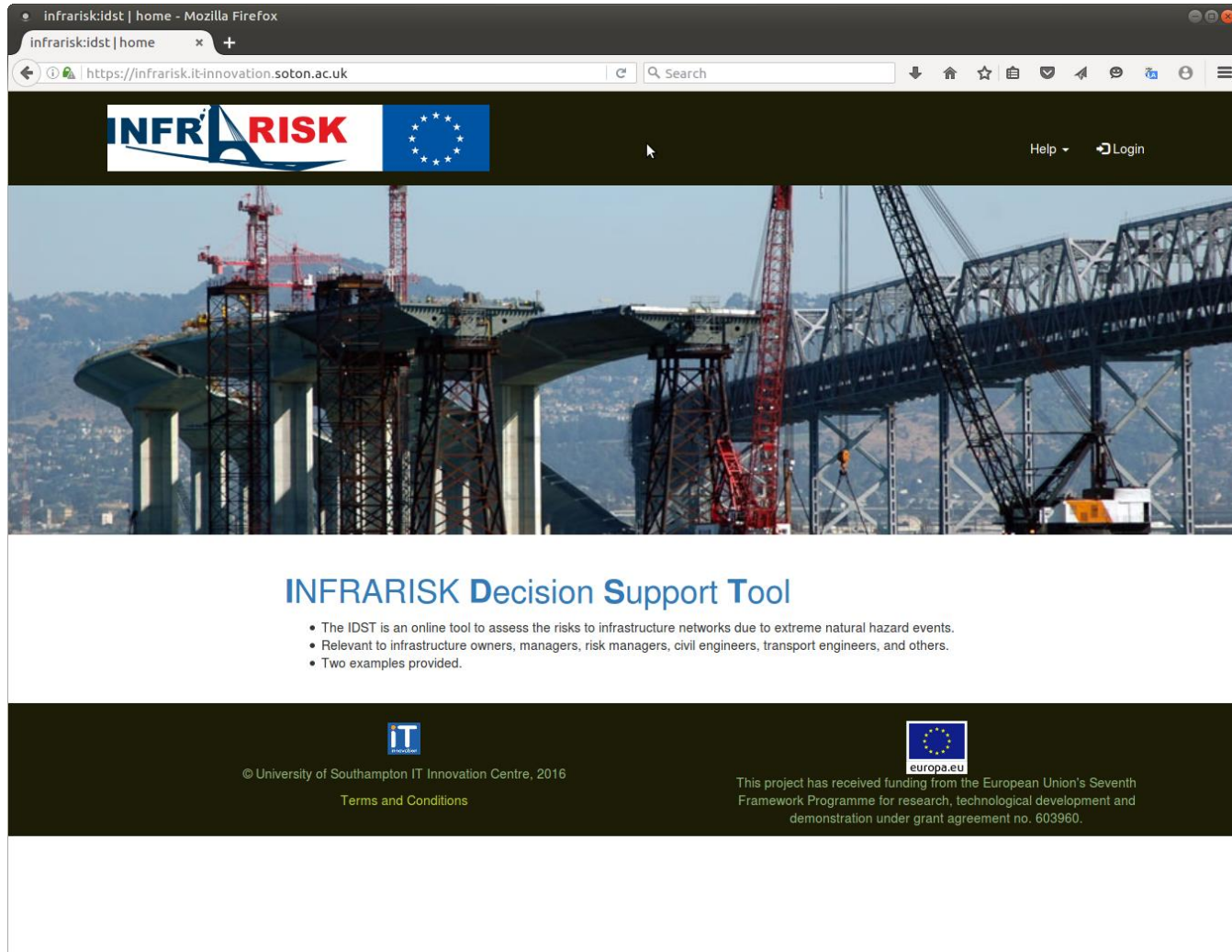
## **IDST Software Design**

- Portal build using Django Framework
- Dynamic content using JavaScript (jQuery, Bootstrap)
- PostgreSQL (PostGIS modules)
- Mapping using OpenStreetMap data
- 

## **IDST services**

- Current releases:  
<http://infrarisk.it-innovation.soton.ac.uk>

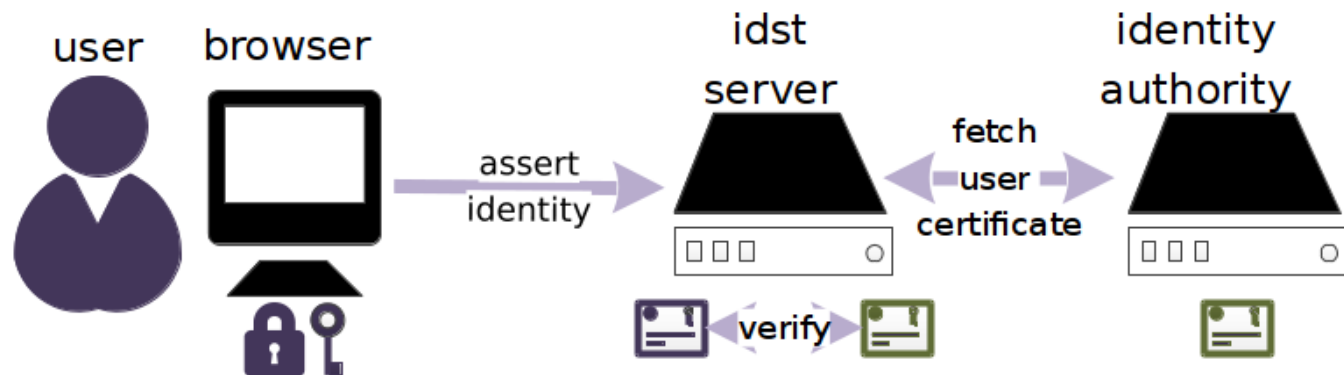
# The IDST Portal Page



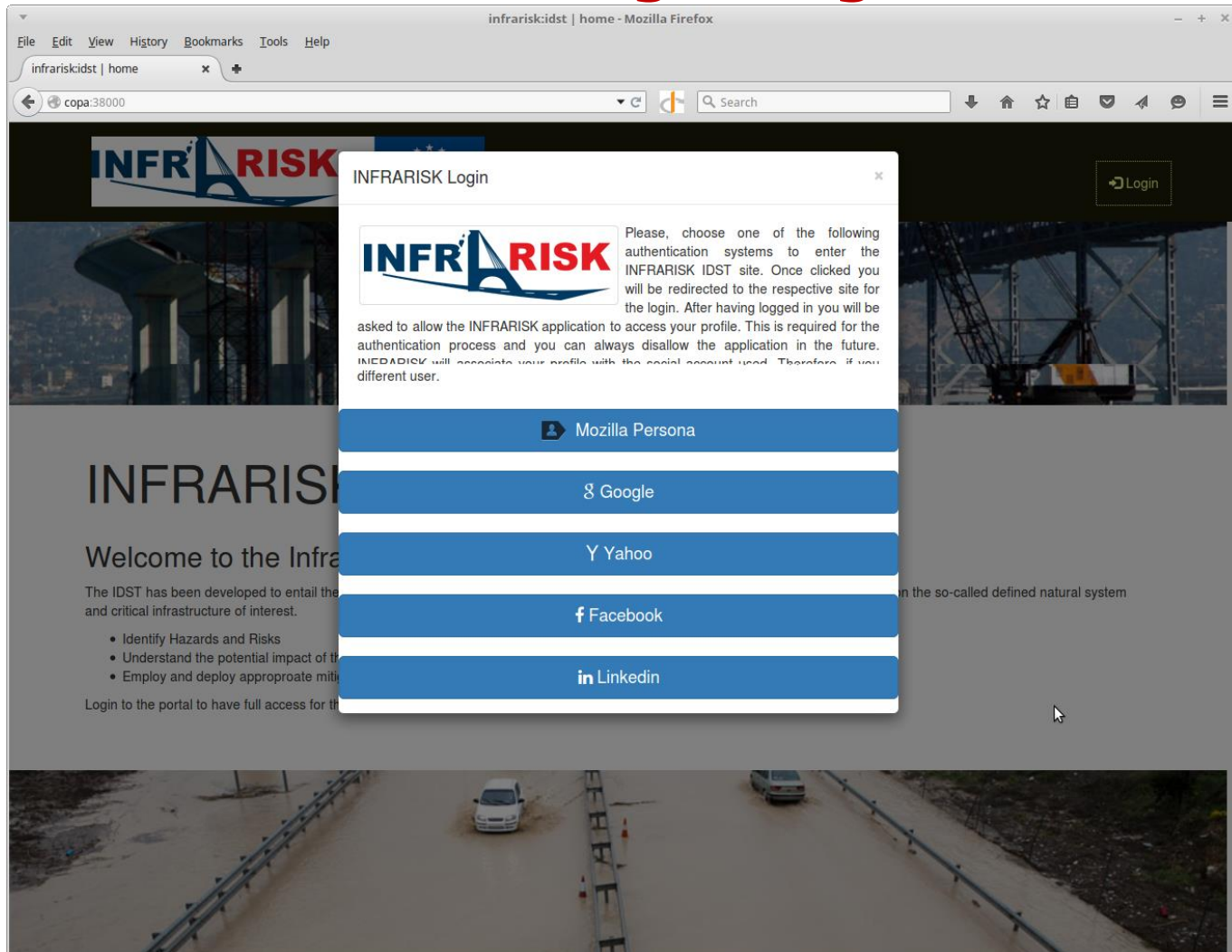
# IDST Authentication System

Authentication in IDST is based on

- Local user account authentication (exclusive for admin users)
- Third party authentication services (for normal users), e.g.
  - Mozilla
  - Google
  - Yahoo
  - LinkedIn

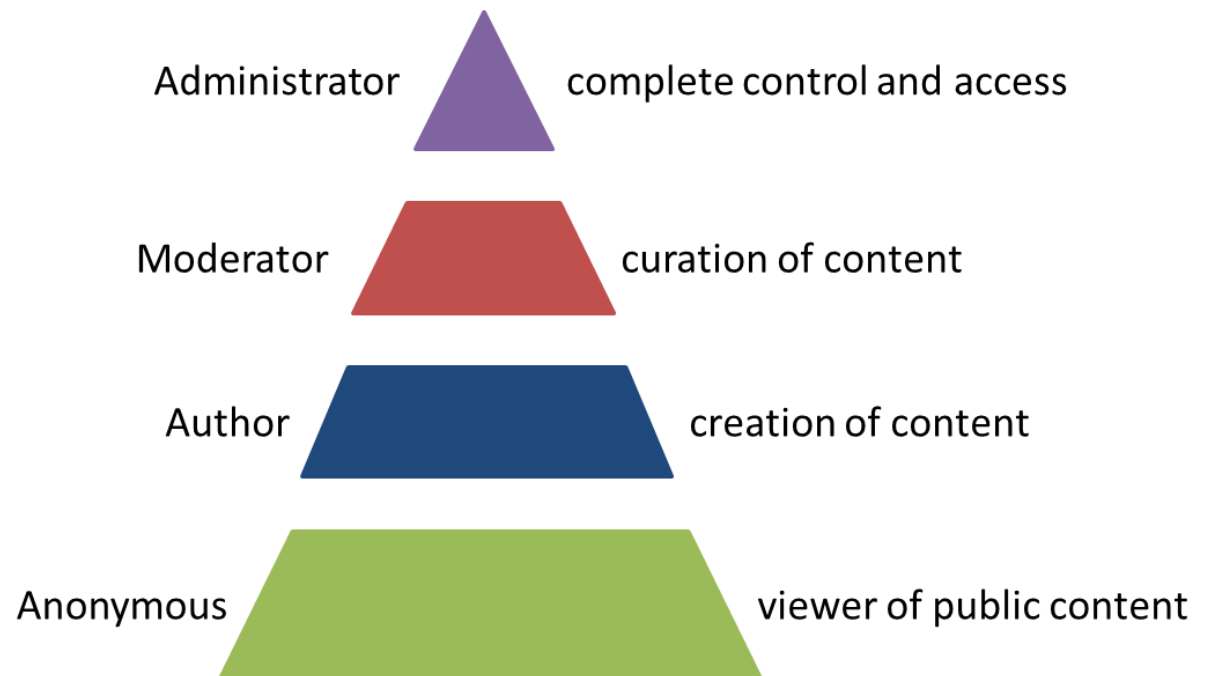


# IDST Login Page

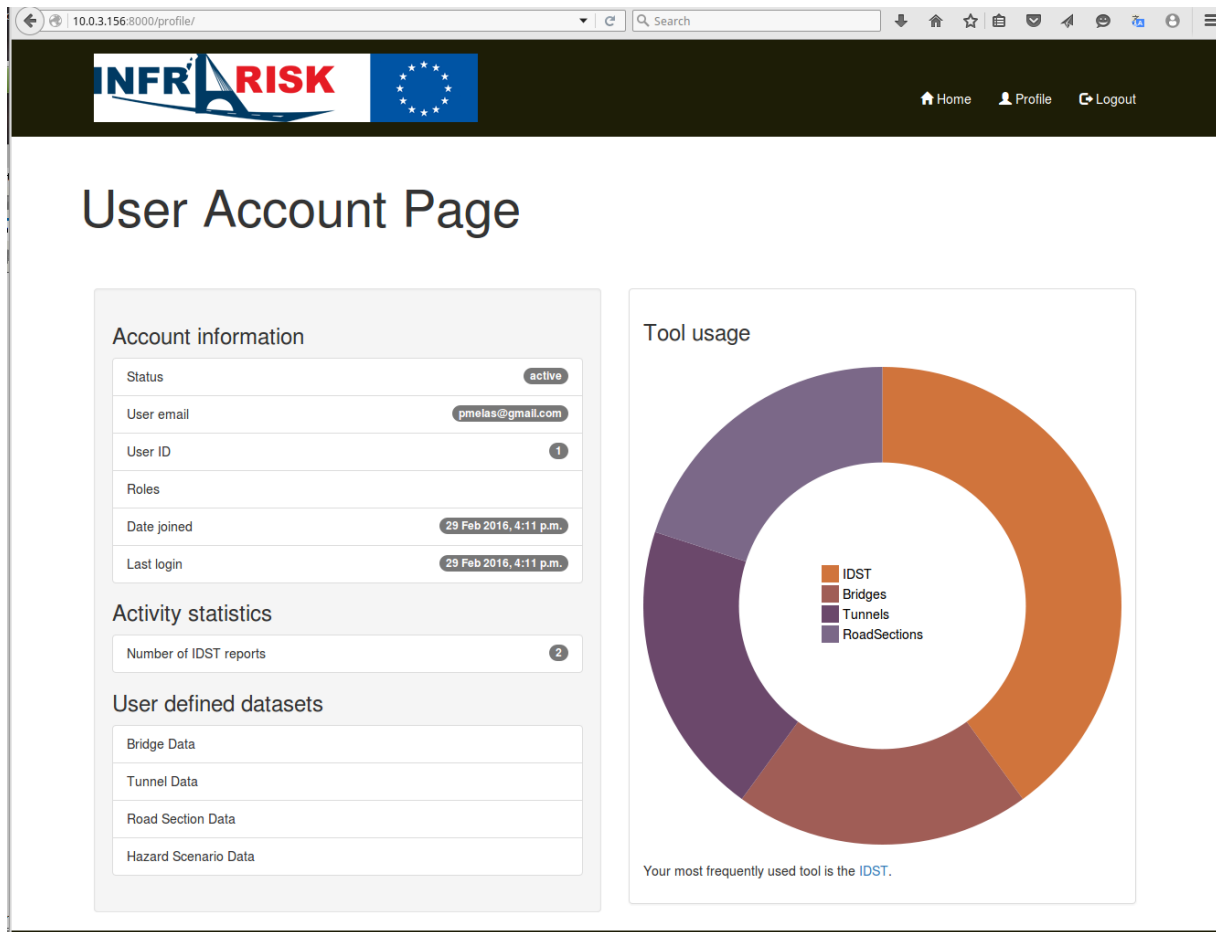


## Authorisation and User Roles in IDSP

Authorisation in IDST is based on Roles  
Role assigns what rights a user has  
A user can have multiple roles



# User profile, status in IDST



The diagram illustrates the database schema for IDSTPWE, showing the relationships between various tables. The tables are organized into a hierarchical structure, with some tables acting as central hubs for multiple other tables.

**Tables and their attributes:**

- idstpwe\_infrastructureobject**: **id** (INTEGER)
- idstpwe\_infrastructurecondition**: **code** (CHARACTER VARYING(32))
- idstpwe\_infrastructureevent**: **id** (INTEGER)
- idstpwe\_infrastructure**: **code** (CHARACTER VARYING(32))
- idstpwe\_social**: **code** (CHARACTER VARYING(32))
- idstpwe\_networkevent**: **id** (INTEGER)
- idstpwe\_networkstate**: **code** (CHARACTER VARYING(32))
- idstpwe\_network**: **code** (CHARACTER VARYING(32))
- idstpwe\_transition**: **code** (CHARACTER VARYING(32))
- idstpwe\_idststate**: **shortname** (CHARACTER VARYING(32))
- idstpwe\_casestudy**: **id** (INTEGER)
- idstpwe\_systemelements**: **id** (INTEGER)
- idstpwe\_systemboundaries**: **id** (INTEGER)
- auth\_user**: **id** (INTEGER)
- idstpwe\_sourceintensity**: **id** (INTEGER)
- idstpwe\_sourceevent**: **id** (INTEGER)
- idstpwe\_sourcetype**: **code** (CHARACTER VARYING(32))
- idstpwe\_hazardintensity**: **id** (INTEGER)
- idstpwe\_hazardevent**: **id** (INTEGER)
- idstpwe\_hazardtype**: **code** (CHARACTER VARYING(32))
- idstpwe\_idstconsequence**: **shortname** (CHARACTER VARYING(32))
- idstpwe\_idstprobability**: **shortname** (CHARACTER VARYING(32))
- idstpwe\_idstrisk**: **shortname** (CHARACTER VARYING(32))
- idstpwe\_temporal**: **id** (INTEGER)
- idstpwe\_spatial**: **id** (INTEGER)

**Relationships:**

- idstpwe\_infrastructureobject** is linked to **idstpwe\_infrastructurecondition** and **idstpwe\_infrastructureevent**.
- idstpwe\_infrastructureevent** is linked to **idstpwe\_infrastructure**.
- idstpwe\_infrastructure** is linked to **idstpwe\_networkstate** and **idstpwe\_network**.
- idstpwe\_networkstate** is linked to **idstpwe\_network**.
- idstpwe\_network** is linked to **idstpwe\_idststate**.
- idstpwe\_idststate** is linked to **idstpwe\_casestudy** and **idstpwe\_systemelements**.
- idstpwe\_casestudy** is linked to **idstpwe\_systemboundaries** and **auth\_user**.
- idstpwe\_systemboundaries** is linked to **auth\_user**.
- idstpwe\_sourceintensity** is linked to **idstpwe\_sourceevent** and **idstpwe\_hazardevent**.
- idstpwe\_sourceevent** is linked to **idstpwe\_sourcetype**.
- idstpwe\_hazardevent** is linked to **idstpwe\_hazardtype**.
- idstpwe\_idstconsequence**, **idstpwe\_idstprobability**, and **idstpwe\_idstrisk** are linked to **idstpwe\_idststate**.
- idstpwe\_temporal** and **idstpwe\_spatial** are linked to **idstpwe\_hazardevent**.




## **IDST modelled data**

- **OSM data sources**
  - Bridge
  - Road
  - Tunnel
- **Hazard data (supported by Ground Motion Models)**
  - PGA
- **Structural data**
  - Bridges
  - Tunnels
  - Road sections


# OSM data models, DB schemas in IDST


osm_bridge	
 <b>id</b>	INTEGER
<b>osm_id</b>	CHARACTER VARYING(11)
<b>name</b>	CHARACTER VARYING(48)
<b>ref</b>	CHARACTER VARYING(16)
<b>type</b>	CHARACTER VARYING(16)
<b>oneway</b>	INTEGER
<b>bridge</b>	INTEGER
<b>tunnel</b>	INTEGER
<b>maxspeed</b>	INTEGER
<b>length</b>	INTEGER
<b>geom</b>	USER-DEFINED


osm_road	
 <b>id</b>	INTEGER
<b>osm_id</b>	CHARACTER VARYING(11)
<b>name</b>	CHARACTER VARYING(48)
<b>ref</b>	CHARACTER VARYING(16)
<b>type</b>	CHARACTER VARYING(16)
<b>oneway</b>	INTEGER
<b>bridge</b>	INTEGER
<b>tunnel</b>	INTEGER
<b>maxspeed</b>	INTEGER
<b>geom</b>	USER-DEFINED


osm_tunnel	
 <b>id</b>	INTEGER
<b>osm_id</b>	CHARACTER VARYING(11)
<b>name</b>	CHARACTER VARYING(48)
<b>ref</b>	CHARACTER VARYING(16)
<b>type</b>	CHARACTER VARYING(16)
<b>oneway</b>	INTEGER
<b>bridge</b>	INTEGER
<b>tunnel</b>	INTEGER
<b>maxspeed</b>	INTEGER
<b>geom</b>	USER-DEFINED

osm_tentroad	
 <b>id</b>	INTEGER
<b>osm_id</b>	CHARACTER VARYING(11)
<b>name</b>	CHARACTER VARYING(48)
<b>ref</b>	CHARACTER VARYING(16)
<b>type</b>	CHARACTER VARYING(16)
<b>oneway</b>	INTEGER
<b>bridge</b>	INTEGER
<b>tunnel</b>	INTEGER
<b>maxspeed</b>	INTEGER
<b>geom</b>	USER-DEFINED

osm_natural	
 <b>id</b>	INTEGER
<b>osm_id</b>	CHARACTER VARYING(11)
<b>name</b>	CHARACTER VARYING(48)
<b>type</b>	CHARACTER VARYING(16)
<b>geom</b>	USER-DEFINED

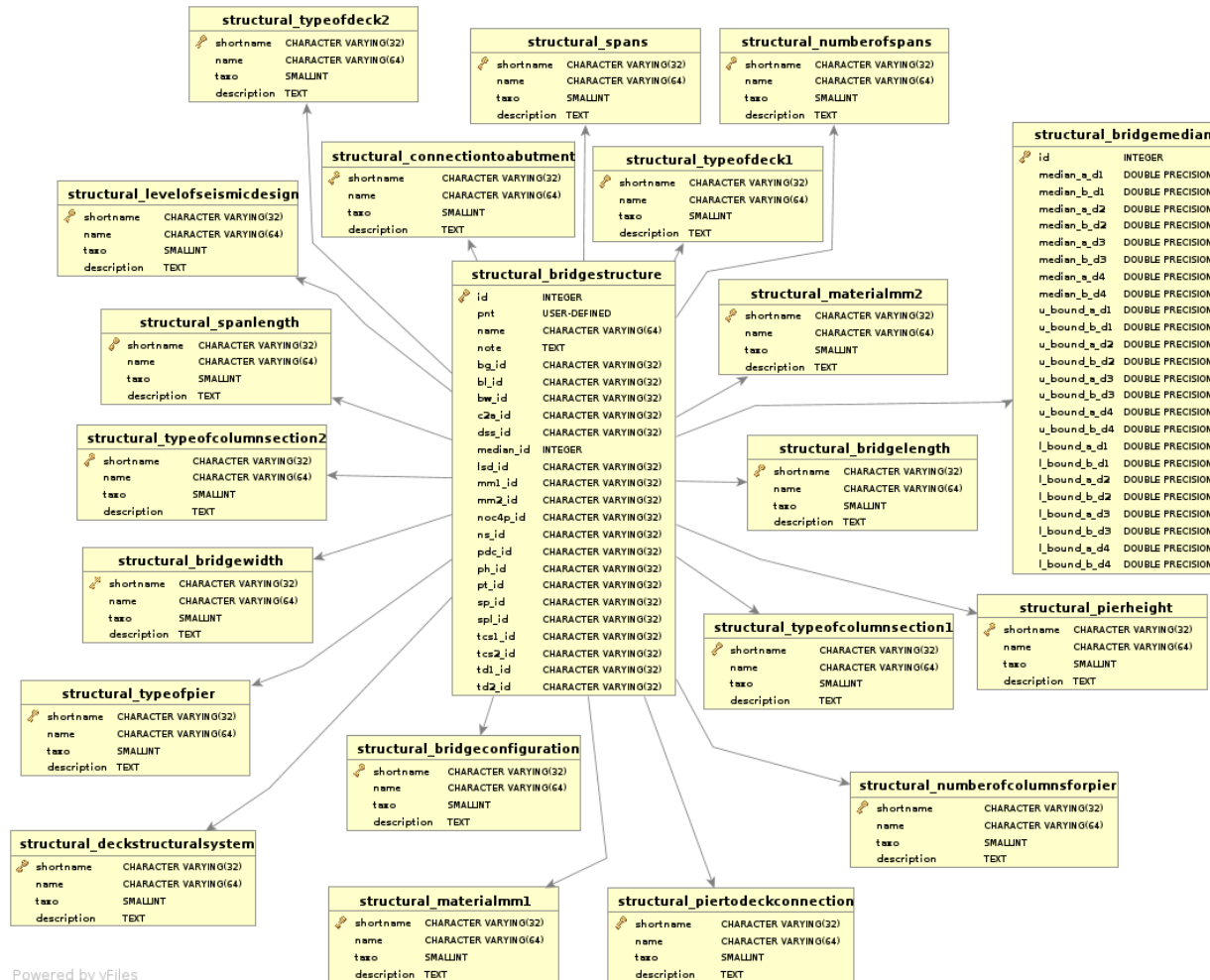
osm_railway	
 <b>id</b>	INTEGER
<b>osm_id</b>	CHARACTER VARYING(11)
<b>name</b>	CHARACTER VARYING(48)
<b>type</b>	CHARACTER VARYING(16)
<b>geom</b>	USER-DEFINED

osm_landuse	
 <b>id</b>	INTEGER
<b>osm_id</b>	CHARACTER VARYING(11)
<b>name</b>	CHARACTER VARYING(48)
<b>type</b>	CHARACTER VARYING(16)
<b>geom</b>	USER-DEFINED

osm_building	
 <b>id</b>	INTEGER
<b>osm_id</b>	CHARACTER VARYING(11)
<b>name</b>	CHARACTER VARYING(48)
<b>type</b>	CHARACTER VARYING(16)
<b>geom</b>	USER-DEFINED

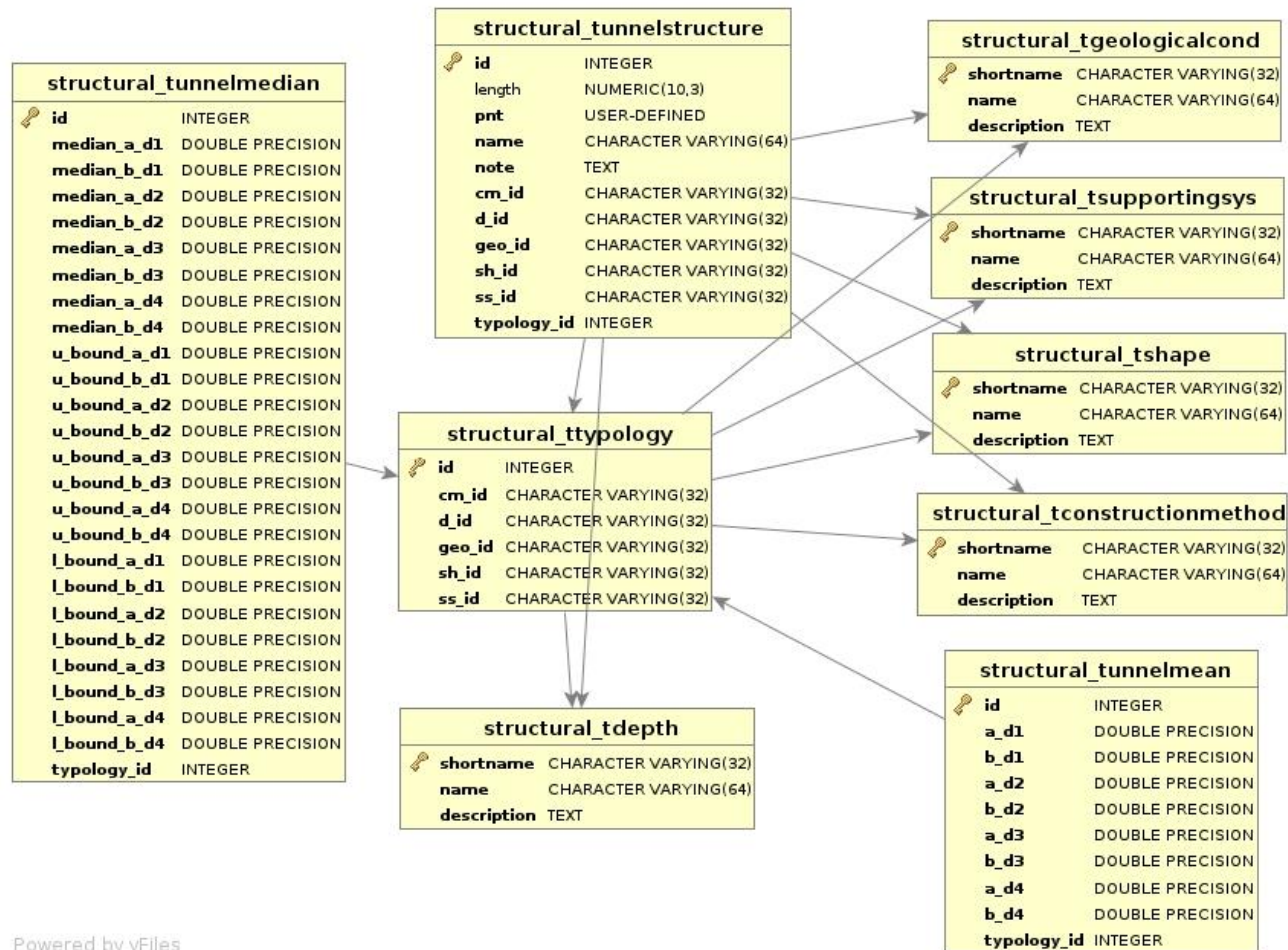
Powered by yFiles

# The IDST Bridge structural model



Powered by yFiles

# The IDST Tunnel structural model



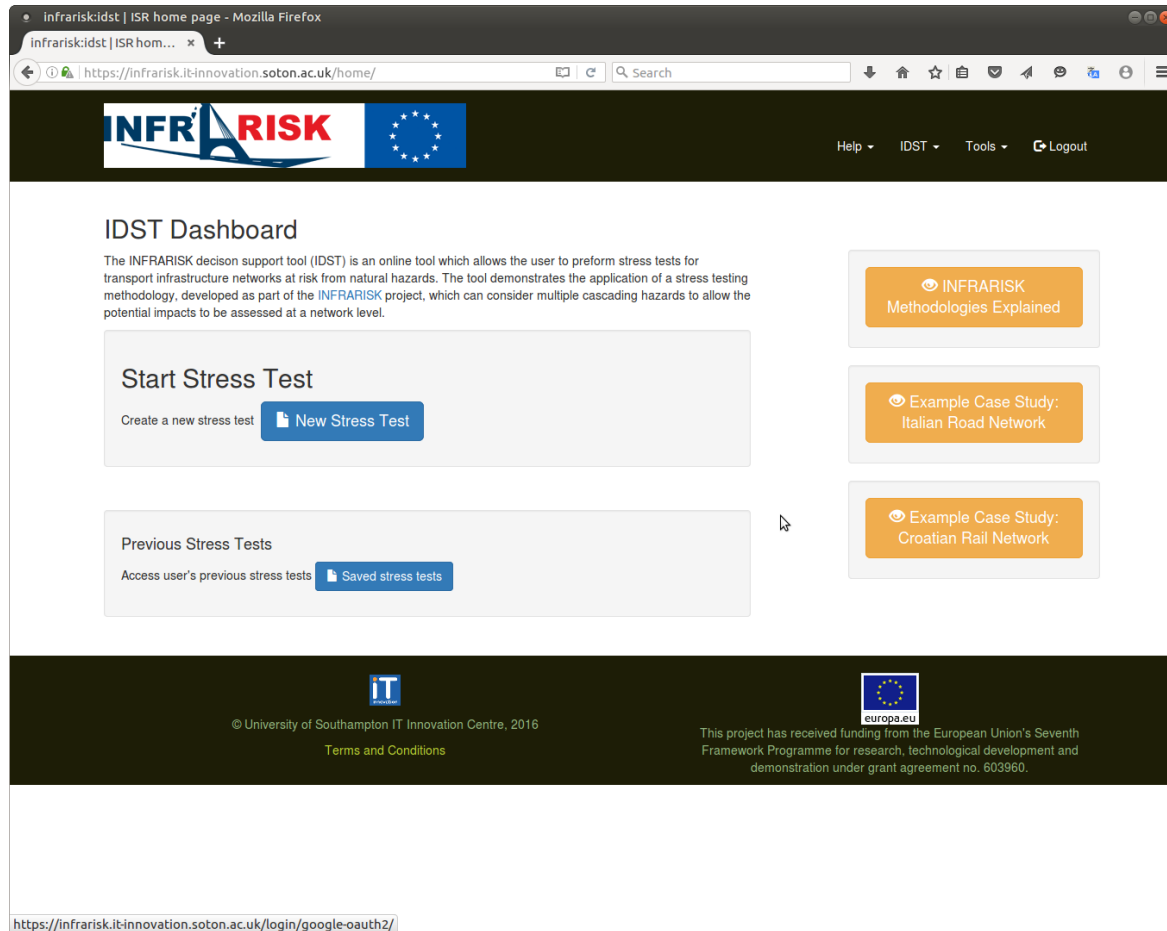
Powered by yFiles

## The IDST Case Study

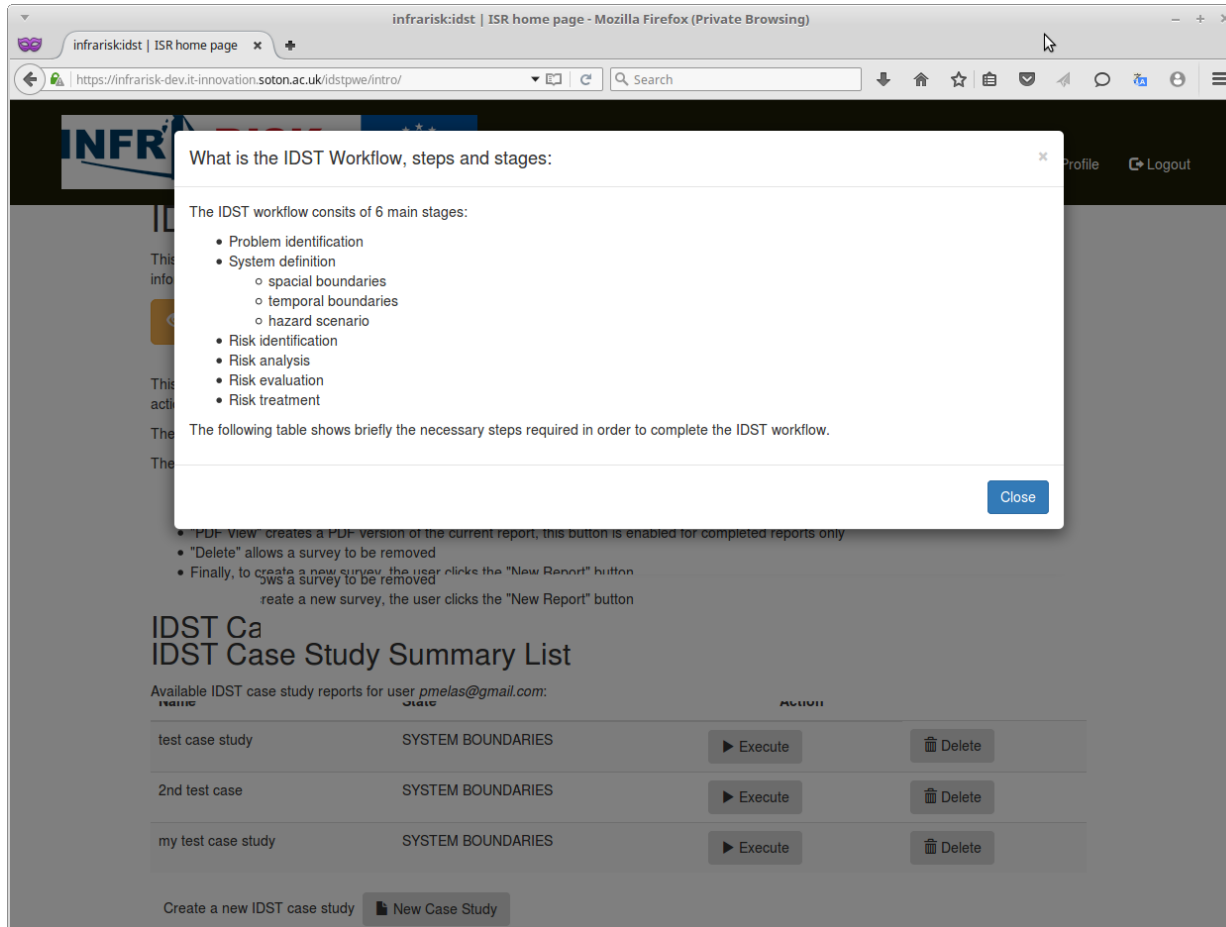
### IDST Terminology:

- An IDST Process Workflow Engine run is a Case Study or scenario
- An IDST case study stores all necessary information to run a workflow.
- Users can create and manage multiple Case Studies, i.e.
  - Create
  - Run
  - Edit
  - Delete

# IDST case study dashboard

A screenshot of a web browser displaying the INFRARISK IDST Dashboard. The browser's address bar shows the URL "https://infrarisk.it-innovation.soton.ac.uk/home/". The dashboard has a dark header with the INFRARISK logo and the European Union flag on the left, and navigation links "Help", "IDST", "Tools", and "Logout" on the right. The main content area is titled "IDST Dashboard" and includes a descriptive paragraph about the tool. Below this, there are three main sections: "Start Stress Test" with a "New Stress Test" button, "Previous Stress Tests" with a "Saved stress tests" button, and a sidebar on the right with three orange buttons: "INFRARISK Methodologies Explained", "Example Case Study: Italian Road Network", and "Example Case Study: Croatian Rail Network". The footer contains the University of Southampton IT Innovation Centre logo and copyright information, the European Union flag and funding information, and a Google OAuth2 login link.

# IDST on-line help page



infrariskidst | ISR home page - Mozilla Firefox (Private Browsing)

https://infrarisk-dev.it-innovation.soton.ac.uk/idstpwe/intro/

What is the IDST Workflow, steps and stages:

The IDST workflow consists of 6 main stages:

- Problem identification
- System definition
  - spacial boundaries
  - temporal boundaries
  - hazard scenario
- Risk identification
- Risk analysis
- Risk evaluation
- Risk treatment

The following table shows briefly the necessary steps required in order to complete the IDST workflow.

Close

PDF View: creates a PDF version of the current report, this button is enabled for completed reports only

"Delete" allows a survey to be removed

Finally, to create a new survey, the user clicks the "New Report" button

create a new survey, the user clicks the "New Report" button

## IDST Case Study Summary List

Available IDST case study reports for user [pmelas@gmail.com](mailto:pmelas@gmail.com):

name	state	action
test case study	SYSTEM BOUNDARIES	Execute Delete
2nd test case	SYSTEM BOUNDARIES	Execute Delete
my test case study	SYSTEM BOUNDARIES	Execute Delete

Create a new IDST case study [New Case Study](#)



# Process Workflow Engine Implementation

- Governed by Overarching Risk Management Framework (ORMF), implemented as a Case Study in IDST
  - Define a new Case Study, i.e. name, description
  - Define system boundaries
  - Define the hazard scenario, i.e. hazard source, assign hazard events
  - Configure hazard event assigned models
  - Define the network scenario, i.e. network type, assign network elements and their fragility curves models
  - Define network characteristics, (datasets)
  - Derive damage states for each element using their fragility curves and hazard intensity (e.g. PGA values)
  - Provide results for further processing outside the IDST



## Case Study Northern Italy Scenario

- Target area: Region of Bologna, Northern Italy
- Network: Road network, (European TEN-T network)
- Hazards source: Earthquake
  - Hazard event: Ground motion (primary)
  - Hazard event: Earthquake-triggered landslides (secondary)
- Network element types:
  - Bridges
  - Tunnels
  - Road sections
- Determine element characteristics, i.e. network elements in IDST database datasets for bridges, tunnels, road section, or upload user defined.
- Stress tests: determine risk associated with an earthquake hazard event on the road network
- Calculate direct costs

# Create a new Case Study, Problem Identification

infrariskidst | IDST Problem Identification - Mozilla Firefox

infrariskidst | IDST Pro... x +

https://infrarisk.it-innovation.soton.ac.uk/idstpwe/new/

INFRARISK

Help IDST Tools Logout

← IDST Home System Definition ▶

## Define Stress Test

This page allows general information on the stress test to be included. This information is not directly used to inform the analysis but is included within an automatically generated summary report upon completion of the stress test.

Enter stress test details:

**Name:**  
Provide a name for the stress test

**Summary (Optional):**  
Provide a brief summary of the stress test

Note that hazard-specific input parameters, e.g. return period, are considered at the "Define Hazard Scenario" stage.

Press the following button to save your stress test, and start the IDST workflow.

Save and proceed

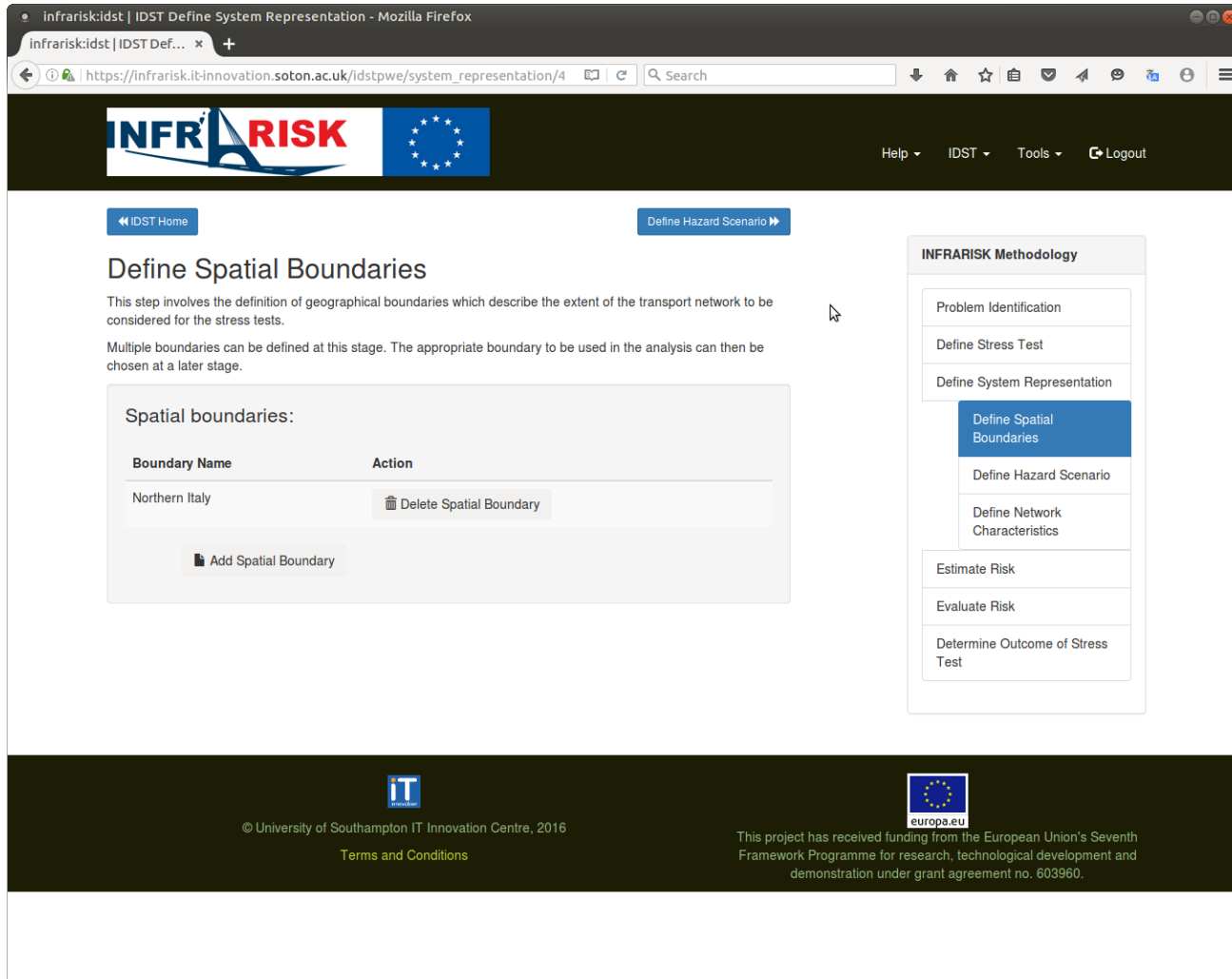
### INFRARISK Methodology

- Define Stress Test
- Define System Representation
  - Define Spatial Boundaries
  - Define Hazard Scenario
  - Define Network Characteristics
- Estimate Risk
- Evaluate Risk
- Determine Outcome of Stress Test

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europa.eu  
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# IDST: Define spatial boundaries



The screenshot shows the 'Define Spatial Boundaries' interface of the INFRARISK IDST application. The browser address bar indicates the URL: [https://infrarisk.it-innovation.soton.ac.uk/idstpwe/system\\_representation/4](https://infrarisk.it-innovation.soton.ac.uk/idstpwe/system_representation/4). The application header includes the INFRARISK logo, the European Union flag, and navigation links for Help, IDST, Tools, and Logout.

At the top of the main content area, there are two buttons: 'IDST Home' and 'Define Hazard Scenario'. The main heading is 'Define Spatial Boundaries'. Below this, a text block explains: 'This step involves the definition of geographical boundaries which describe the extent of the transport network to be considered for the stress tests. Multiple boundaries can be defined at this stage. The appropriate boundary to be used in the analysis can then be chosen at a later stage.'

The 'Spatial boundaries:' section contains a table with the following data:

Boundary Name	Action
Northern Italy	<a href="#">Delete Spatial Boundary</a>

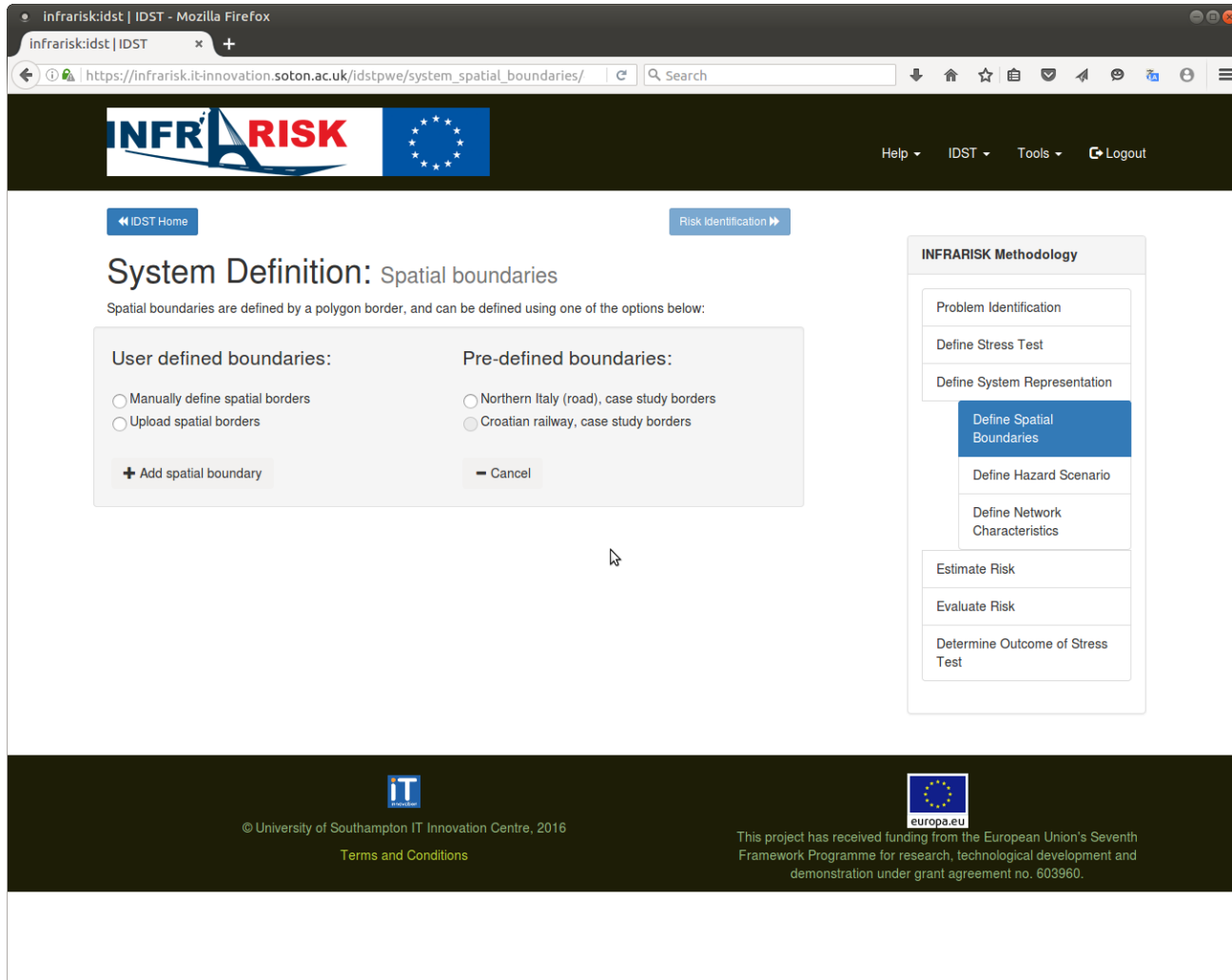
Below the table is an 'Add Spatial Boundary' button.

On the right side, the 'INFRARISK Methodology' sidebar lists the following steps:

- Problem Identification
- Define Stress Test
- Define System Representation
  - Define Spatial Boundaries** (selected)
  - Define Hazard Scenario
  - Define Network Characteristics
- Estimate Risk
- Evaluate Risk
- Determine Outcome of Stress Test

The footer contains the University of Southampton IT Innovation Centre logo and copyright information (© 2016), a link to 'Terms and Conditions', and a statement about funding from the European Union's Seventh Framework Programme (grant agreement no. 603960).

# IDST: Define spatial boundaries



The screenshot shows a web browser window with the URL [https://infrarisk.it-innovation.soton.ac.uk/idstpwe/system\\_spatial\\_boundaries/](https://infrarisk.it-innovation.soton.ac.uk/idstpwe/system_spatial_boundaries/). The page title is "infrarisk:dst | IDST - Mozilla Firefox". The browser's address bar shows the URL and a search bar.

The page header features the INFRARISK logo and the European Union flag. Navigation links include "Help", "IDST", "Tools", and "Logout".

The main content area is titled "System Definition: Spatial boundaries". Below the title, it states: "Spatial boundaries are defined by a polygon border, and can be defined using one of the options below:".

There are two sections for defining boundaries:

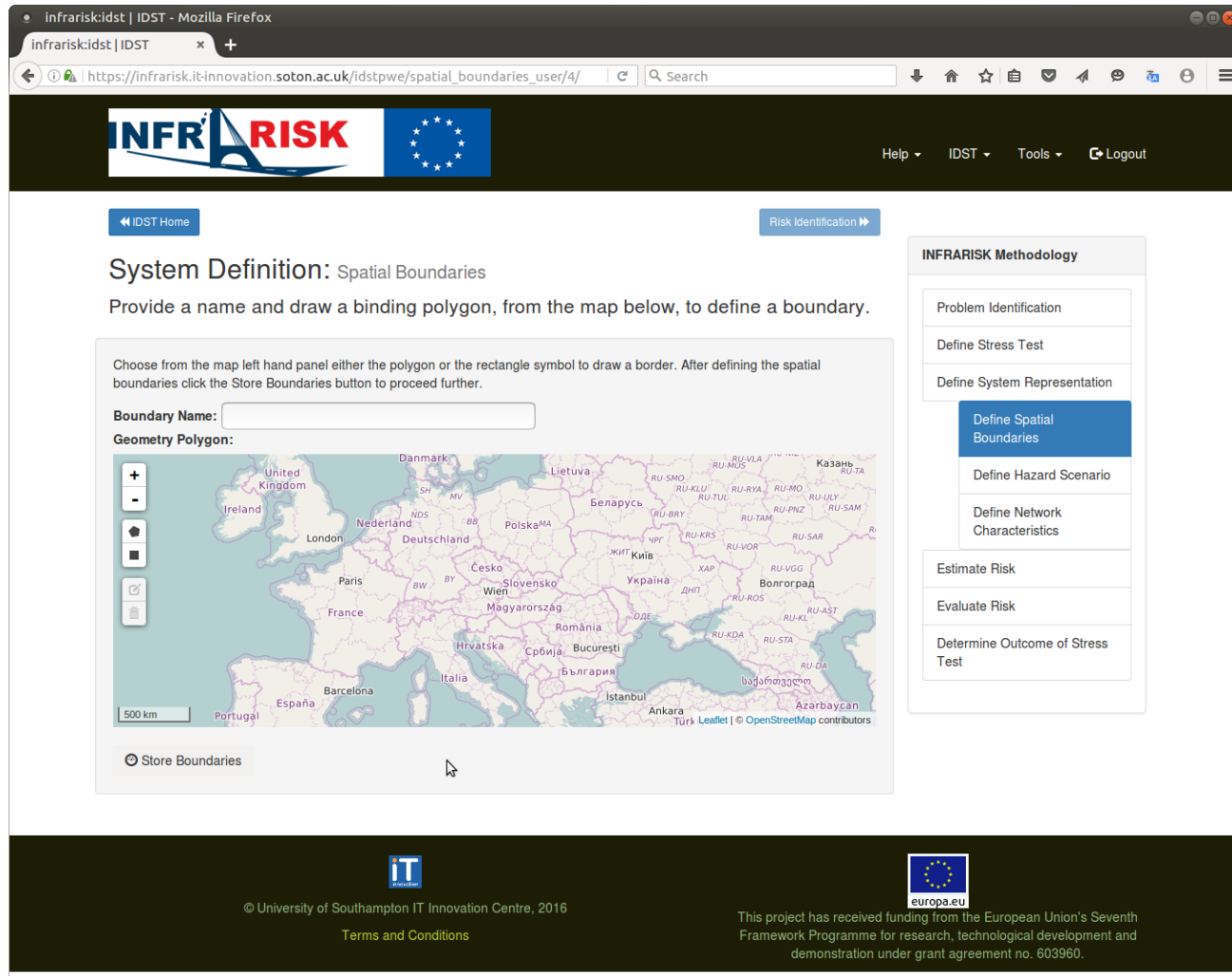
- User defined boundaries:**
  - ☐ Manually define spatial borders
  - ☐ Upload spatial borders
  - [+ Add spatial boundary](#)
- Pre-defined boundaries:**
  - ☐ Northern Italy (road), case study borders
  - ☐ Croatian railway, case study borders
  - [- Cancel](#)

On the right side, there is a sidebar titled "INFRARISK Methodology" with a list of steps:

- Problem Identification
- Define Stress Test
- Define System Representation
  - Define Spatial Boundaries** (highlighted)
  - Define Hazard Scenario
  - Define Network Characteristics
- Estimate Risk
- Evaluate Risk
- Determine Outcome of Stress Test

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# IDST: Define spatial boundaries manually



The screenshot shows the INFRARISK IDST web application in a Mozilla Firefox browser. The URL is [https://infrarisk.it-innovation.soton.ac.uk/idstpwe/spatial\\_boundaries\\_user/4/](https://infrarisk.it-innovation.soton.ac.uk/idstpwe/spatial_boundaries_user/4/). The page title is "infrarisk: idst | IDST - Mozilla Firefox".

The interface includes a header with the INFRARISK logo, the European Union flag, and navigation links: Help, IDST, Tools, and Logout. Below the header, there are two buttons: "IDST Home" and "Risk Identification".

The main content area is titled "System Definition: Spatial Boundaries". It contains the instruction: "Provide a name and draw a binding polygon, from the map below, to define a boundary." Below this, a text box for "Boundary Name:" is visible. A "Geometry Polygon:" section contains a map of Europe with various countries labeled in their respective languages. A scale bar indicates 500 km. A "Store Boundaries" button is located at the bottom of the map area.

On the right side, there is a sidebar titled "INFRARISK Methodology" with a list of steps: Problem Identification, Define Stress Test, Define System Representation, Define Spatial Boundaries (highlighted in blue), Define Hazard Scenario, Define Network Characteristics, Estimate Risk, Evaluate Risk, and Determine Outcome of Stress Test.

The footer contains the IT Innovation Centre logo, the text "© University of Southampton IT Innovation Centre, 2016", and a link to "Terms and Conditions". It also features the European Union flag and the text "europa.eu". A note states: "This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 603960."

## **IDST: define hazard scenario**

- Source event: e.g. earthquake
- Hazard events:
  - A ground motion hazard
  - and the cascading effects, i.e. earthquake-triggered landslides

# IDST: define hazard scenario

infrarisk:dst | IDST Define Hazard Scenario - Mozilla Firefox
infrarisk:dst | IDST Def...
https://infrarisk.it-innovation.soton.ac.uk/idstpwe/define\_hazard\_scenario/22/
Search
Help IDST Tools Logout

## Define Hazard Scenario

This step includes choosing the natural hazard(s) to be considered for the stress test.

This is carried out in three steps:

- choose hazard source to be considered
- choose the resulting hazard events(s) to be considered
- choose hazard model(s) to represent the hazard event(s)

### Hazard Source

Choose the hazard source for this stress test.

Hazard source: Earthquake Store Hazard Source

The IDST does not currently support other hazard sources, please contact us for further information on how these should be considered.

### Hazard Events

Add hazard events to your hazard scenario.

Associated hazard event list:

Hazard Type	Primary/Secondary	Model	Action
Ground Motion	primary	INFRARISK GM MODEL	<span>Change model</span> <span>Delete</span>
Landslide	secondary	N/A	<span>Void</span> <span>Delete</span>

Add Hazard Event

INFRARISK Methodology

- Problem Identification
- Define Stress Test
- Define System Representation
  - Define Spatial Boundaries
  - Define Hazard Scenario
  - Define Network Characteristics
- Estimate Risk
- Evaluate Risk
- Determine Outcome of Stress Test

# IDST: configure hazard model

infrarisk:dst | IDST Ground Motion PGA Grid - Mozilla Firefox
infrarisk:dst | IDST Gro...
https://infrarisk.it-innovation.soton.ac.uk/hazards/hazard\_scenario/4/7/
Search
Help ▾ IDST ▾ Tools ▾ Logout

IDST Home
Network Scenario

## IDST INFRARISK Ground Motion Model Configuration

This ground motion hazard model is based on the INFRARISK GM model. Please select the PGA grid for the Ground Motion event.

Help

Seismic activity model: Low activity ▾

Ground-motion prediction model: Low attenuation ▾

Hazard level (Mean return period): 2500 years ▾


Fractile of extreme ground-motion: 0.50 ▾

Store stress test hazard configuration.

Store hazard configuration


### INFRARISK Methodology

- Problem Identification
- Define Stress Test
- Define System Representation
  - Define Spatial Boundaries
  - Define Hazard Scenario
  - Define Network Characteristics
- Estimate Risk
- Evaluate Risk
- Determine Outcome of Stress Test



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# IDST: define network scenario

IDST Home
Add Network Elements

## Define Network Characteristics

This involves defining the network type and extent along with the element types to consider as part of the stress test. This requires a number of steps as shown below:

- Choose network type
- Choose types of network elements to be considered
  - Choose hazard event deemed to impact each element type
  - Choose approach for assigning fragility functions to element types
- Assign spatial boundary to network

### Network Infrastructure

Choose the network type.

Infrastructure:
Road Network
Store Network Infrastructure

### Network Elements

Add the element types on the network to be considered in the stress test.

Help

Network element type	Hazard event	Fragility Functions	Action
Bridge	Ground Motion	BRIDGE	Change approach Delete
Tunnel	Ground Motion	TUNNEL	Change approach Delete

Add Element Types

### Spatial Boundaries

Choose boundary to assign to network

Spatial boundaries bound to this hazard scenario is: NORTHERN ITALY

Change Spatial Border

#### INFRARISK Methodology

Problem Identification
Define Stress Test
Define System Representation

Define Spatial Boundaries
Define Hazard Scenario
Define Network Characteristics

Estimate Risk
Evaluate Risk
Determine Outcome of Stress Test

## Assigning Bridge, Tunnel Fragility Curves

- Median fragility curves with confidence bounds is ported to IDST
- Bridge and tunnel structural data modelled and ingested in IDST, 340 bridges, 30 tunnels
- Mean and standard-deviation for all damage states is calculated for 4 damage states
- Damage state sampling algorithm is also ported in IDST for a given hazard intensity (IM)

a/a	Damage State	Description
0	DS0	No damage
1	DS1	Slight damage
2	DS2	Moderate damage
3	DS3	Extensive damage
4	DS4	Complete damage

# Assigning Road Section Fragility Curves

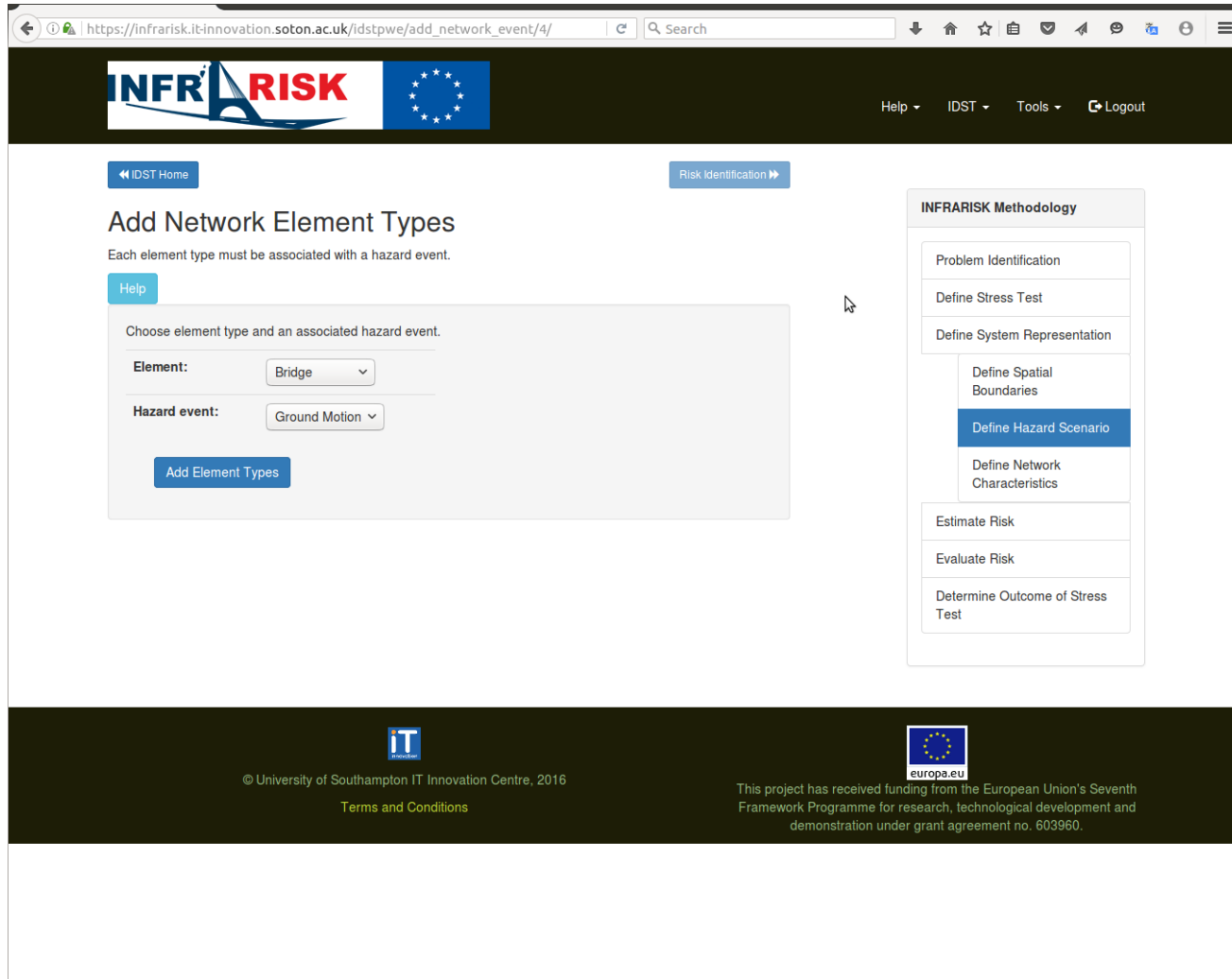
Structural Road sections data are modelled

Landslide data are modelled

Fragility Curves calculation porting to IDST is implemented

a/a	Damage State	Description
0	DS0	No damage
1	DS1	Slight damage
2	DS2	Moderate damage
3	DS3	Extensive damage

# IDST: add network type elements



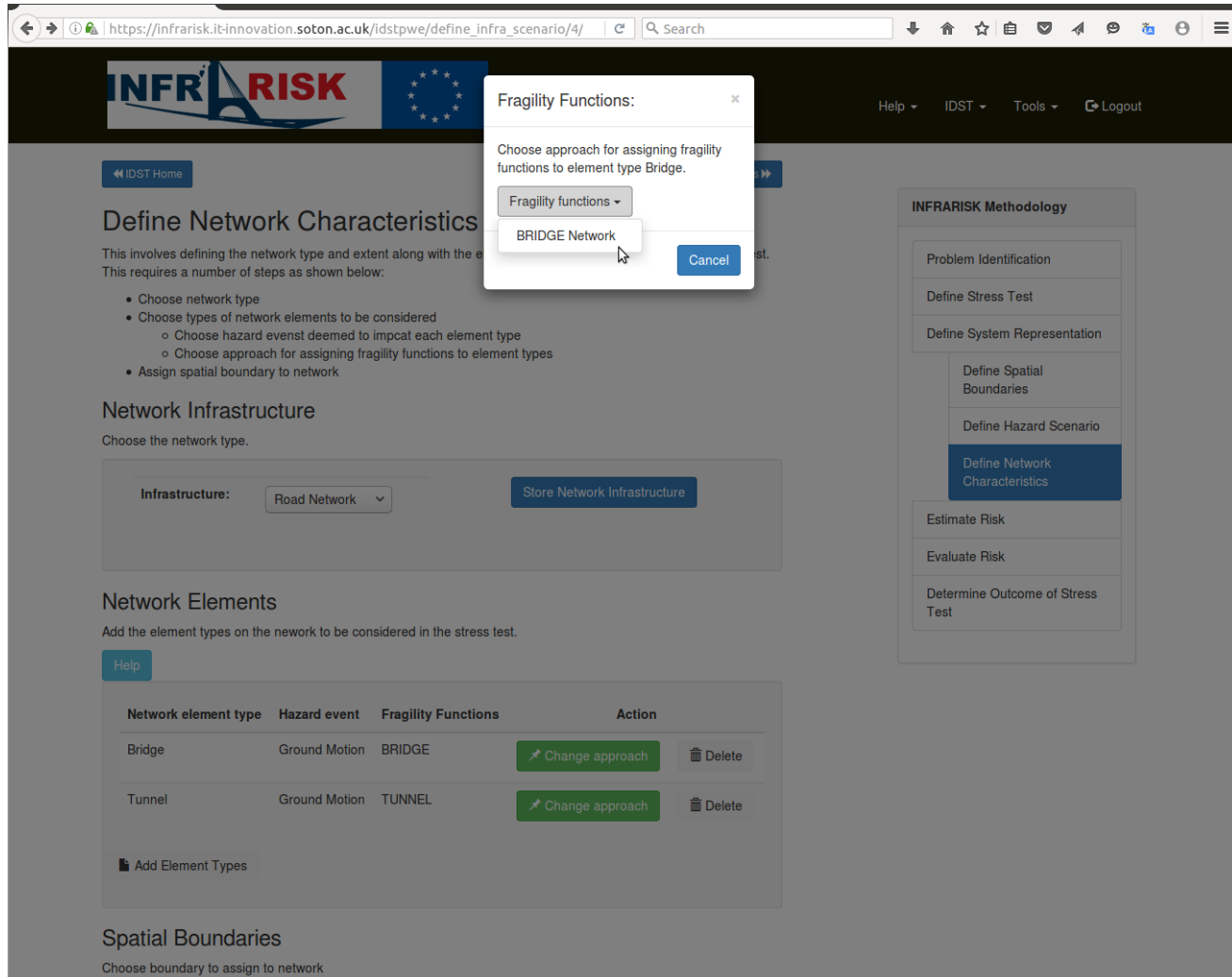
The screenshot shows the INFRARISK web application interface. The browser address bar displays the URL: [https://infrarisk.it-innovation.soton.ac.uk/idstpwe/add\\_network\\_event/4/](https://infrarisk.it-innovation.soton.ac.uk/idstpwe/add_network_event/4/). The page header includes the INFRARISK logo and the European Union flag. Navigation links include Help, IDST, Tools, and Logout.

The main content area is titled "Add Network Element Types" and includes a sub-header "Each element type must be associated with a hazard event." A "Help" button is available. The form prompts the user to "Choose element type and an associated hazard event." It features two dropdown menus: "Element:" with "Bridge" selected, and "Hazard event:" with "Ground Motion" selected. An "Add Element Types" button is at the bottom of the form.

A sidebar titled "INFRARISK Methodology" lists the following steps: Problem Identification, Define Stress Test, Define System Representation, Define Spatial Boundaries, Define Hazard Scenario (highlighted in blue), Define Network Characteristics, Estimate Risk, Evaluate Risk, and Determine Outcome of Stress Test.

The footer contains the IT Innovation logo, the text "© University of Southampton IT Innovation Centre, 2016", a link to "Terms and Conditions", the European Union flag with "europa.eu", and a statement: "This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 603960."

# IDST: assign fragility functions



The screenshot shows the INFRARISK web application interface. The main heading is "Define Network Characteristics". Below it, a list of steps is provided: "Choose network type", "Choose types of network elements to be considered" (with sub-steps for hazard events and fragility functions), and "Assign spatial boundary to network". The "Network Infrastructure" section has a dropdown menu set to "Road Network" and a "Store Network Infrastructure" button. The "Network Elements" section contains a table with columns for "Network element type", "Hazard event", "Fragility Functions", and "Action". The table lists "Bridge" and "Tunnel" elements, both associated with "Ground Motion" hazard events. The "Fragility Functions" column shows "BRIDGE" and "TUNNEL" respectively. The "Action" column includes "Change approach" and "Delete" buttons. A modal window titled "Fragility Functions:" is open, prompting the user to "Choose approach for assigning fragility functions to element type Bridge." The modal shows a dropdown menu with "Fragility functions" selected, and a "BRIDGE Network" option is visible. A "Cancel" button is also present. On the right side, a sidebar titled "INFRARISK Methodology" lists the steps: "Problem Identification", "Define Stress Test", "Define System Representation", "Define Spatial Boundaries", "Define Hazard Scenario", "Define Network Characteristics" (highlighted in blue), "Estimate Risk", "Evaluate Risk", and "Determine Outcome of Stress Test".

**Define Network Characteristics**

This involves defining the network type and extent along with the elements to be considered. This requires a number of steps as shown below:

- Choose network type
- Choose types of network elements to be considered
  - Choose hazard event deemed to impact each element type
  - Choose approach for assigning fragility functions to element types
- Assign spatial boundary to network

**Network Infrastructure**

Choose the network type.

Infrastructure: Road Network Store Network Infrastructure

**Network Elements**

Add the element types on the network to be considered in the stress test.

Network element type	Hazard event	Fragility Functions	Action
Bridge	Ground Motion	BRIDGE	<span>Change approach</span> <span>Delete</span>
Tunnel	Ground Motion	TUNNEL	<span>Change approach</span> <span>Delete</span>

Add Element Types

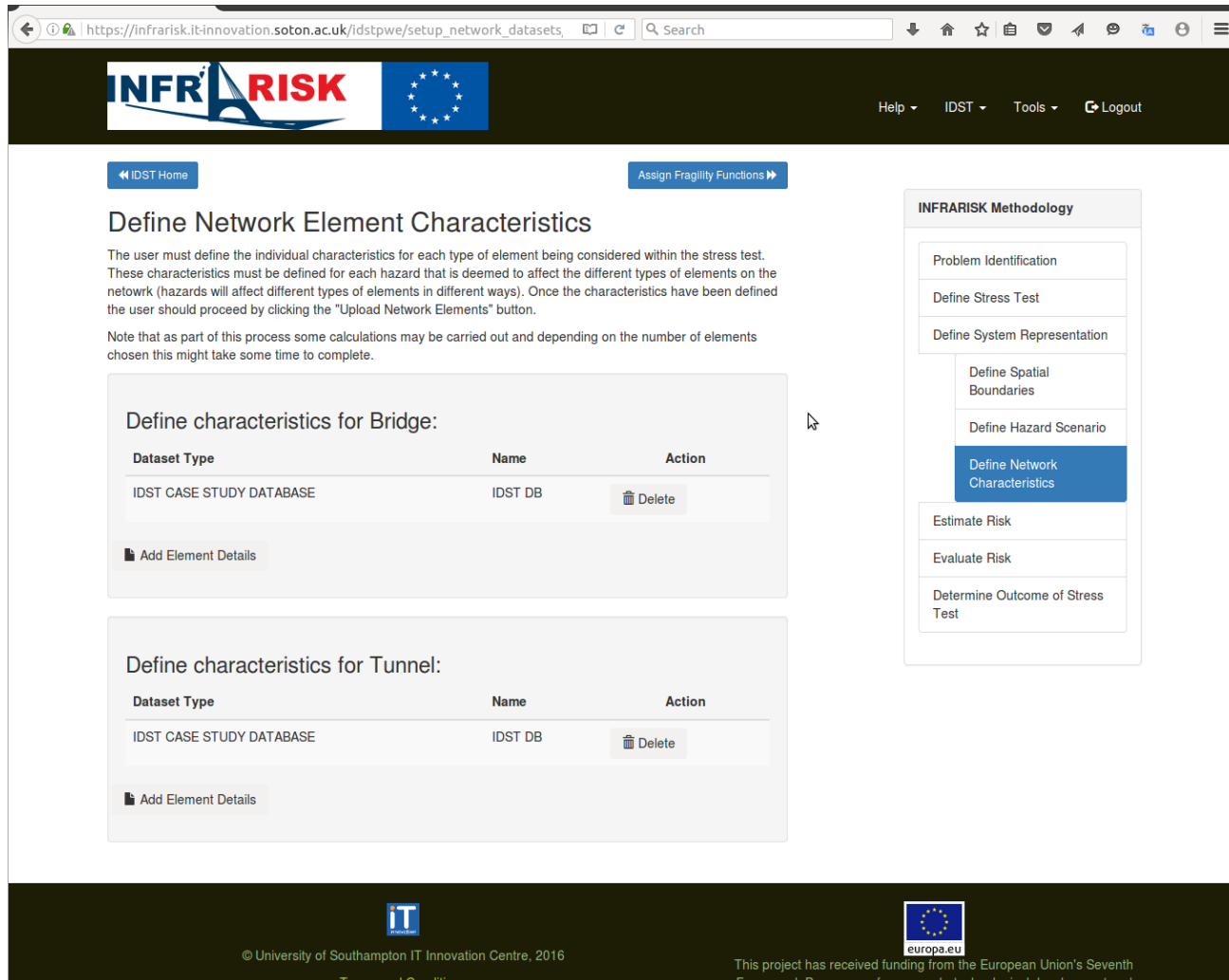
**Spatial Boundaries**

Choose boundary to assign to network

**INFRARISK Methodology**

- Problem Identification
- Define Stress Test
- Define System Representation
  - Define Spatial Boundaries
  - Define Hazard Scenario
  - Define Network Characteristics**
- Estimate Risk
- Evaluate Risk
- Determine Outcome of Stress Test

# IDST: Define network element characteristics



The screenshot shows the INFRARISK web application interface. The browser address bar displays the URL: [https://infrarisk.it-innovation.soton.ac.uk/idstpwe/setup\\_network\\_datasets](https://infrarisk.it-innovation.soton.ac.uk/idstpwe/setup_network_datasets). The page header includes the INFRARISK logo and the European Union flag. Navigation links for Help, IDST, Tools, and Logout are visible.

The main content area is titled "Define Network Element Characteristics". It includes a brief explanation: "The user must define the individual characteristics for each type of element being considered within the stress test. These characteristics must be defined for each hazard that is deemed to affect the different types of elements on the network (hazards will affect different types of elements in different ways). Once the characteristics have been defined the user should proceed by clicking the 'Upload Network Elements' button." A note mentions that calculations may be carried out depending on the number of elements chosen, which might take some time to complete.

There are two sections for defining characteristics: "Define characteristics for Bridge:" and "Define characteristics for Tunnel:". Each section contains a table with the following columns: Dataset Type, Name, and Action.



Dataset Type	Name	Action
IDST CASE STUDY DATABASE	IDST DB	Delete

Below each table is a button labeled "Add Element Details".

On the right side, there is a sidebar titled "INFRARISK Methodology" with a list of steps: Problem Identification, Define Stress Test, Define System Representation, Define Spatial Boundaries, Define Hazard Scenario, Define Network Characteristics (highlighted in blue), Estimate Risk, Evaluate Risk, and Determine Outcome of Stress Test.

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# IDST: Dataset network element characteristics

[Help](#)
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[IDST Home](#)
[Risk Identification](#)

## System Definition: Define Network Element Characteristics

The current version of the IDST supports the following formats for defining element characteristics:

- Network element datasets already preloaded in IDST databases, e.g. Northern Italy case study.
- User defined network element datasets in a shapefile format.
- User defined network element datasets in a CSV format.

Please choose any of the following methods to define characteristics for individual network elements.


User defined network element characteristics:

☐ Use elements found in IDST databases.
 ☐ User upload elements in shapefile format.
 ☐ User upload elements in CSV format.

[+ Add network elements](#)
[X Cancel](#)


### INFRARISK Methodology

- Problem Identification
- Define Stress Test
- Define System Representation
  - Define Spatial Boundaries
  - Define Hazard Scenario
  - Define Network Characteristics**
- Estimate Risk
- Evaluate Risk
- Determine Outcome of Stress Test



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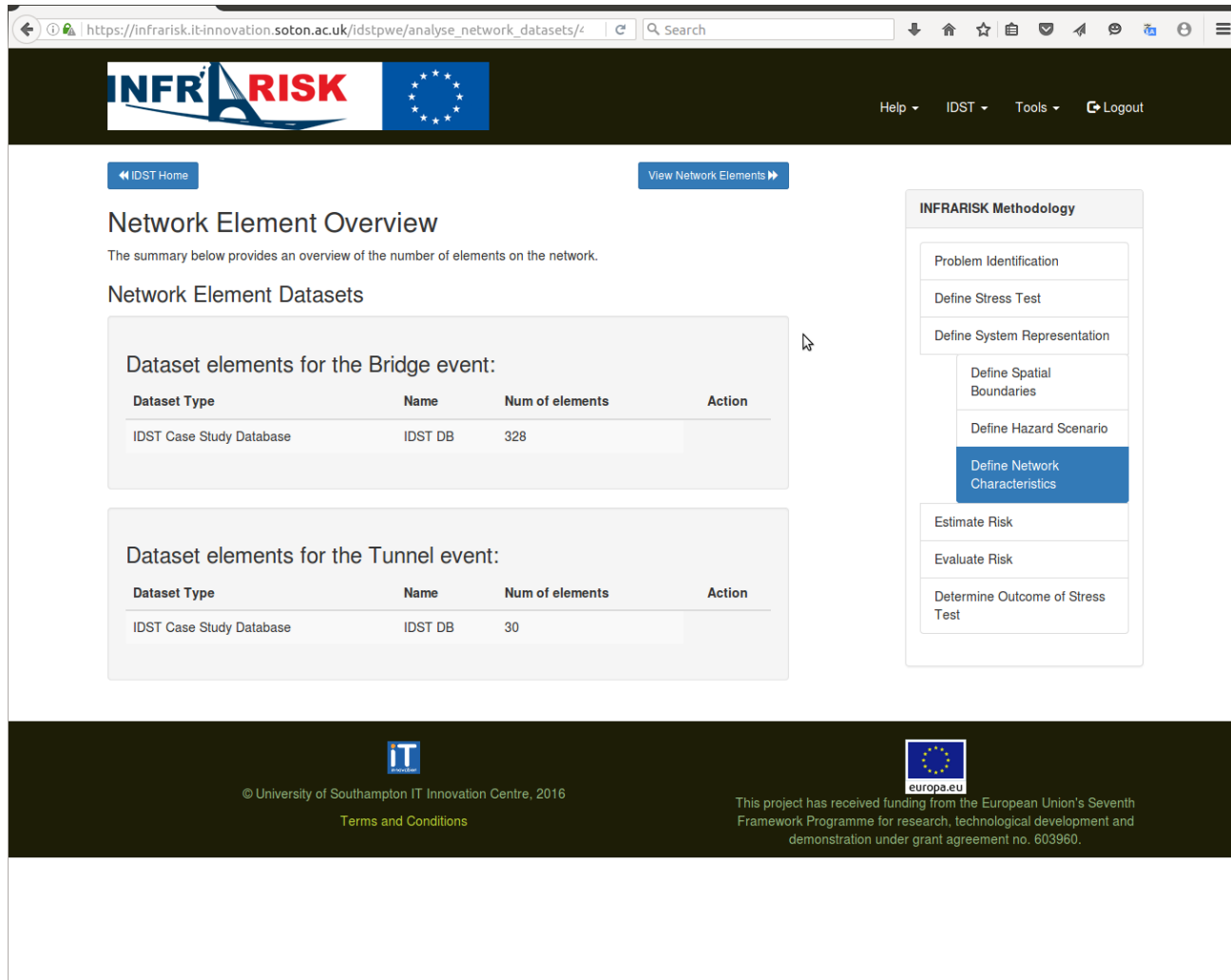
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# IDST: Overview of network element datasets



The screenshot shows the INFRARISK web application interface. The browser address bar displays the URL: [https://infrarisk.it-innovation.soton.ac.uk/idstpwe/analyse\\_network\\_datasets/](https://infrarisk.it-innovation.soton.ac.uk/idstpwe/analyse_network_datasets/). The page features a dark header with the INFRARISK logo and the European Union flag. Navigation links include Help, IDST, Tools, and Logout.

The main content area is titled "Network Element Overview" and includes a sub-header "Network Element Datasets". It provides a summary of the number of elements on the network. Two tables are displayed, one for the Bridge event and one for the Tunnel event.

**Dataset elements for the Bridge event:**

Dataset Type	Name	Num of elements	Action
IDST Case Study Database	IDST DB	328	

**Dataset elements for the Tunnel event:**

Dataset Type	Name	Num of elements	Action
IDST Case Study Database	IDST DB	30	



On the right side, there is a sidebar titled "INFRARISK Methodology" with a list of steps: Problem Identification, Define Stress Test, Define System Representation, Define Spatial Boundaries, Define Hazard Scenario, Define Network Characteristics (highlighted in blue), Estimate Risk, Evaluate Risk, and Determine Outcome of Stress Test.

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# IDST: Network element overview

[https://infrarisk.it-innovation.soton.ac.uk/idstpwe/view/4/](#)

[Help](#)
[IDST](#)
[Tools](#)
[Logout](#)

[IDST Home](#)
[Select Centre Point](#)

## Network Element Overview: Northern Italy 2016-09-15

09:59:20.484043

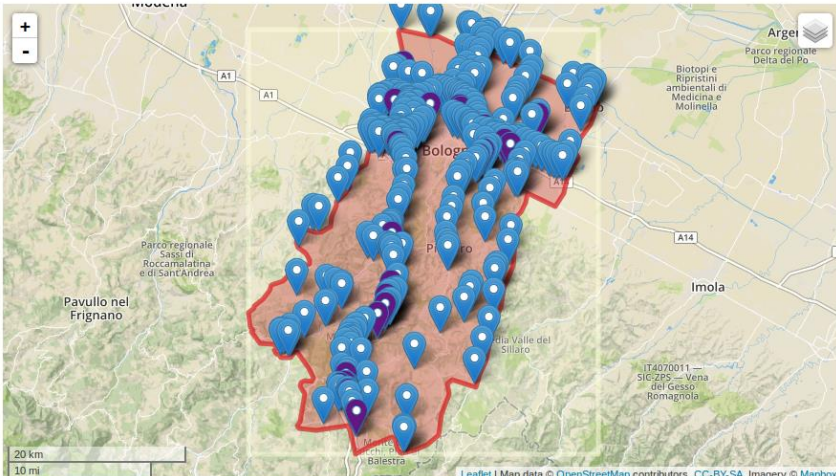
Infrastructure elements included in this stress test:

- Number of bridges: 328
- Number of tunnels: 30

Next: select the centre point of the PGA grid for this case study.



N.B. Hover over the layers icon, on the right hand side of the map below, to control the display of network element markers on the map.

Click on any element for further details.



### INFRARISK Methodology

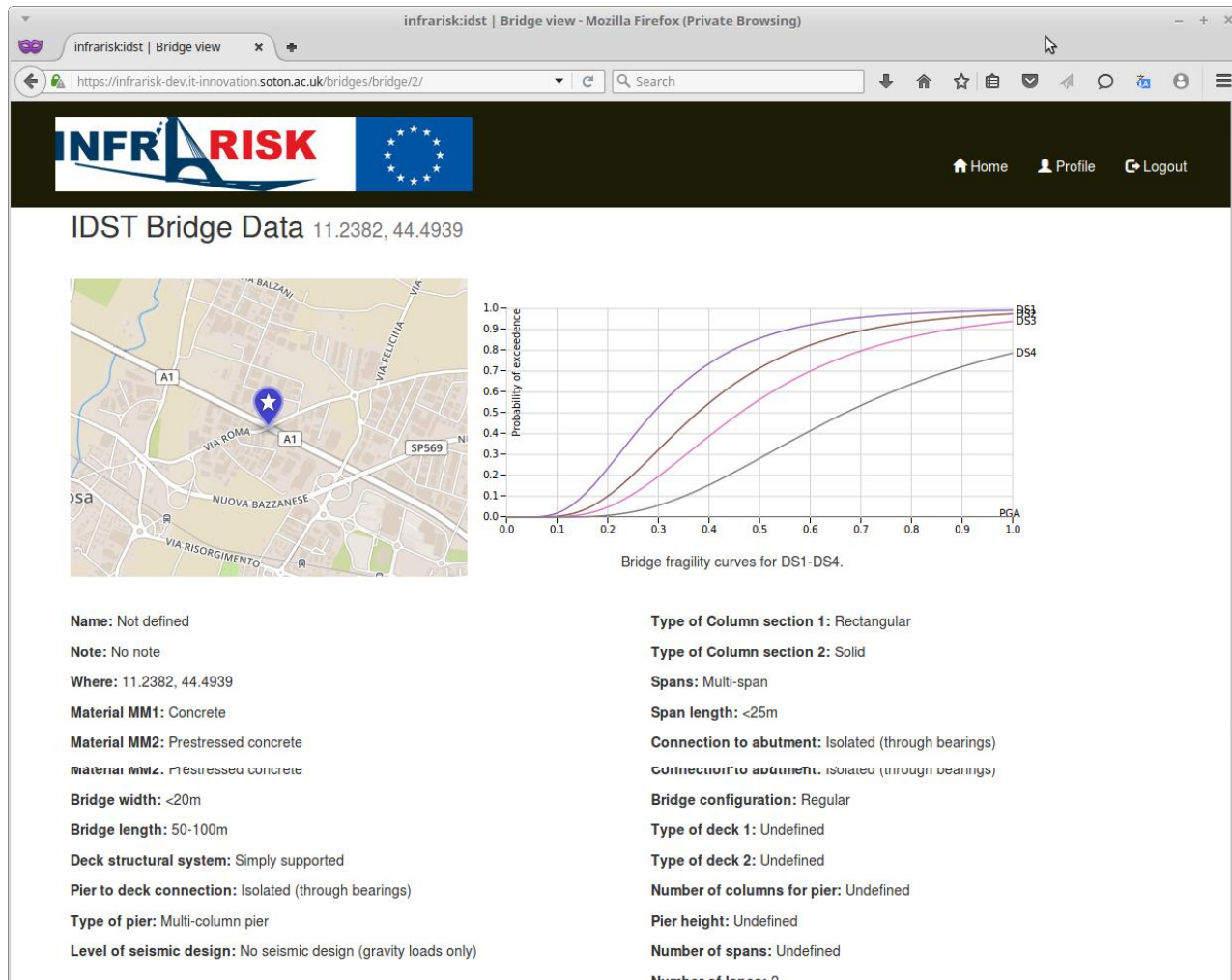
- Problem Identification
- Define Stress Test
- Define System Representation
  - Define Spatial Boundaries
  - Define Hazard Scenario
  - Define Network Characteristics**
- Estimate Risk
- Evaluate Risk
- Determine Outcome of Stress Test

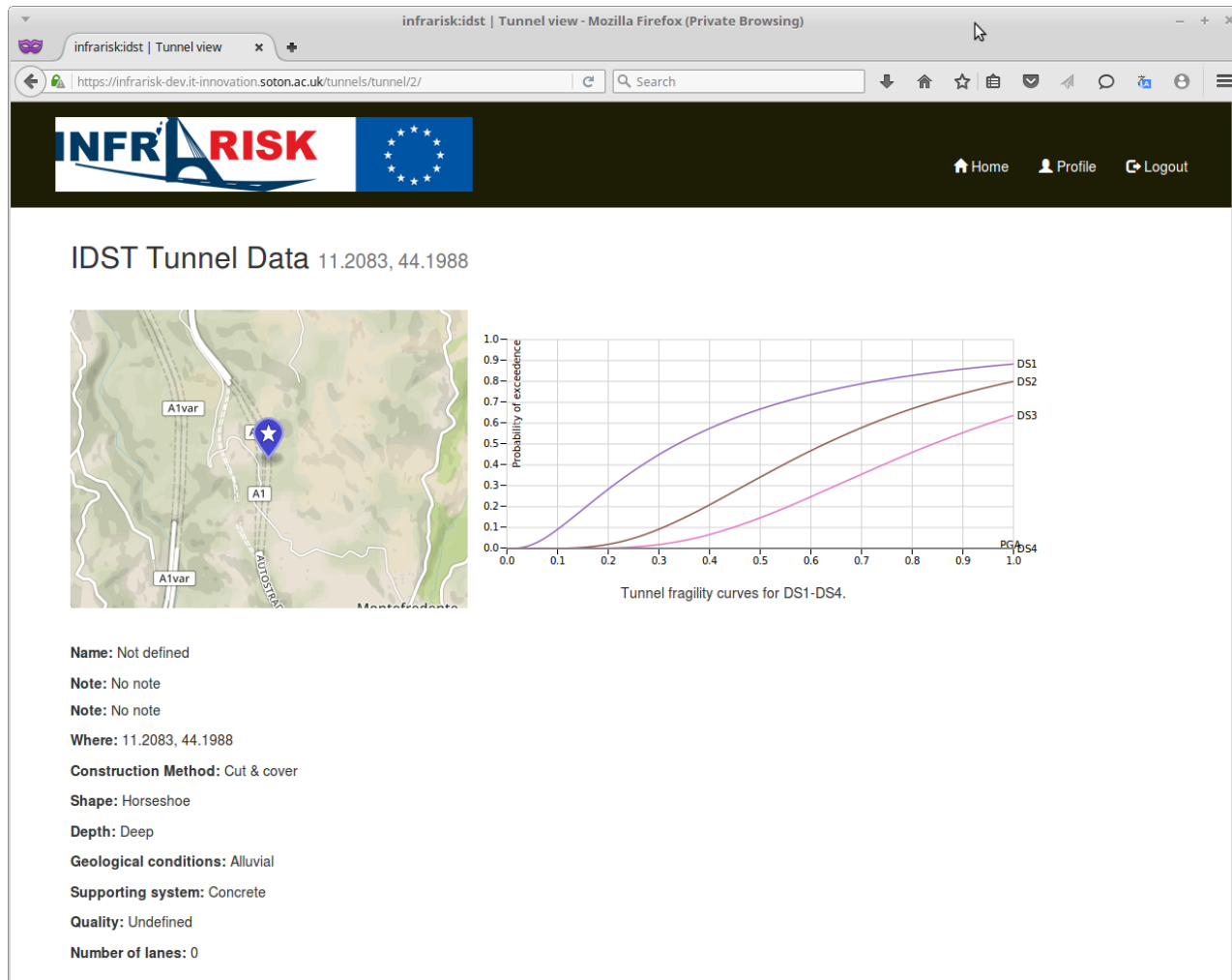
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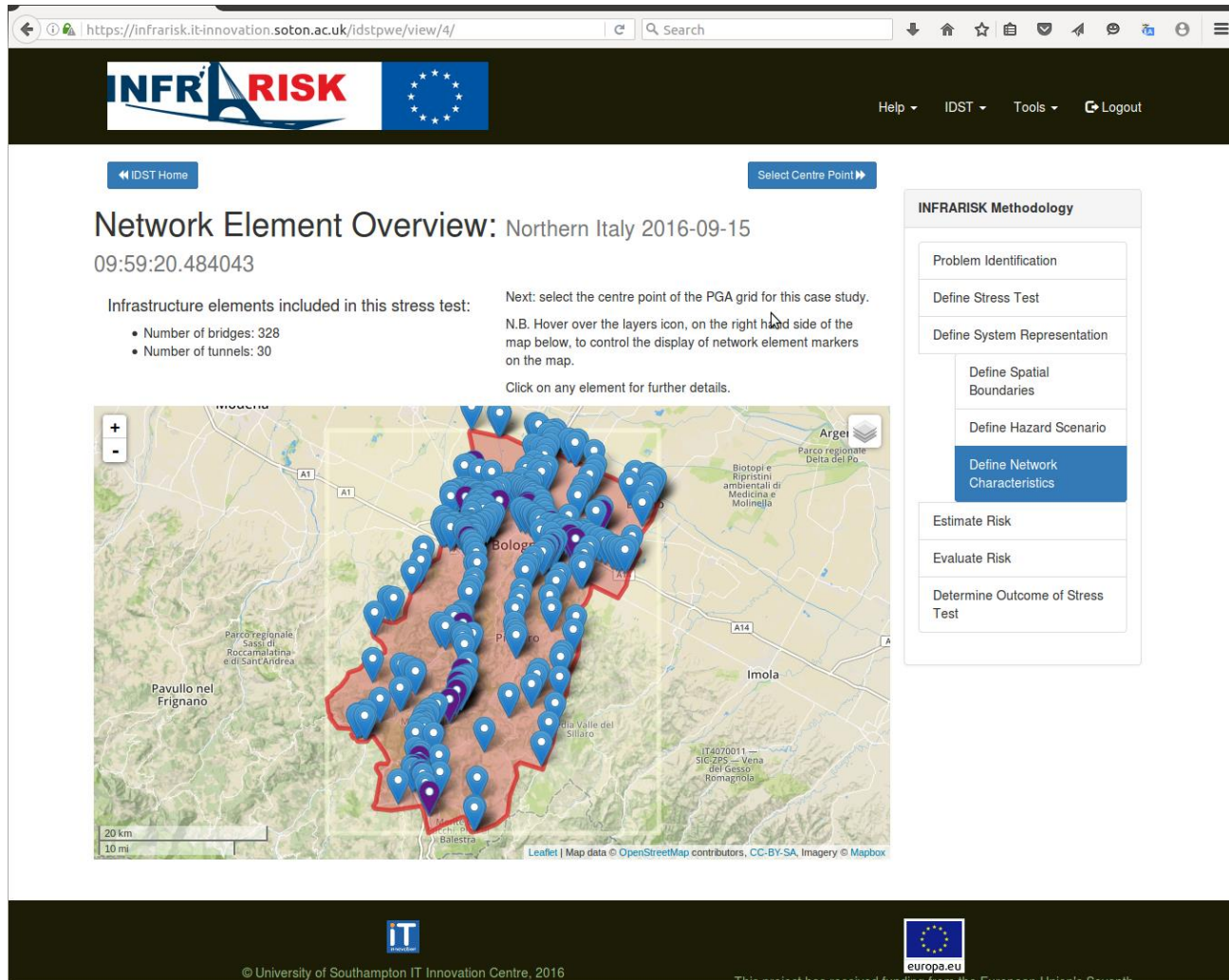
# Bridge summary with assigned Fragility Curves



# Tunnel summary with assigned Fragility Curves



# IDST: Choose centre point of interest



https://infrarisk.it-innovation.soton.ac.uk/idstpwe/view/4/

INFRARISK

Help ▾ IDST ▾ Tools ▾ Logout

◀ IDST Home Select Centre Point ▶▶

## Network Element Overview: Northern Italy 2016-09-15

09:59:20.484043

Infrastructure elements included in this stress test:

- Number of bridges: 328
- Number of tunnels: 30

Next: select the centre point of the PGA grid for this case study.

N.B. Hover over the layers icon, on the right hand side of the map below, to control the display of network element markers on the map.

Click on any element for further details.

Argenta  
Parco regionale Delta del Po  
Biotopi e ripristini ambientali di Medicina e Molinella  
Pavullo nel Frignano  
Parco regionale Sassi di Roccamatena e di Sant'Andrea  
Imola  
Vena del Gesso  
Romagnola  
Balestra

20 km  
10 mi

Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

### INFRARISK Methodology

- Problem Identification
- Define Stress Test
- Define System Representation
  - Define Spatial Boundaries
  - Define Hazard Scenario
  - Define Network Characteristics**
- Estimate Risk
- Evaluate Risk
- Determine Outcome of Stress Test

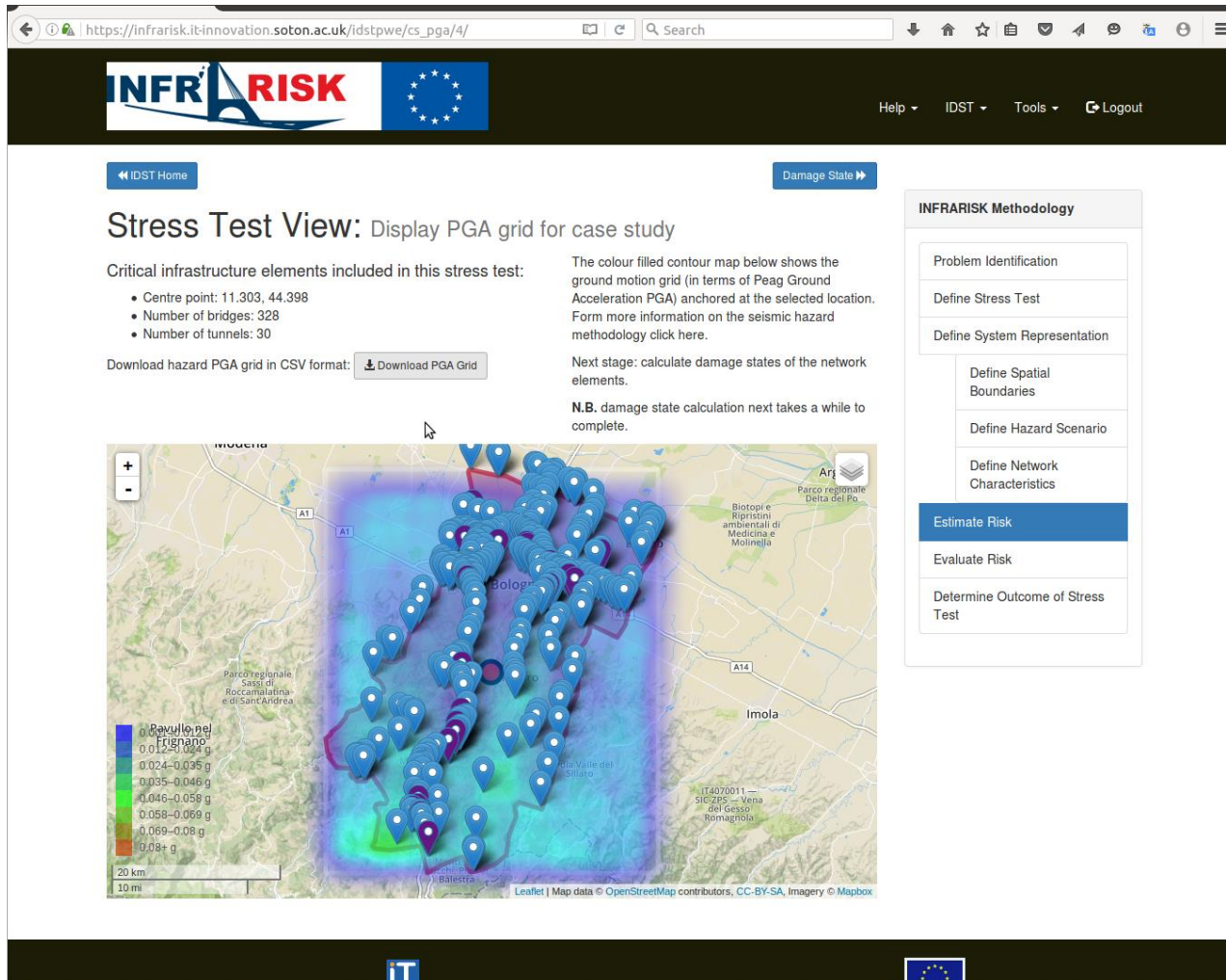
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# IDST: Anchor PGA grid on centre point



# IDST: Calculate Damage States

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[IDST Home](#)
[View Network Stats](#)

## Network Element Damage States Calculation

the damage state for the individual elements have now been calculated. Proceed to view some statistics on the damage of the network.

### Network Element Datasets

Dataset elements for the Bridge event:


Dataset Type	Name	Num of elements	Action
IDST Case Study Database	IDST DB	328	

Dataset elements for the Tunnel event:

Dataset Type	Name	Num of elements	Action
IDST Case Study Database	IDST DB	30	


#### INFRARISK Methodology

- Problem Identification
- Define Stress Test
- Define System Representation
  - Define Spatial Boundaries
  - Define Hazard Scenario
  - Define Network Characteristics**
- Estimate Risk
- Evaluate Risk
- Determine Outcome of Stress Test



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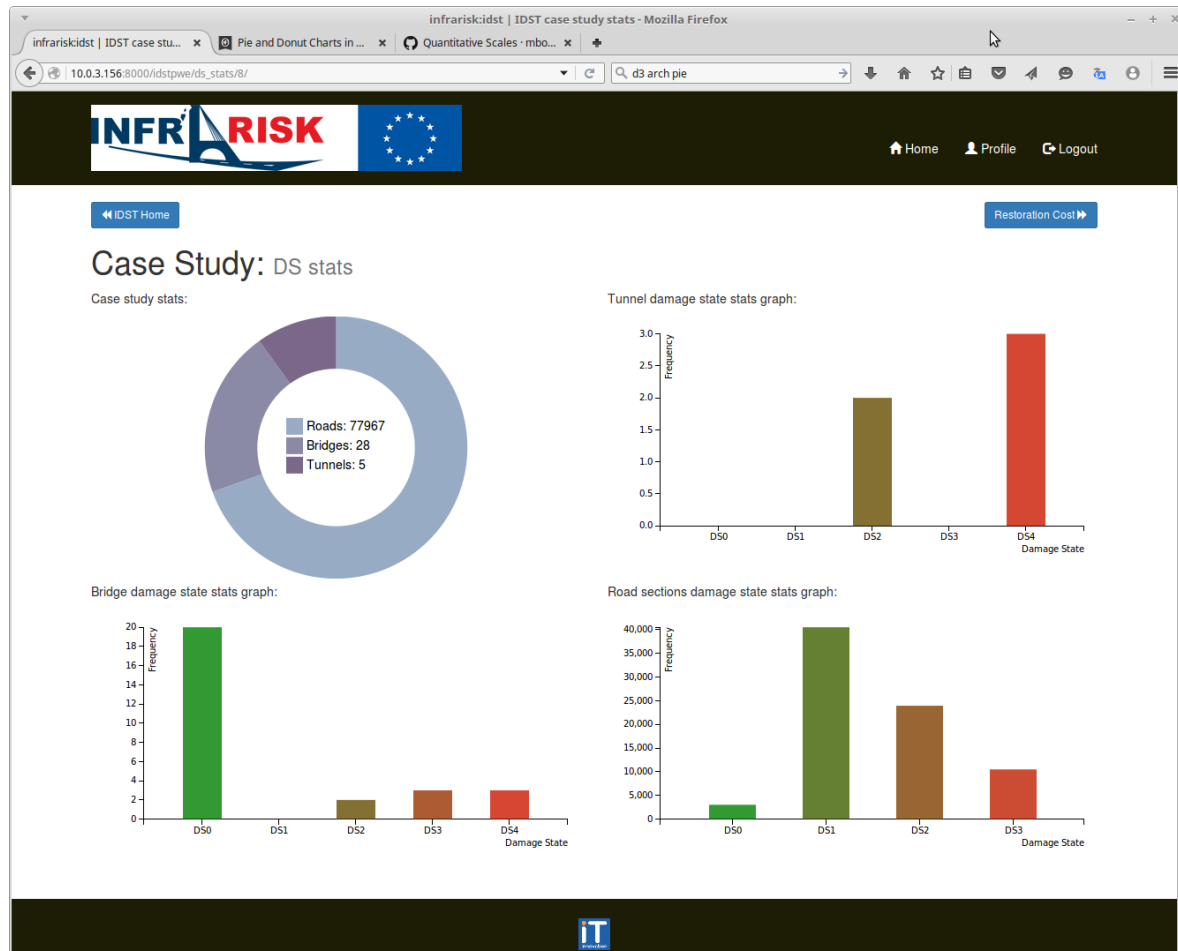
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# Case Study Damage State stats



# Assigning provisional consequence parameters

	Functional Capacity Loss	Functional Capacity Loss during Restoration	Restoration Time	Restoration Cost
	(% Lane Closure)	(% Lane Closure)	(Days)	(Euros)
Pavements (All)				
No Damage	0	0	0	0
Slight/Minor	0	0.5	1	500
Moderate	0.5	0.5	1	1000
Extensive/Complete	1	1	1	3500
Bridges (All)				
No Damage	0	0	0	0
Slight/Minor	0	0.5	120	100000
Moderate	0.5	0.5	120	750000
Extensive/Major/Severe	1	1	150	1000000
Complete/Collapse/Failure	1	1	150	1000000
Tunnels (All)				
No Damage	0	0	0	0
Slight/Minor	0.75	0.75	120	150000
Moderate	1	1	120	1000000
Extensive/Major/Severe	1	1	120	3000000
Complete/Collapse/Failure	1	1	365	10000000



## **Join us to run the IDST**

<https://infrarisk.it-innovation.soton.ac.uk/>

**Also see the training YouTube video for using the IDST**

<https://www.youtube.com/watch?v=nK2li3t8NU4>

## **Thank You**



Novel Indicators for identifying critical **INFRA**structure at **RISK** from Natural Hazards

**Website**

[www.infrarisk-fp7.eu](http://www.infrarisk-fp7.eu)

**Acknowledgement**

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