ISESS 2017

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

Dr Zoheir Sabeur *et al*

University of Southampton IT Innovation Centre, UK.

ISESS 2017 Conference, 10th – 12th May 2017, Zadar, Croatia.

IDST Design, Architecture

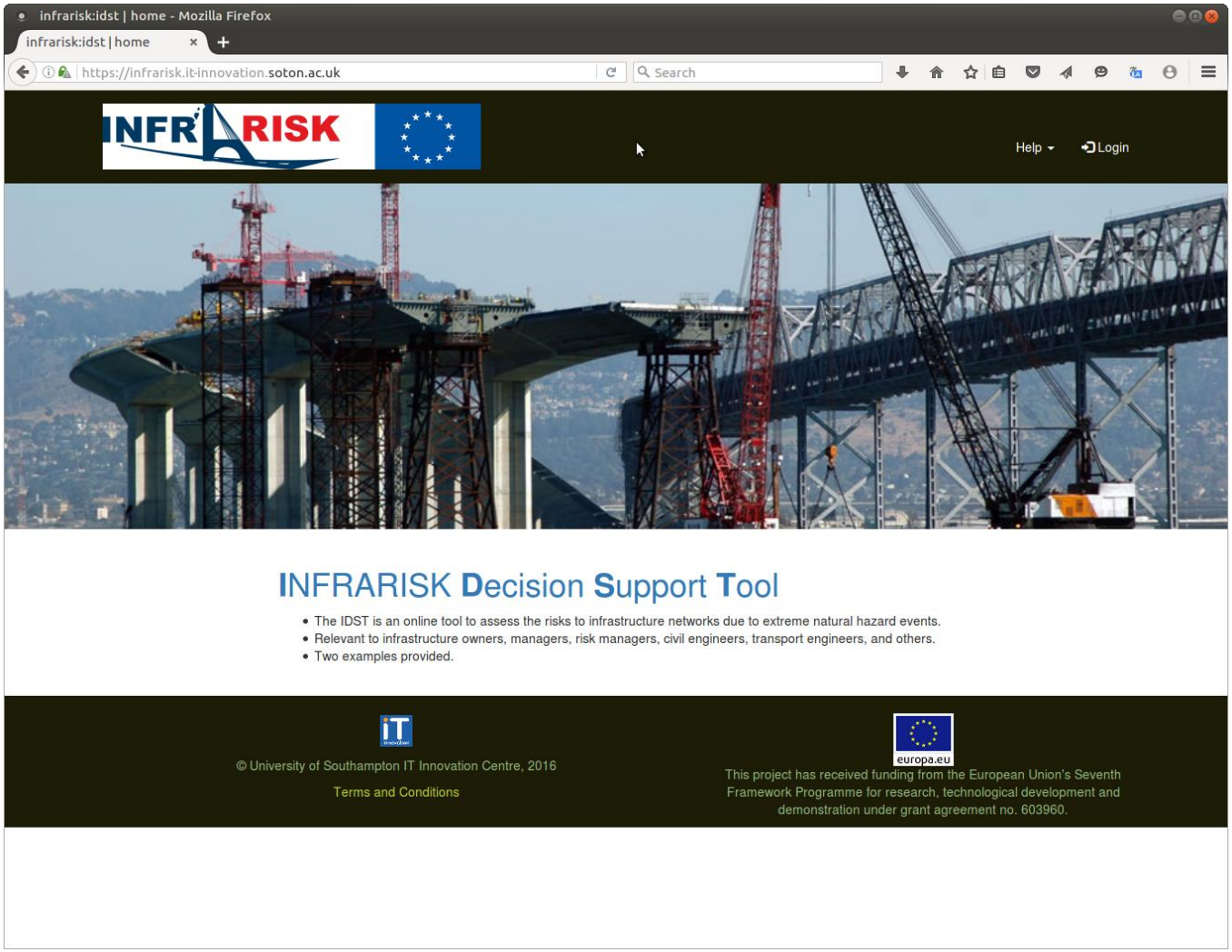
IDST Software Design

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

IDST services

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

The IDST Portal Page



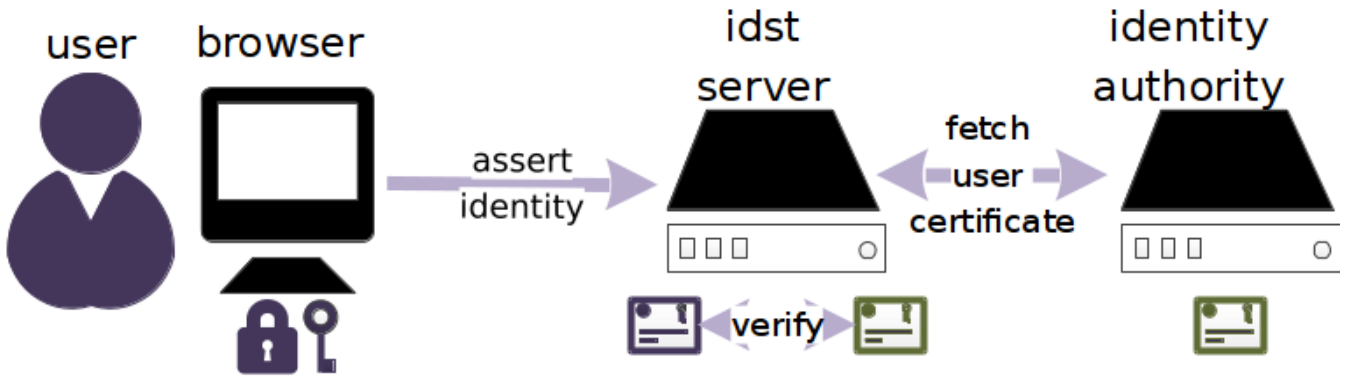
IDST Authentication System

Authentication in IDST is based on

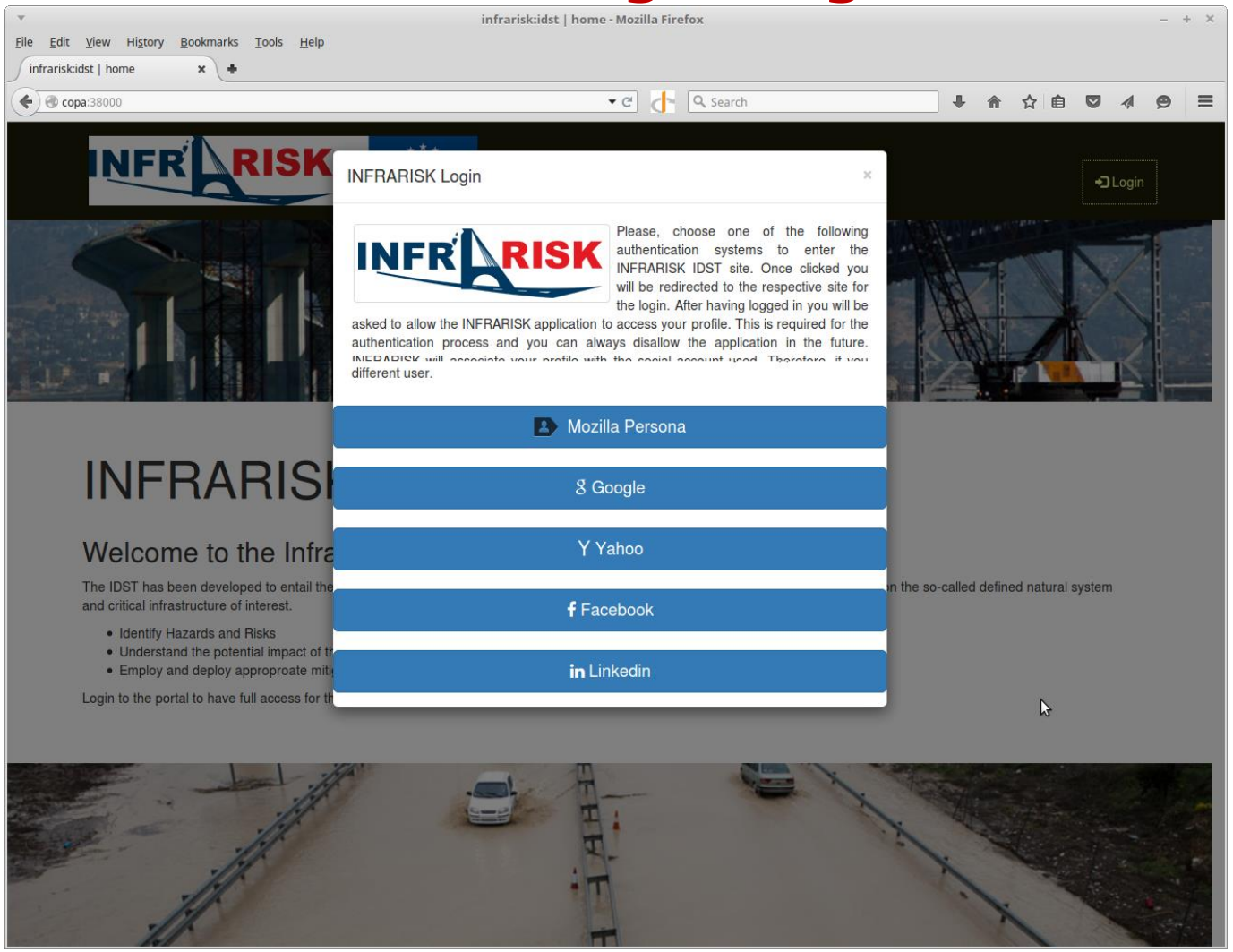
- Local user account authentication (exclusive for admin users)

- Third party authentication services (for normal users), e.g.

- **Mozilla**
- **Google**
- **Yahoo**
- **LinkedIn**

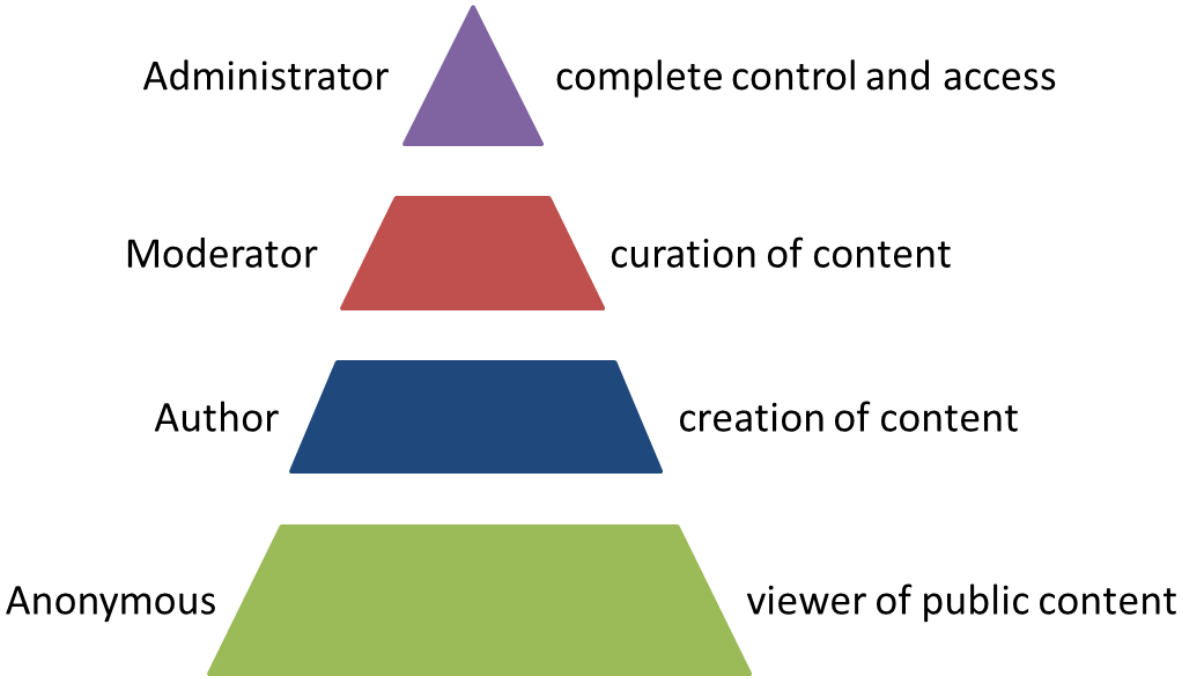


IDST Login Page

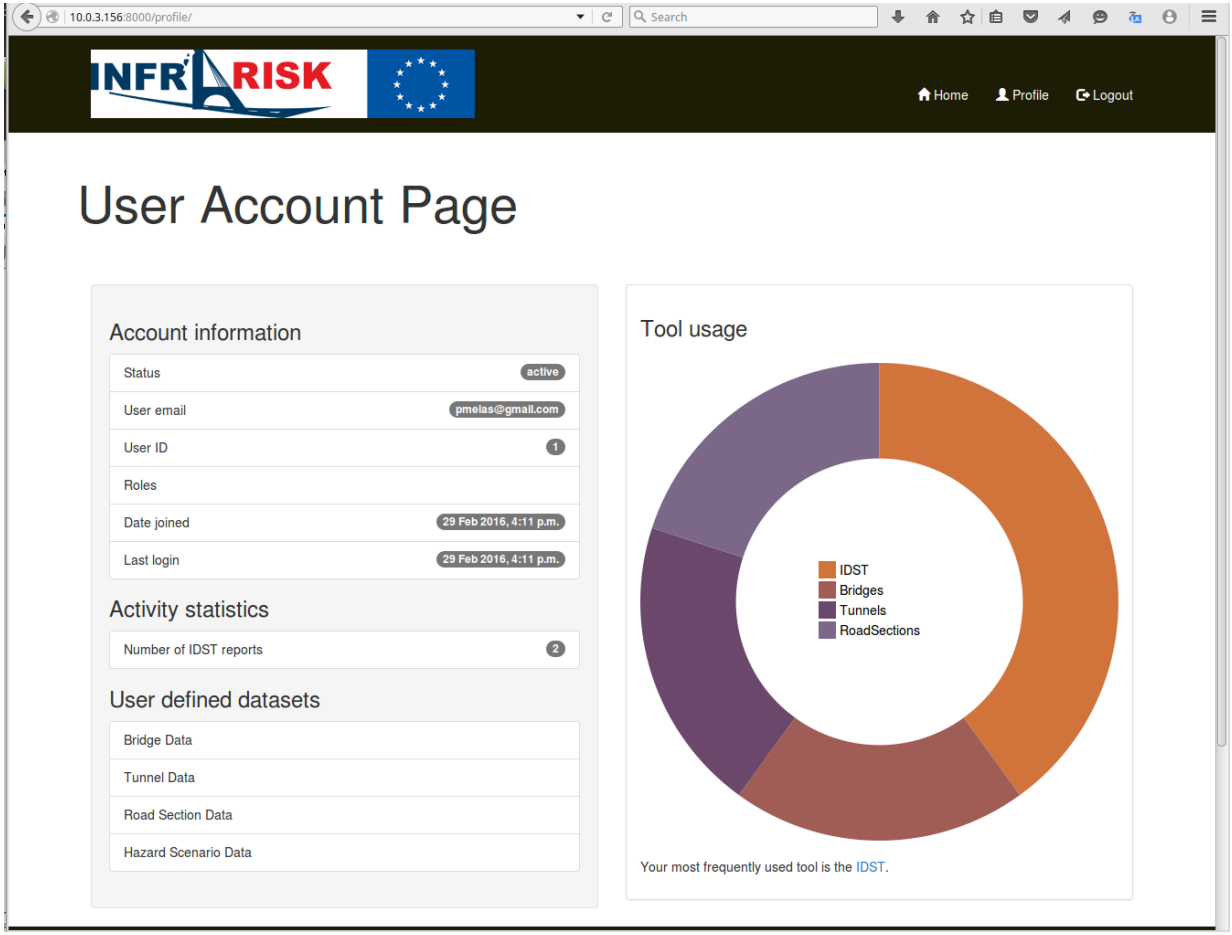


Authorisation and User Roles in IDSP

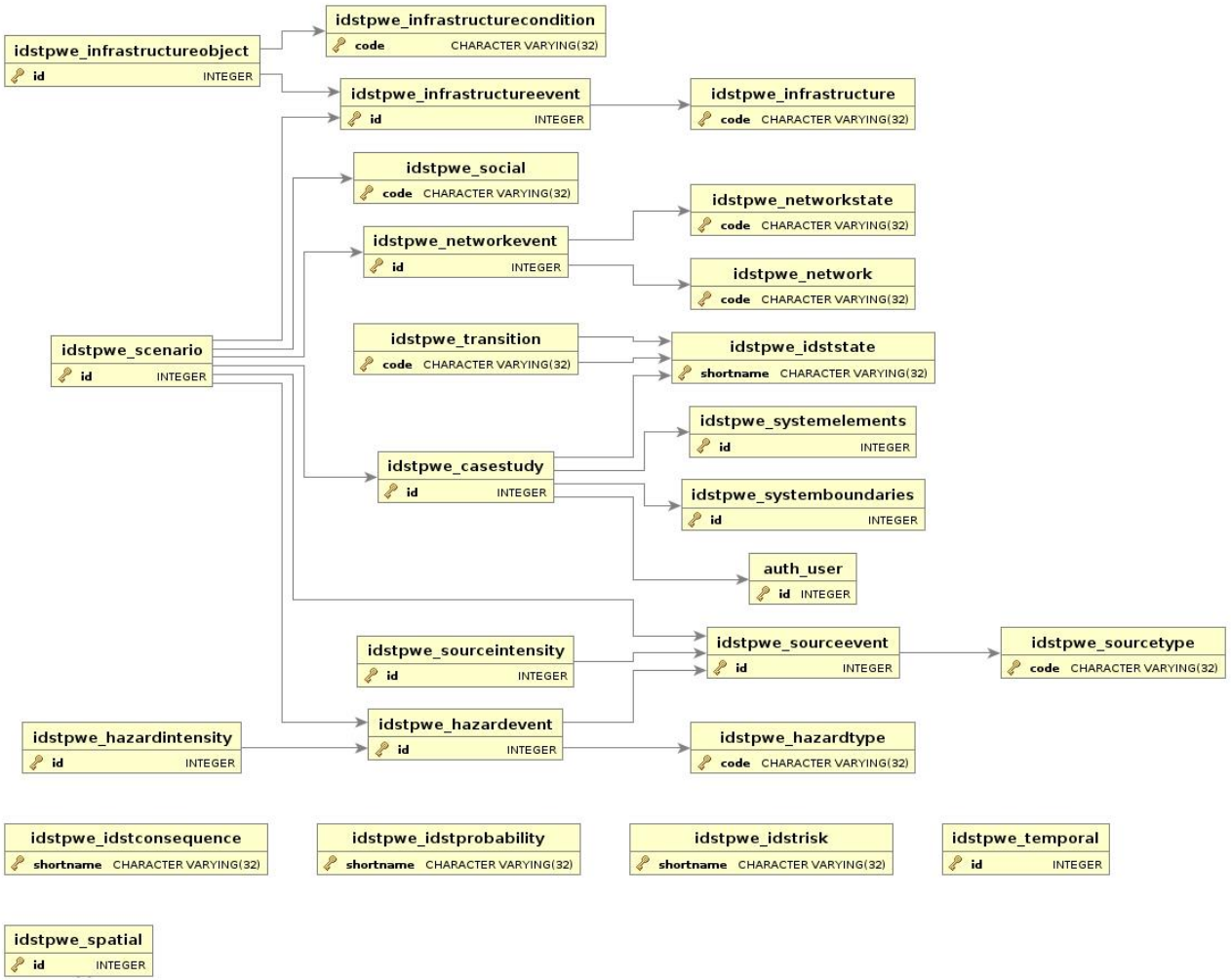
Authorisation in IDST is based on Roles
Role assigns what rights a user has
A user can have multiple roles



User profile, status in IDST



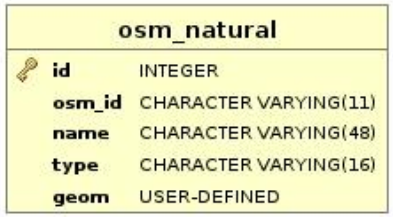
The Case Study Information Model in IDST

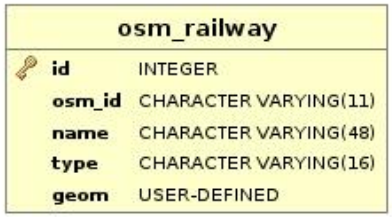


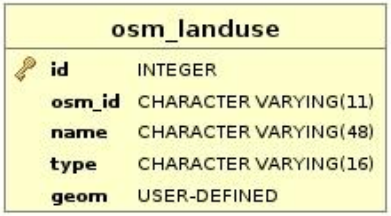
IDST modelled data

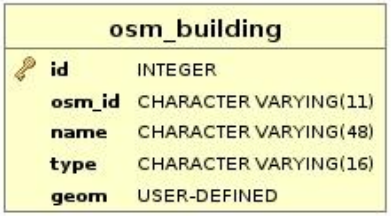
- OSM data sources
  - Bridge
  - Road
  - Tunnel
- Hazard data (supported by Ground Motion Models)
  - PGA
- Structural data
  - Bridges
  - Tunnels
  - Road sections

OSM data models, DB schemas in IDST



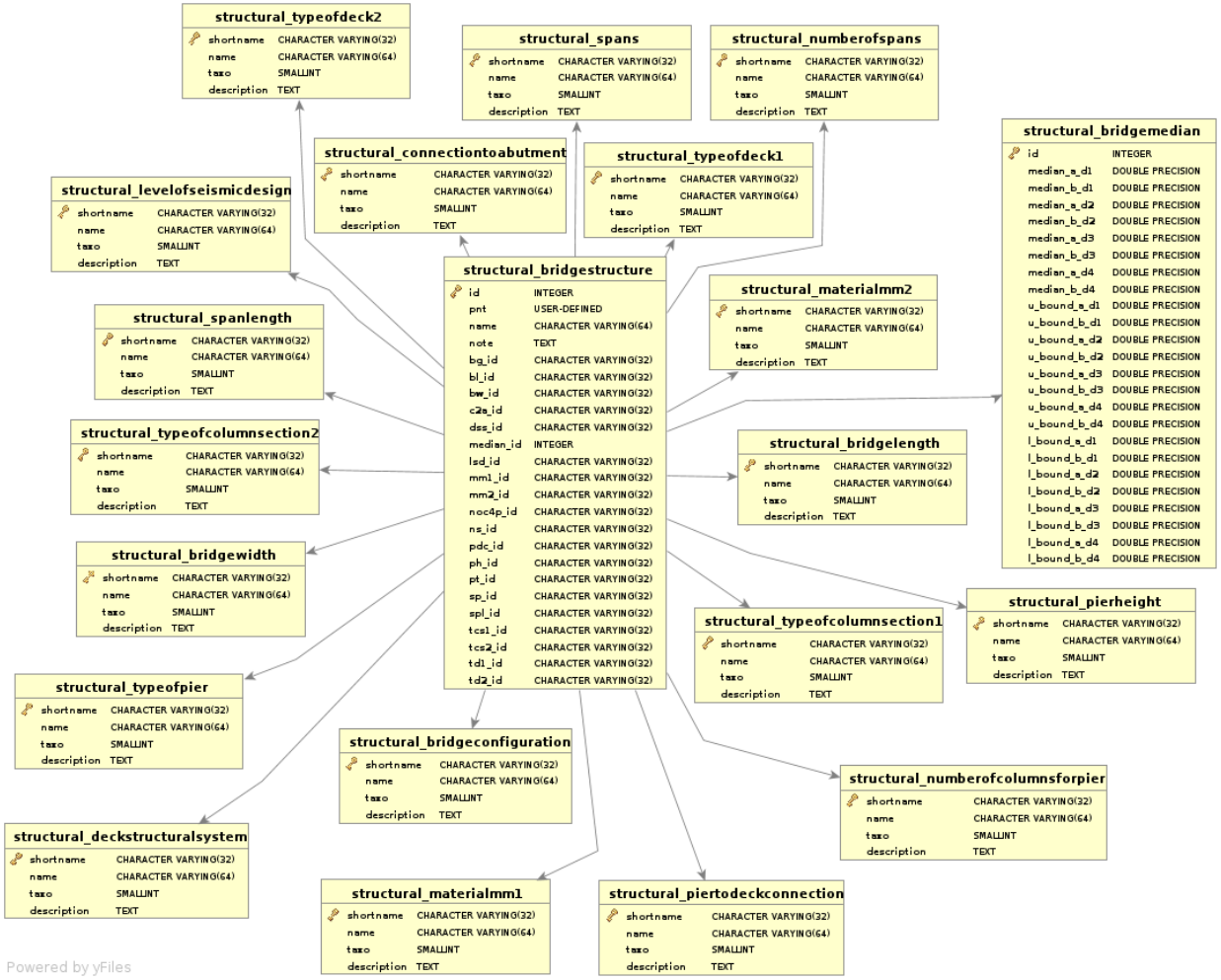




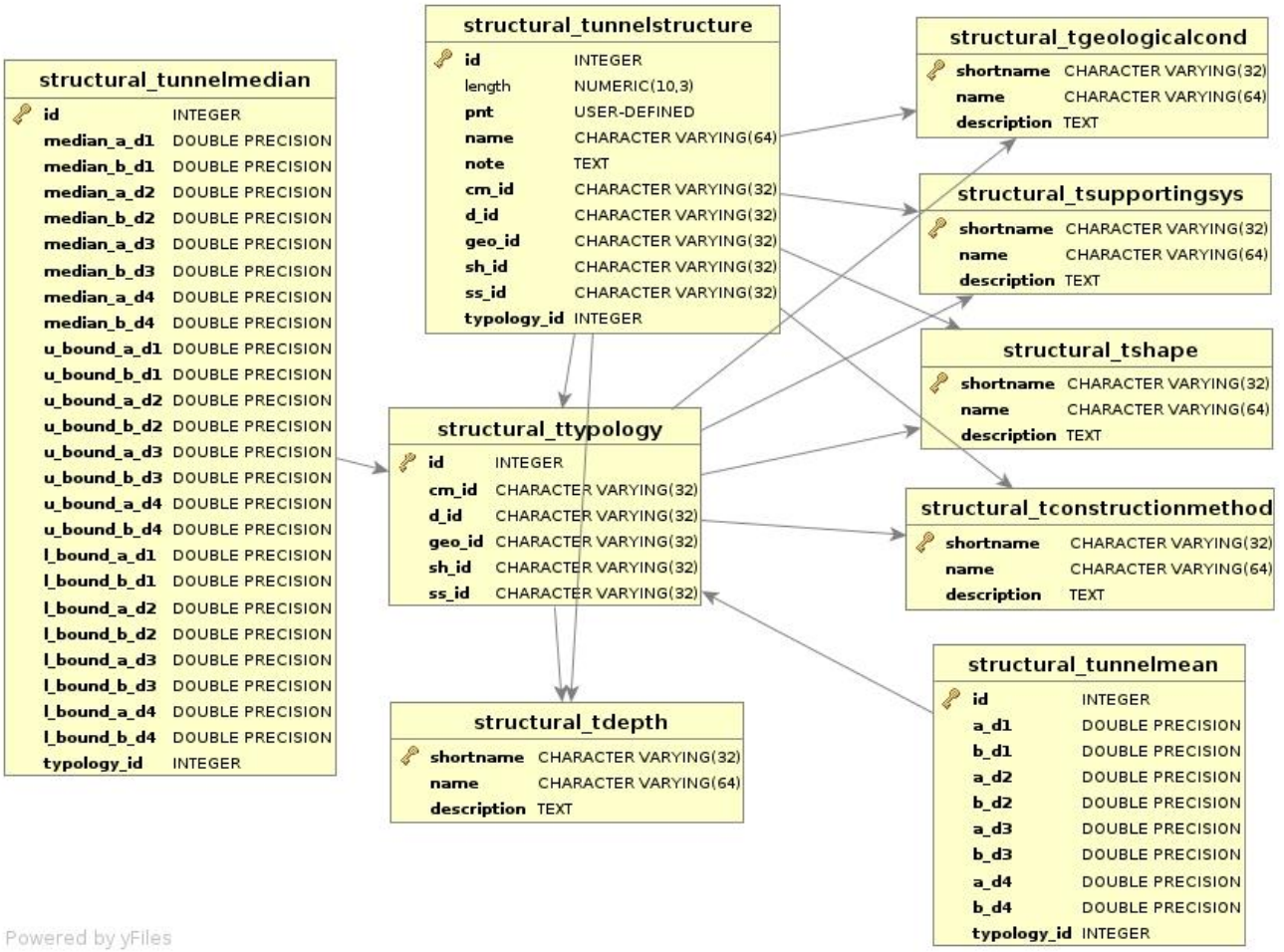


Powered by yFiles

The IDST Bridge structural model



The IDST Tunnel structural model

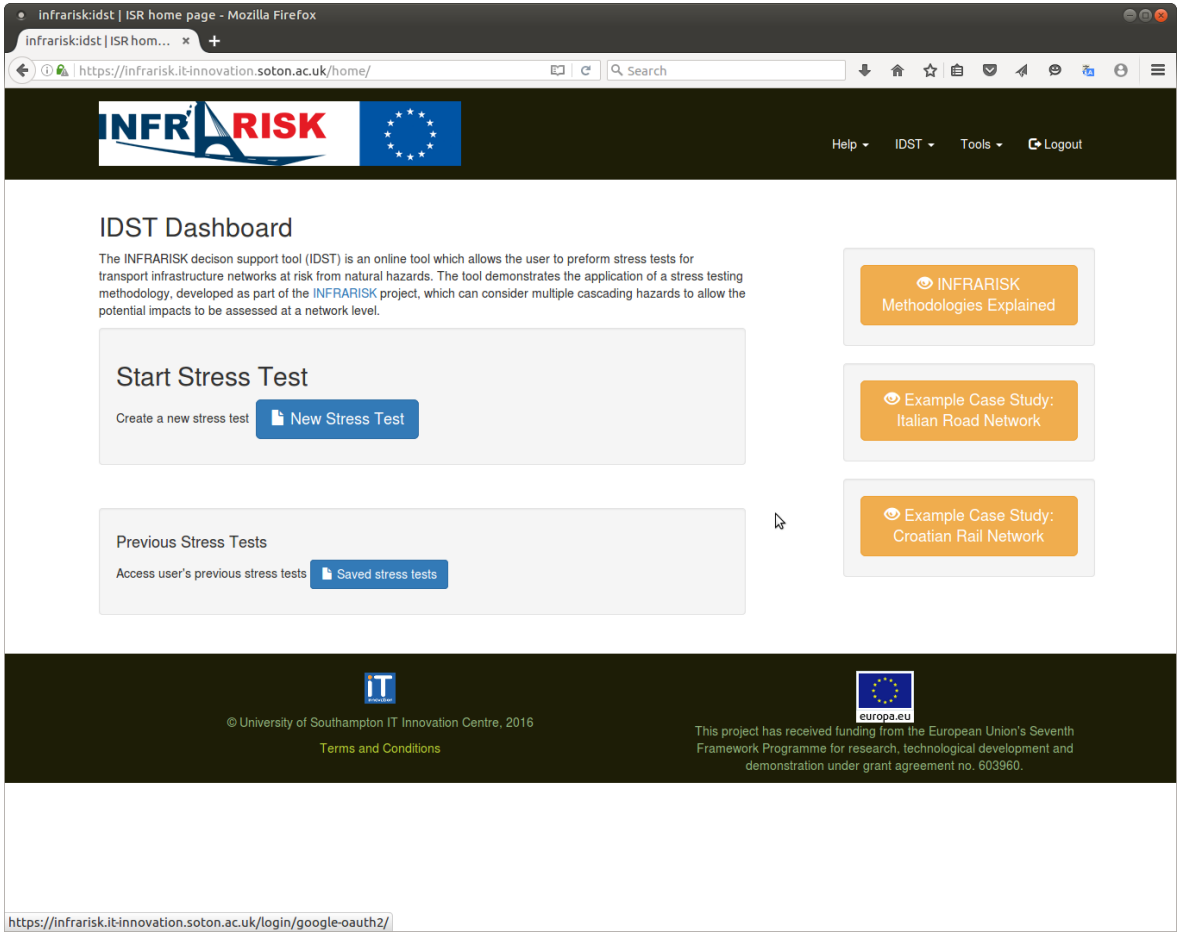


The IDST Case Study

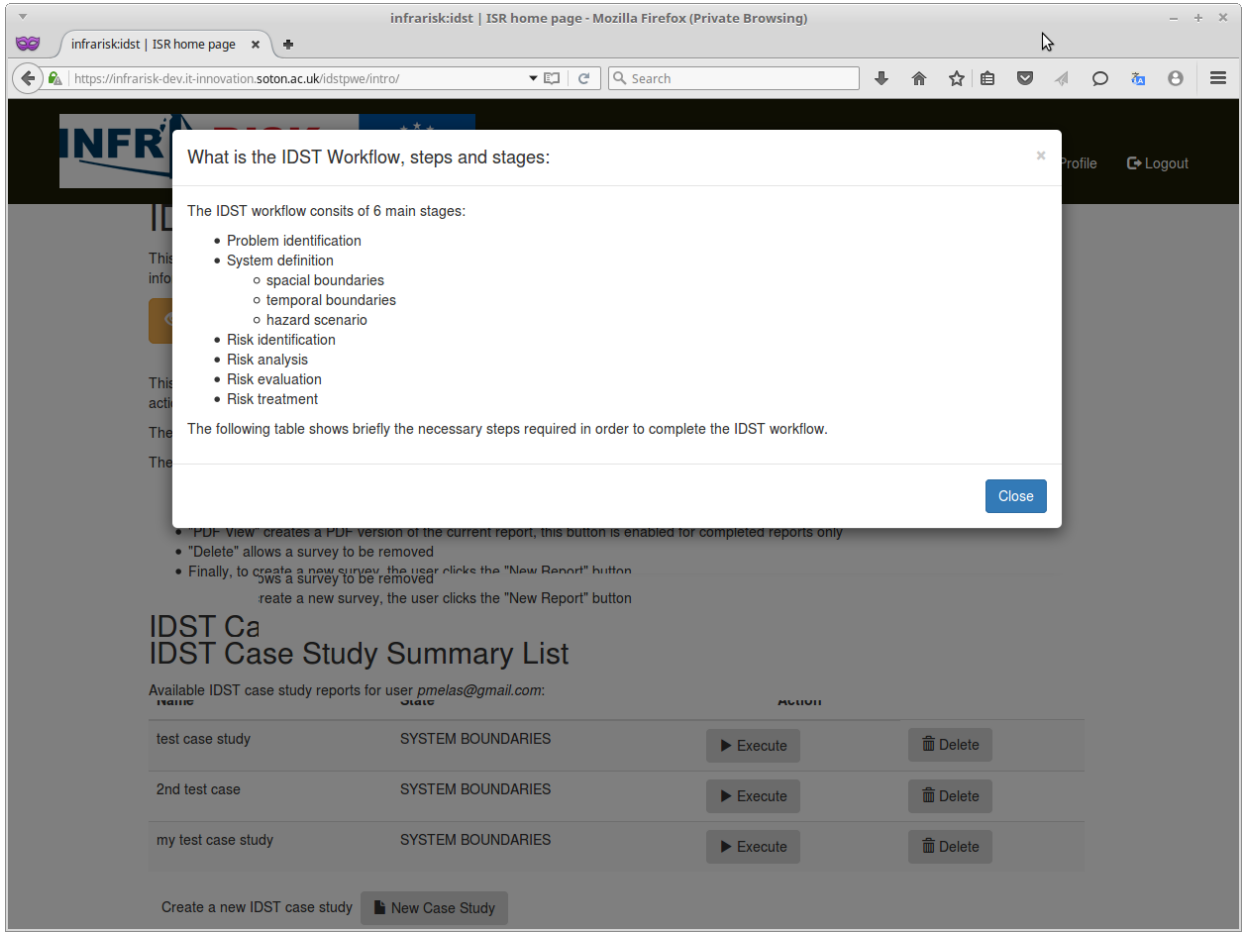
IDST Terminology:

- 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



IDST on-line help page



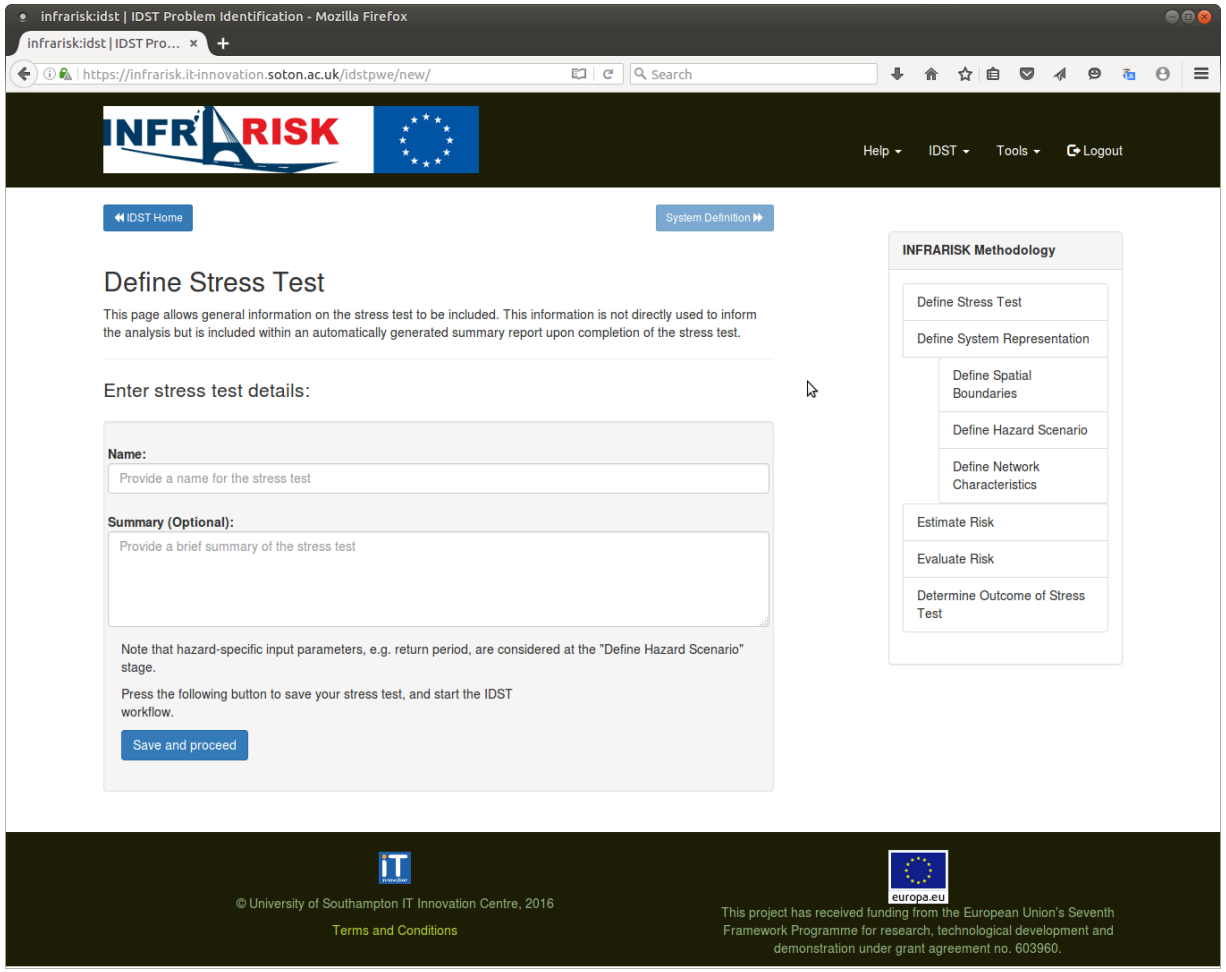
Process Workflow Engine Implementation

- 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

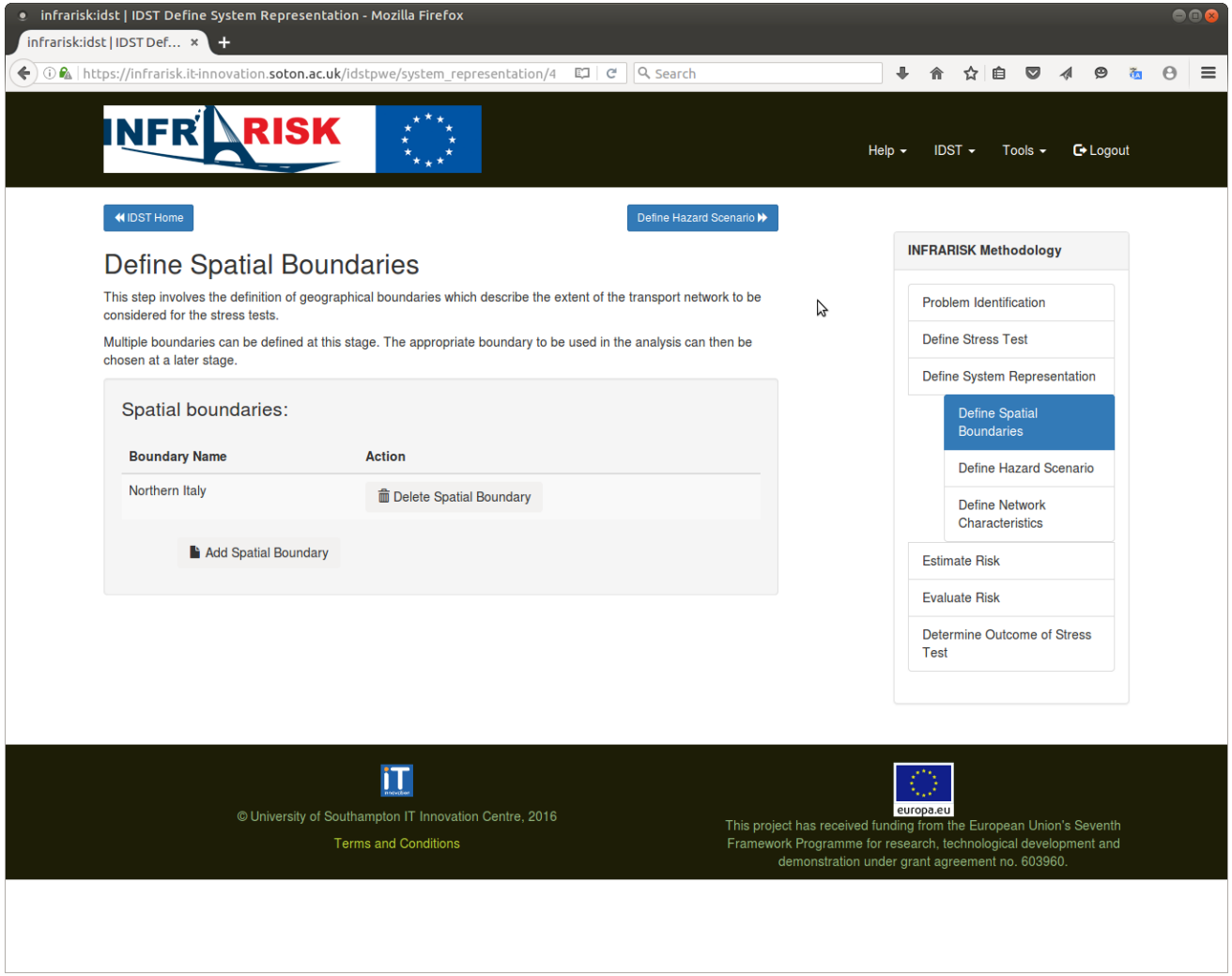
Case Study Northern Italy Scenario

- 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

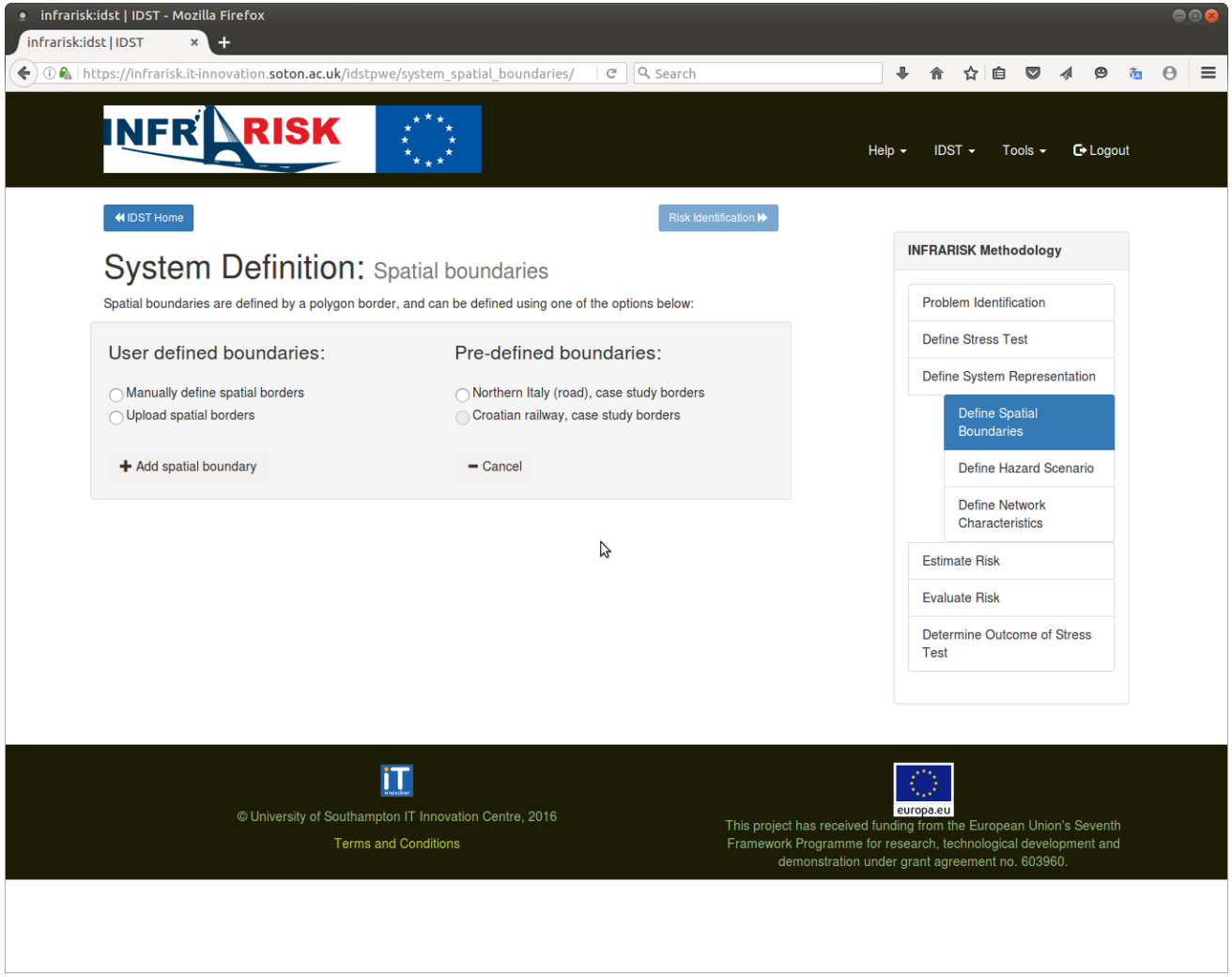
Create a new Case Study, Problem Identification



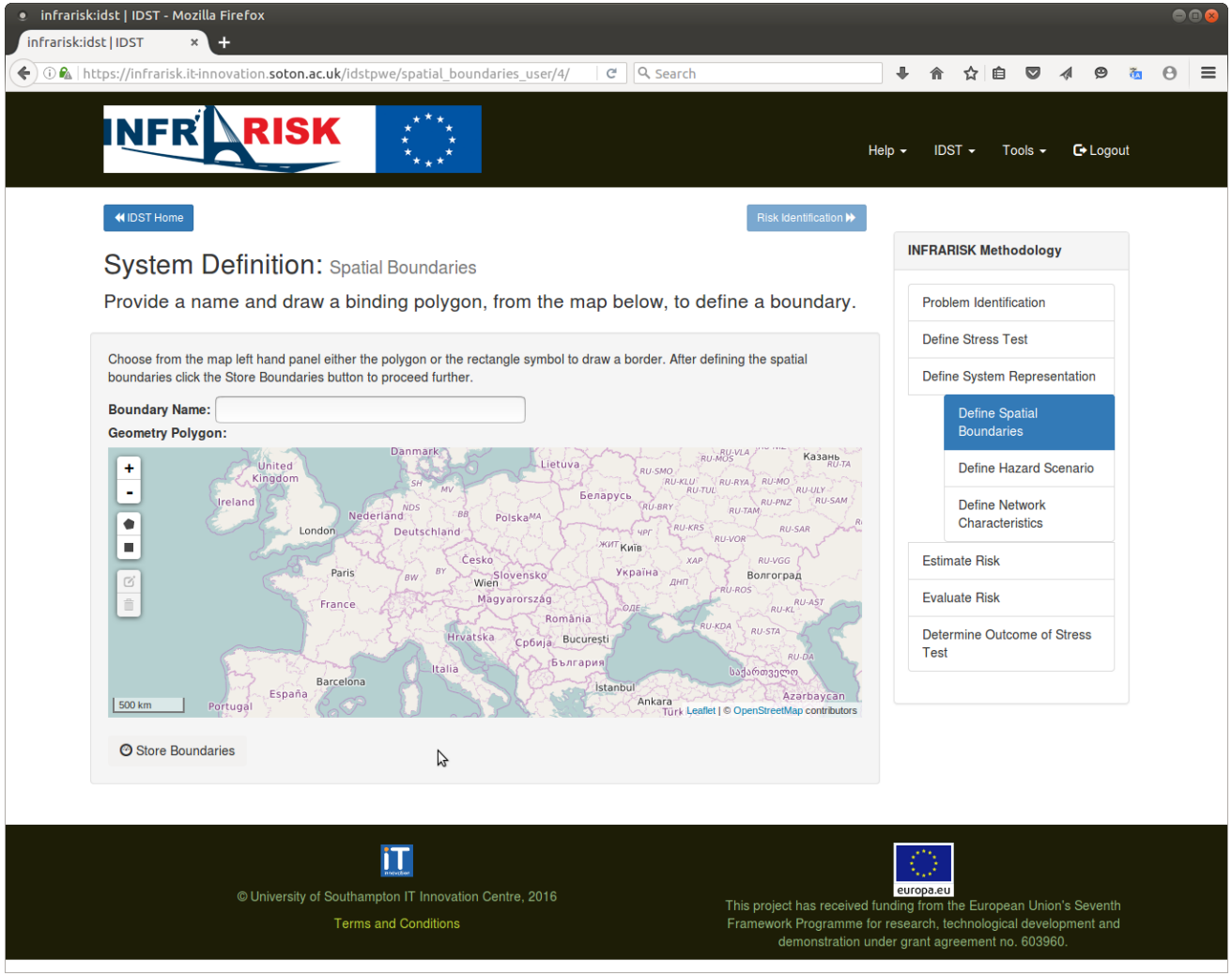
IDST: Define spatial boundaries



IDST: Define spatial boundaries



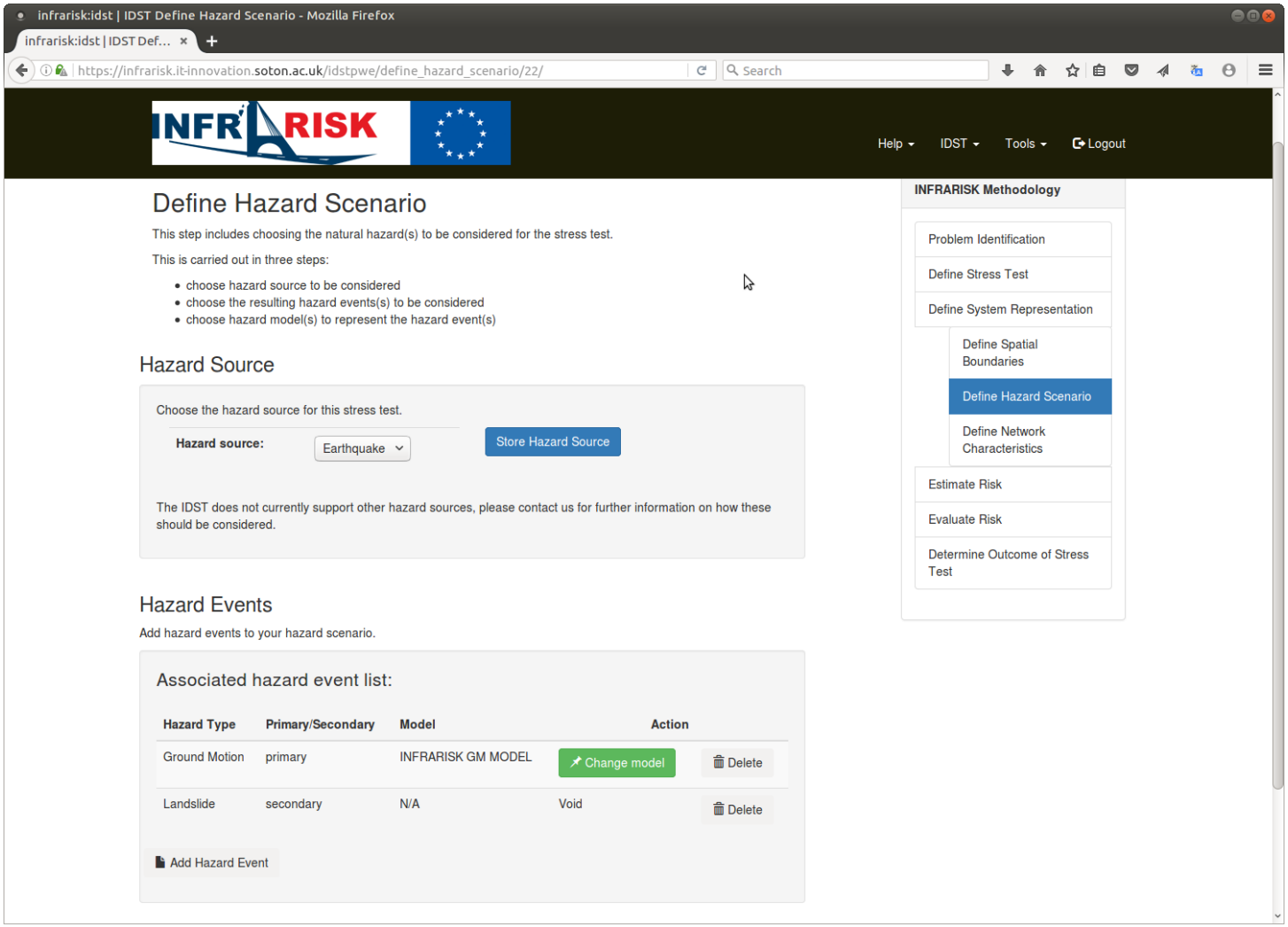
IDST: Define spatial boundaries manually



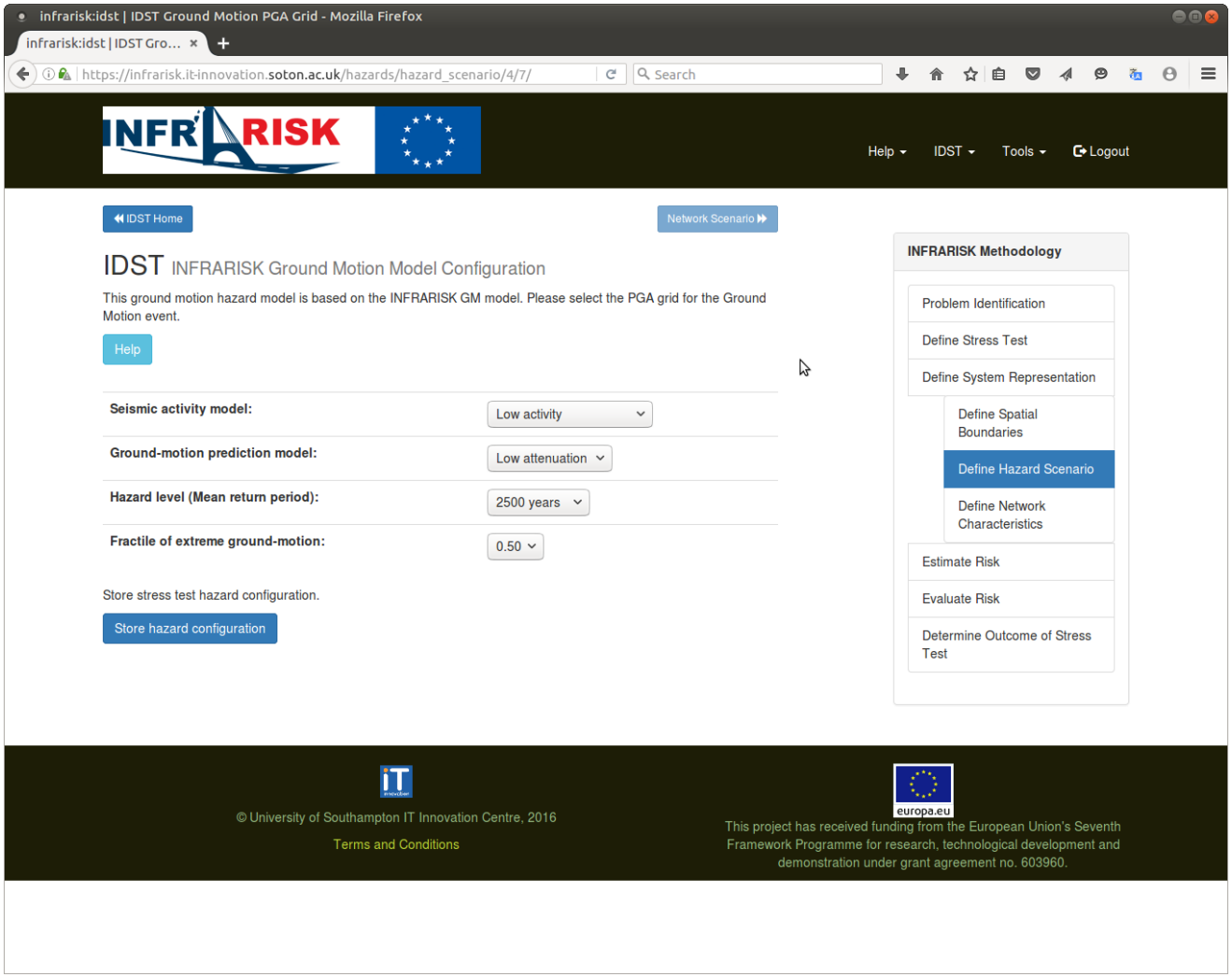
IDST: define hazard scenario

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

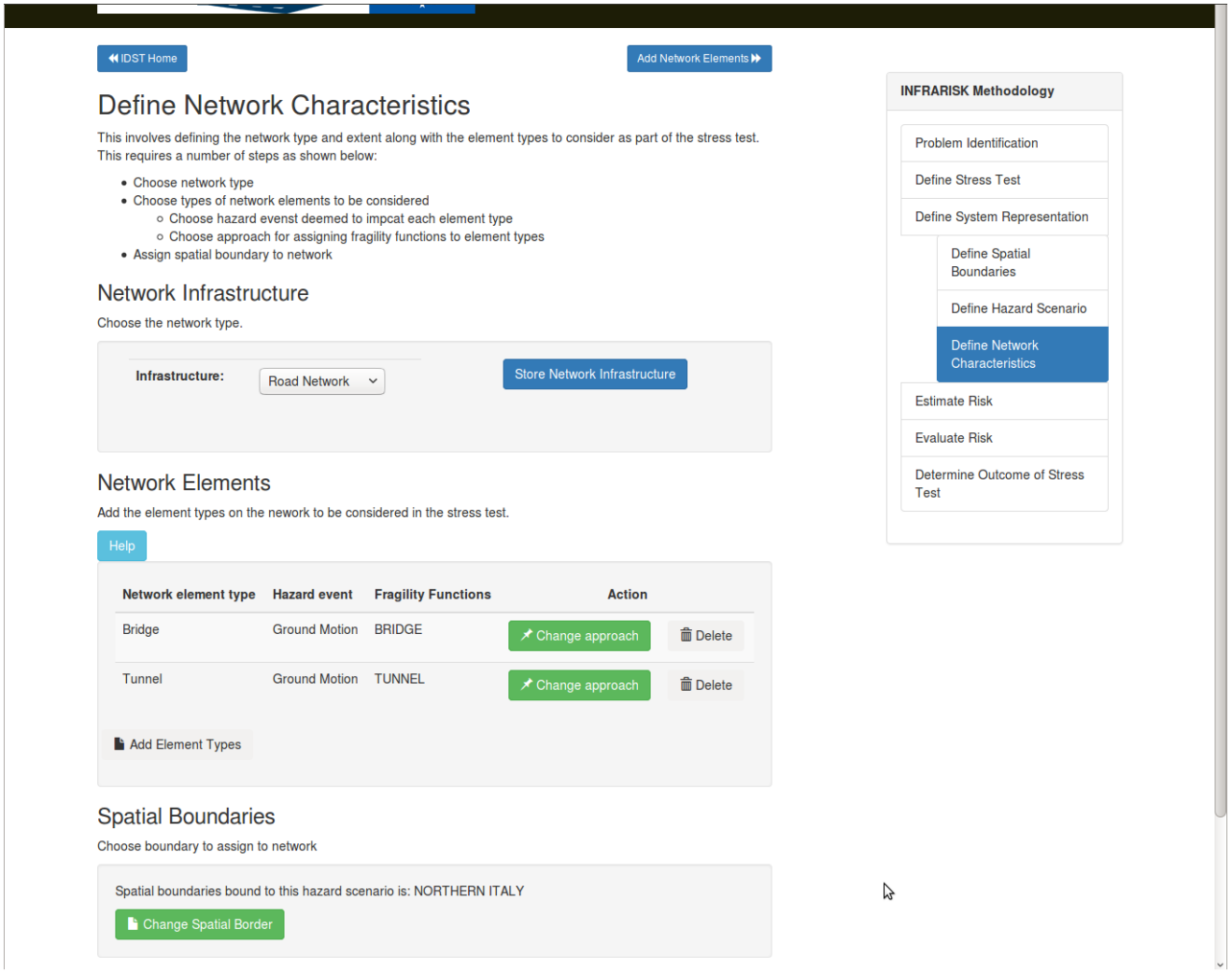
IDST: define hazard scenario



IDST: configure hazard model



IDST: define network scenario



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

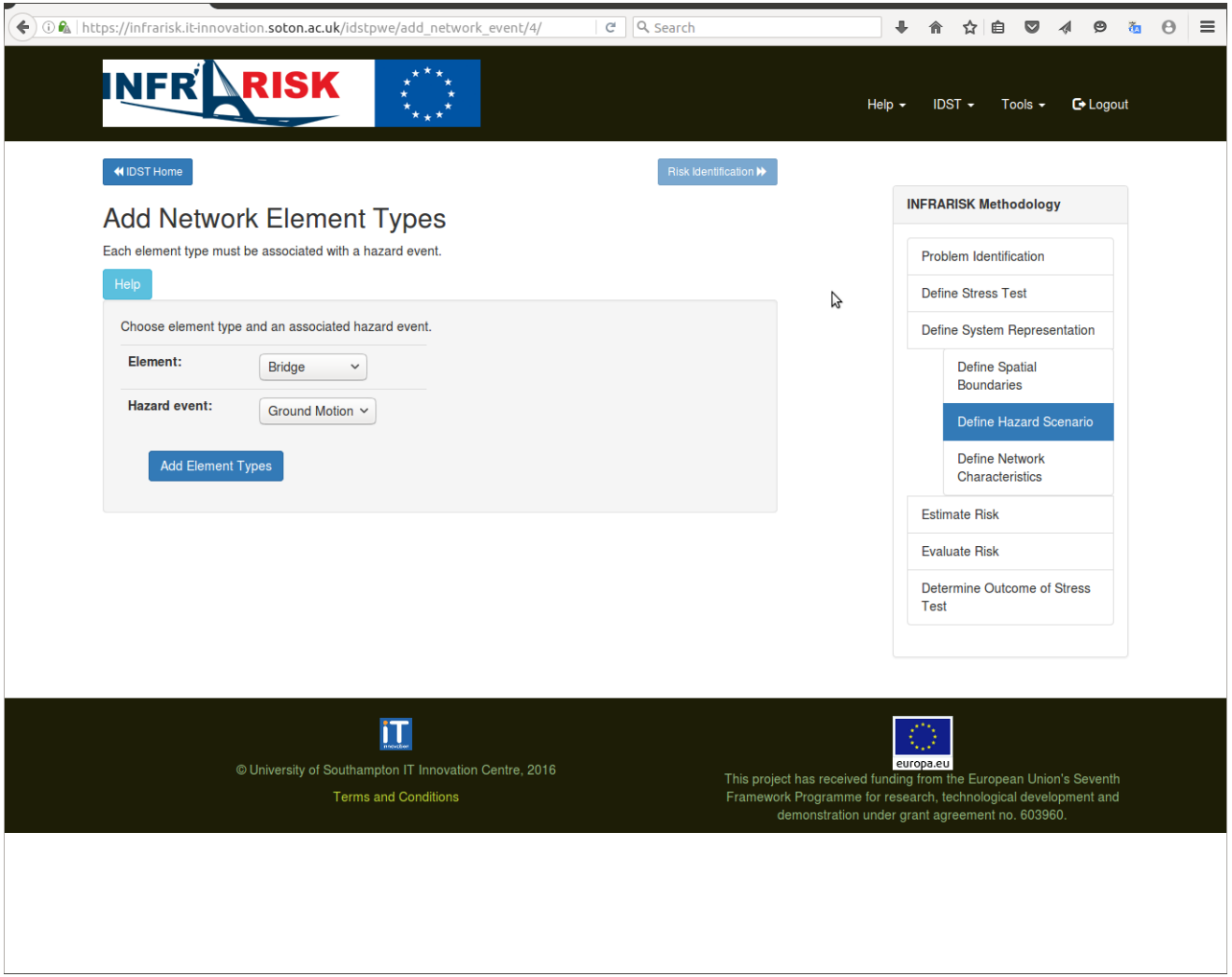
Structural Road sections data are modelled

Landslide data are modelled

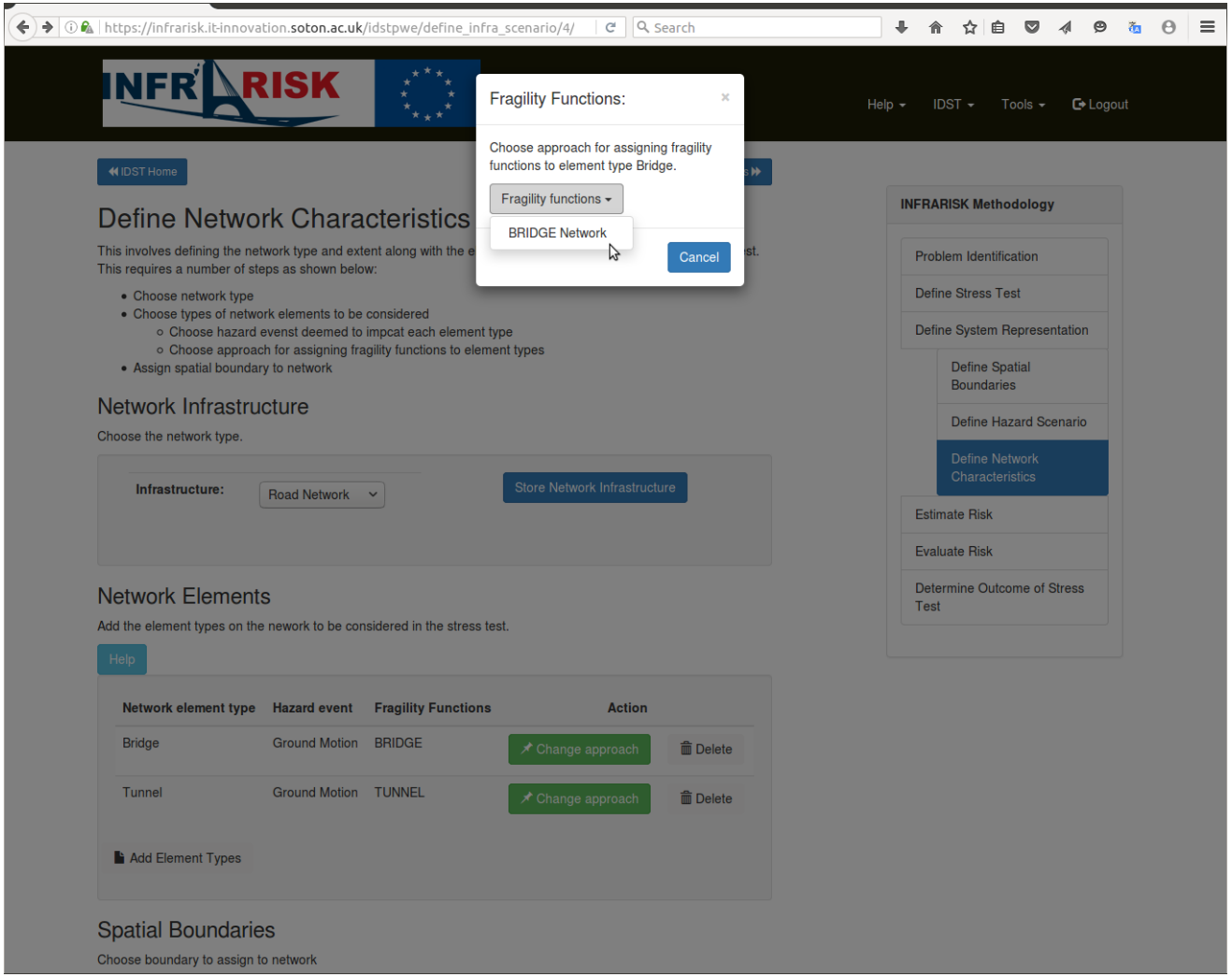
Fragility Curves calculation porting to IDST is implemented

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

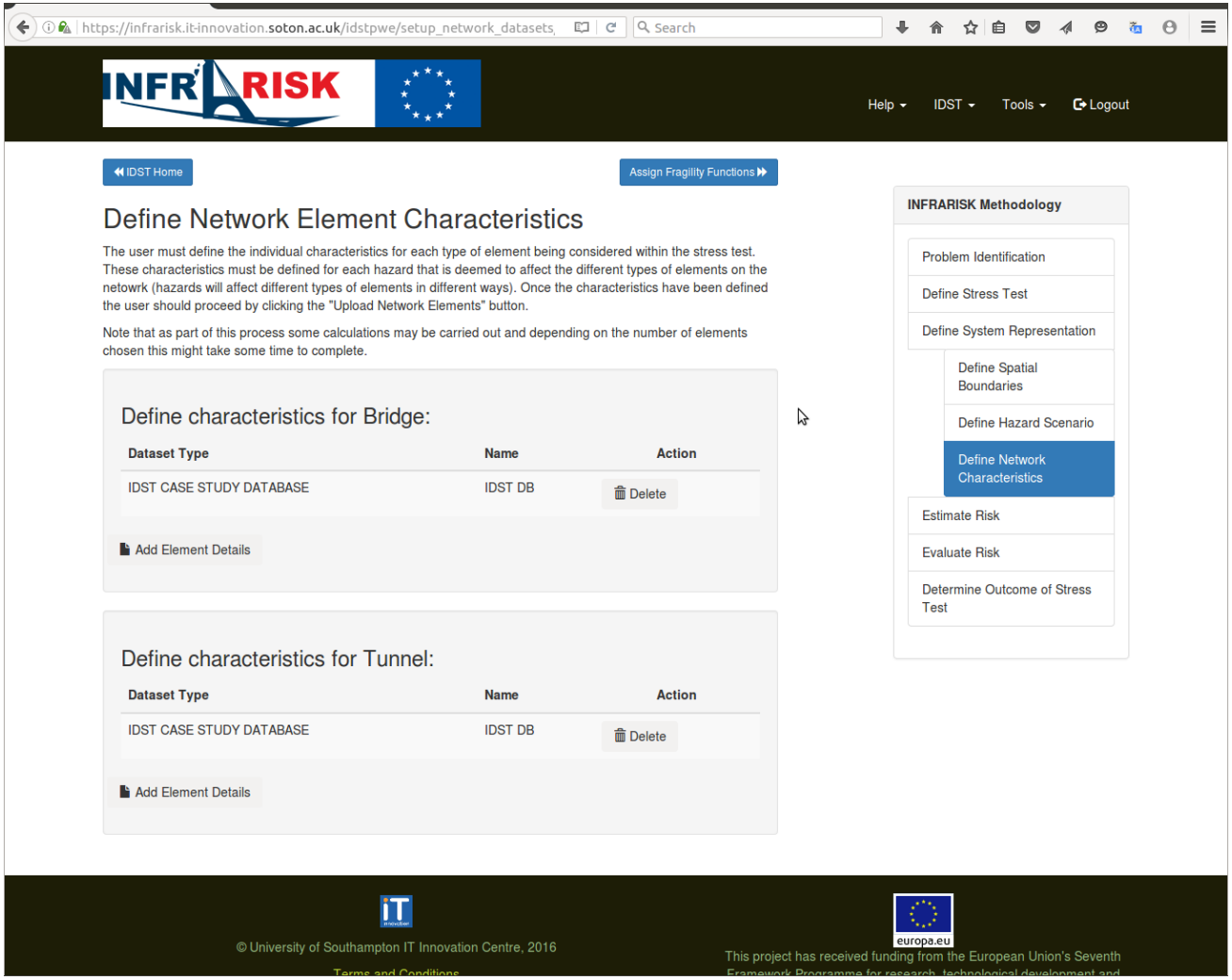
IDST: add network type elements



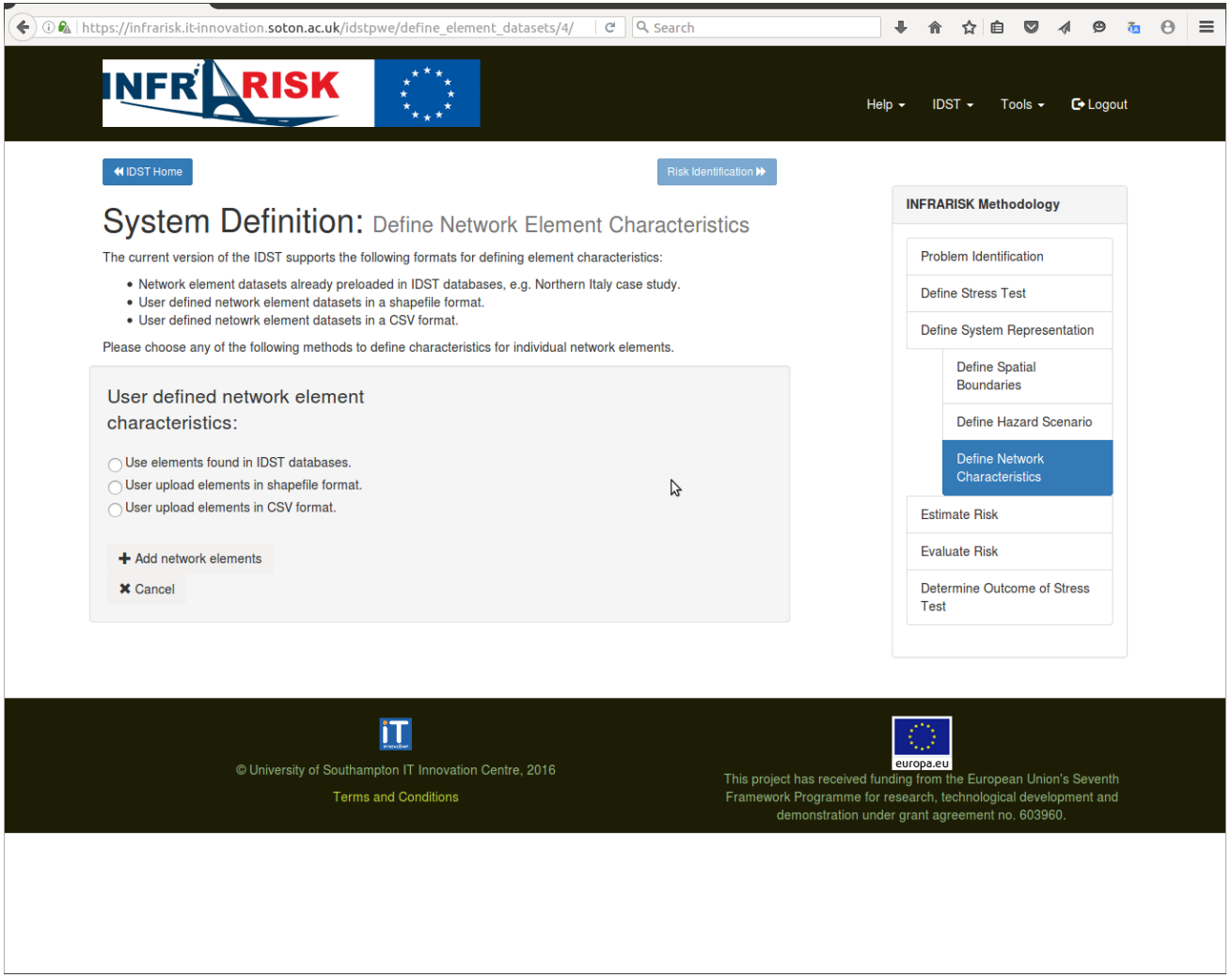
IDST: assign fragility functions



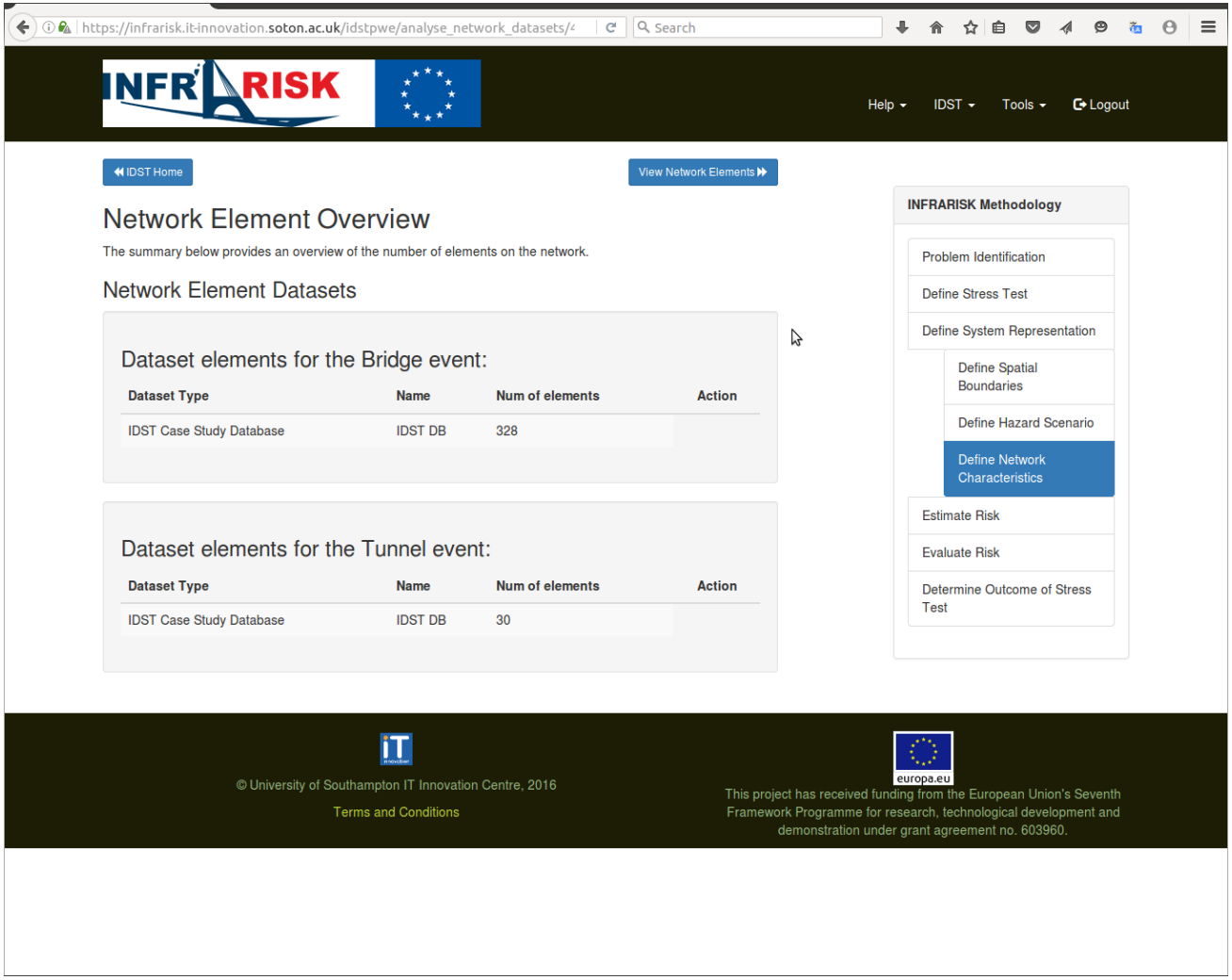
IDST: Define network element characteristics



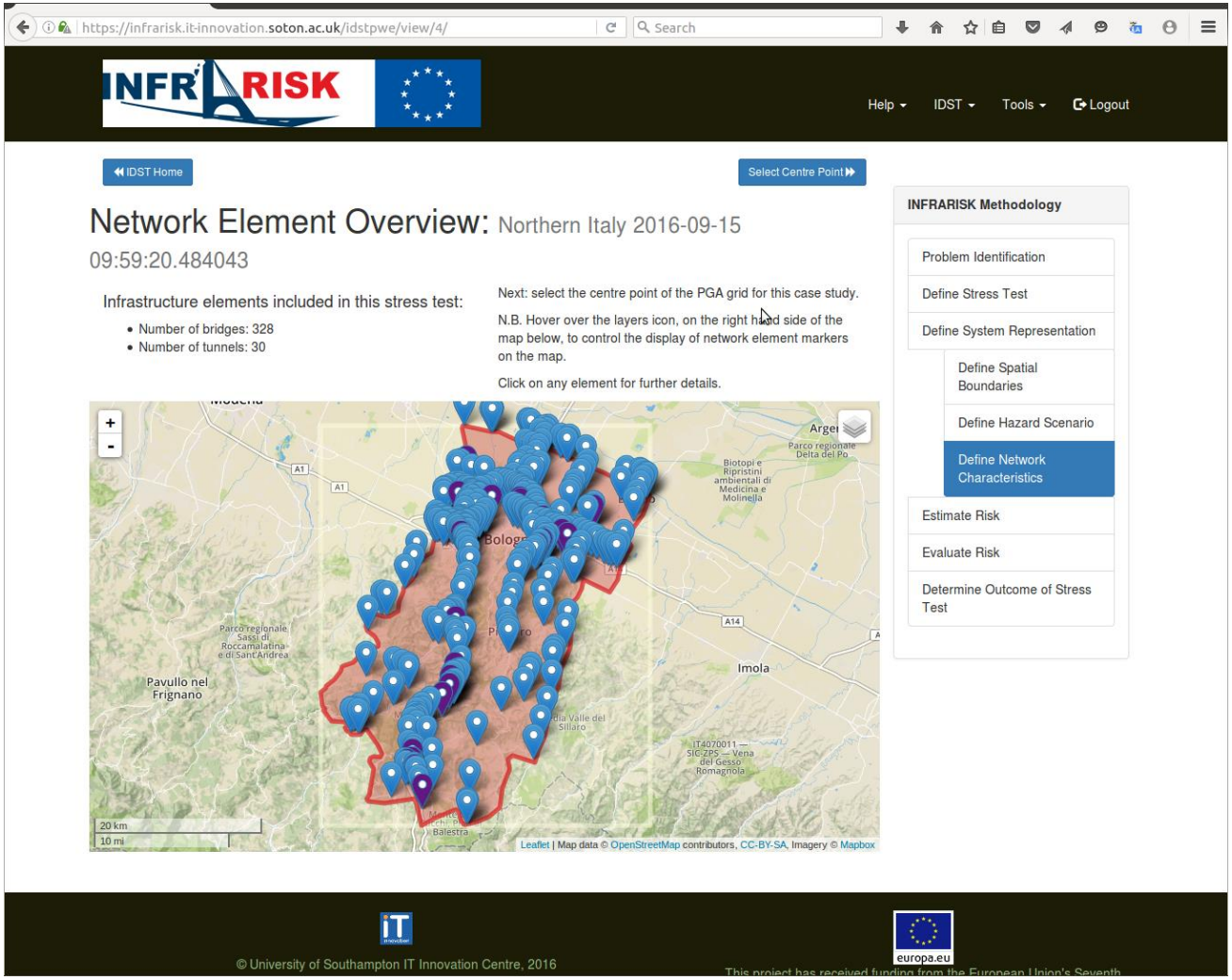
IDST: Dataset network element characteristics



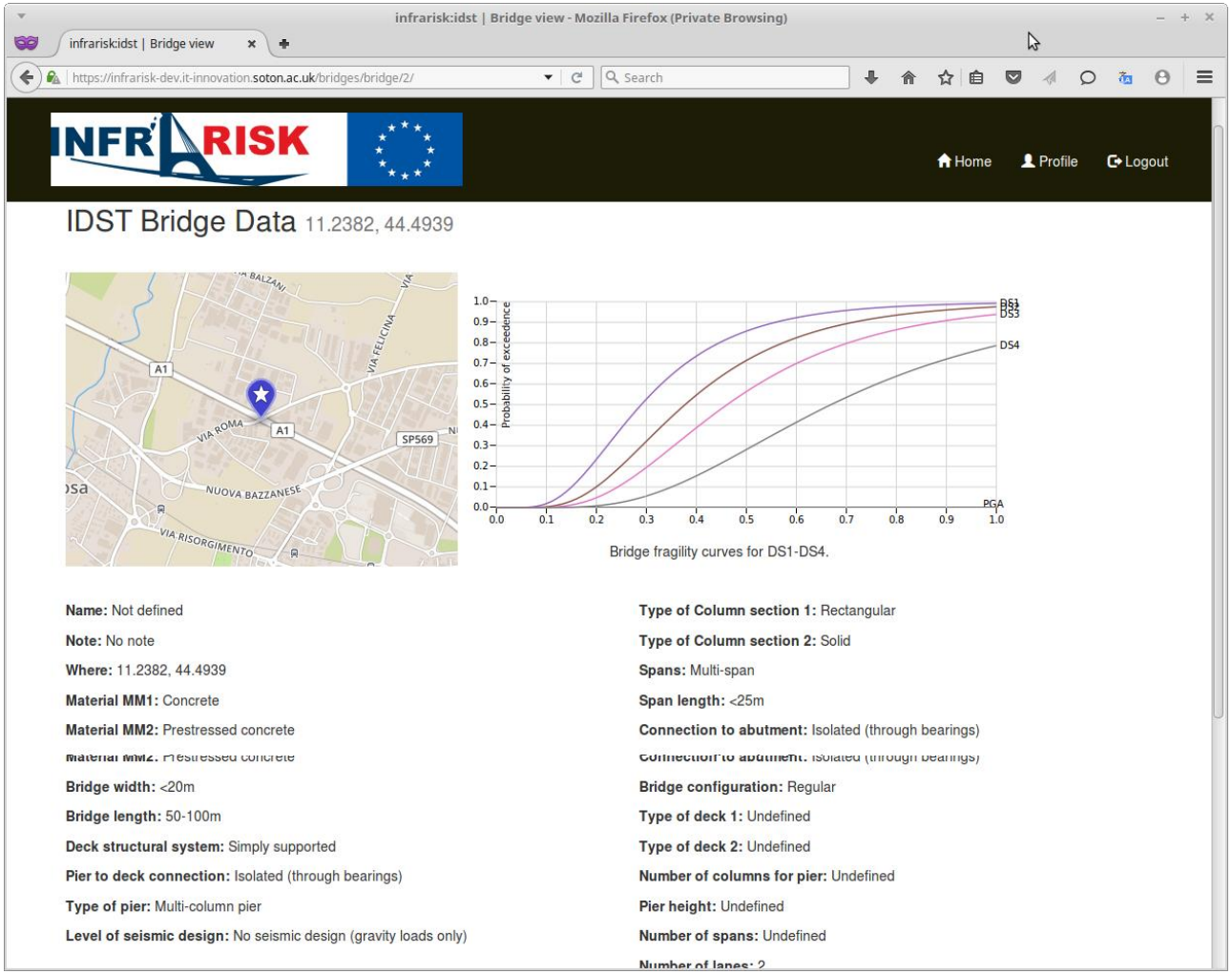
IDST: Overview of network element datasets



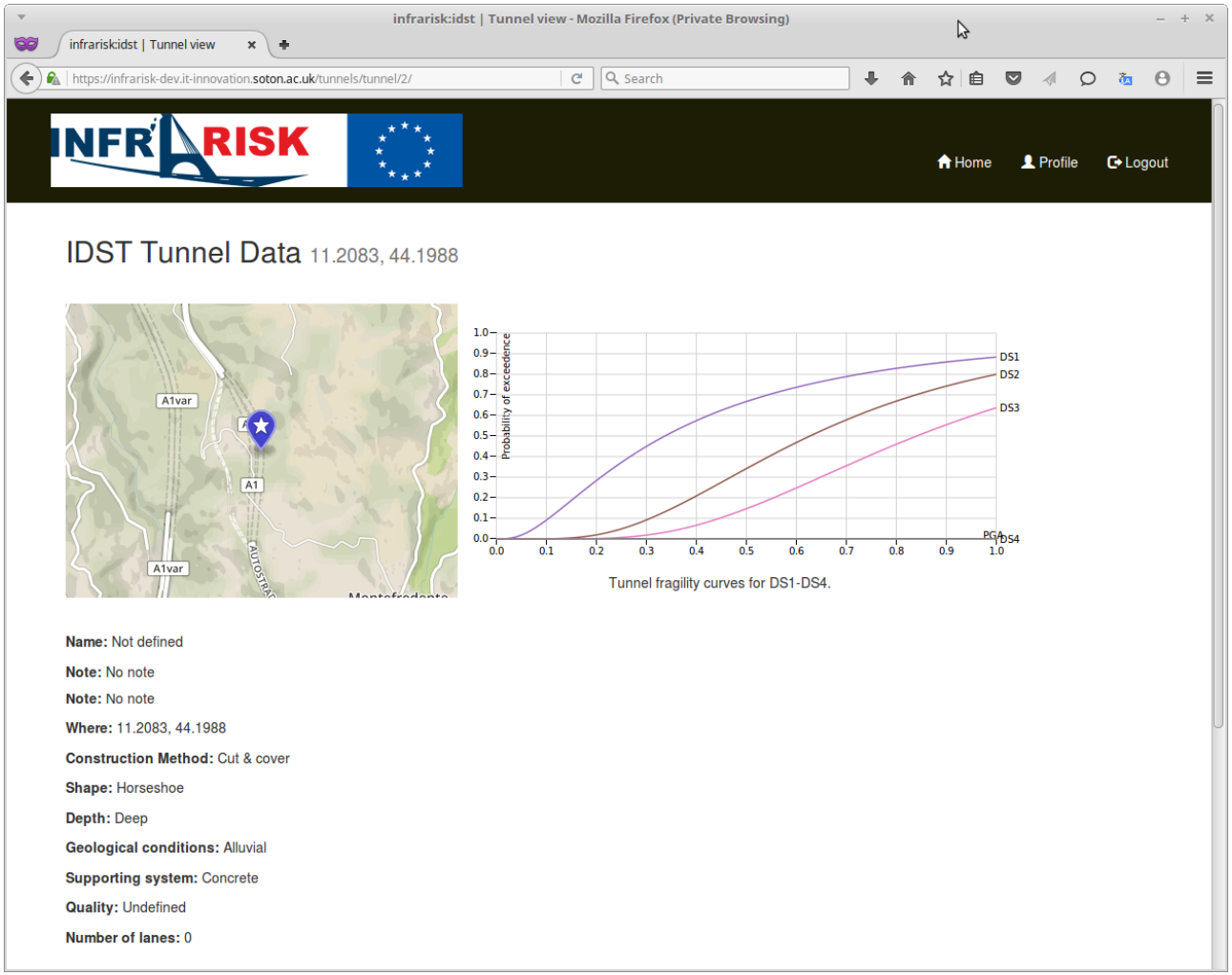
IDST: Network element overview



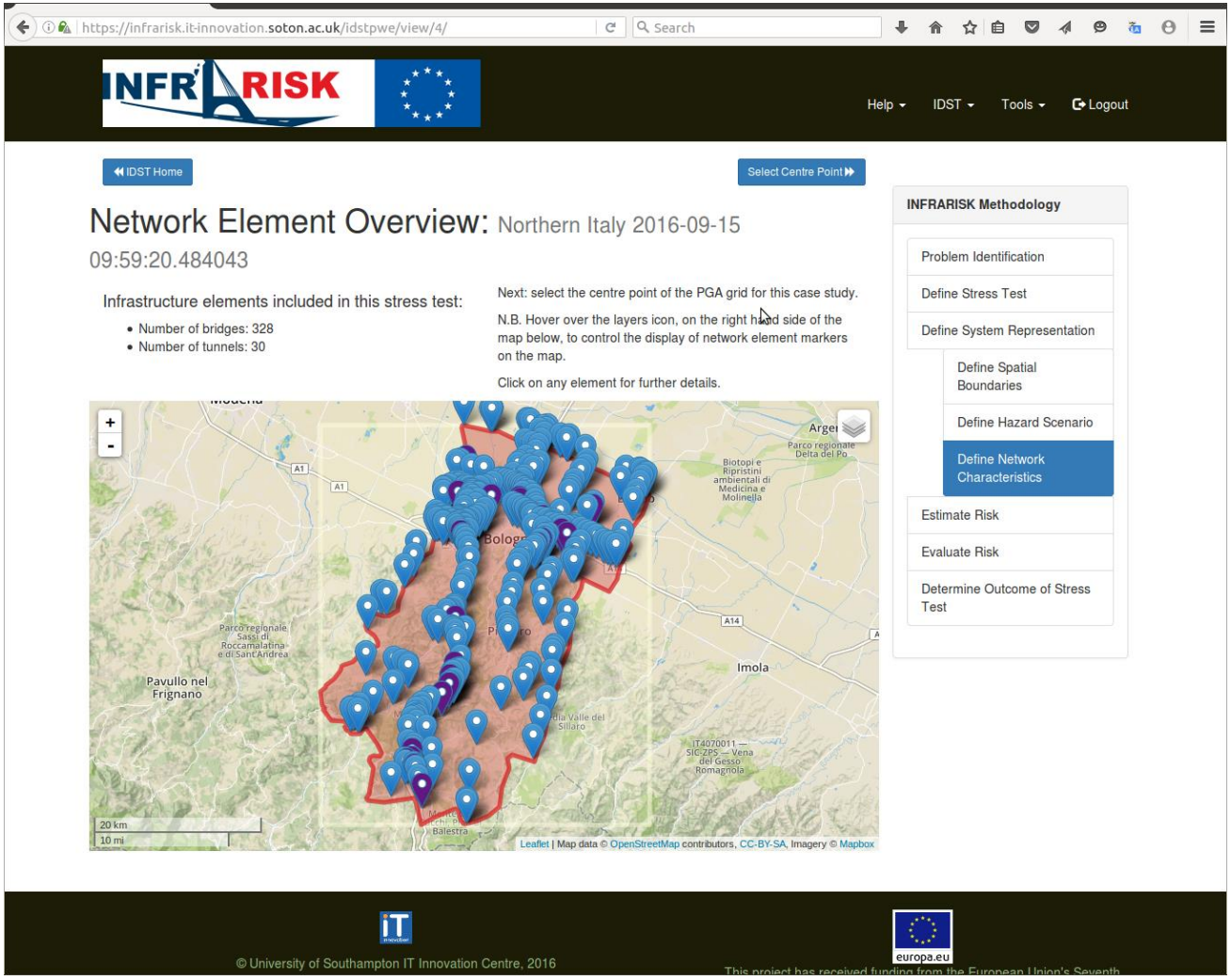
Bridge summary with assigned Fragility Curves



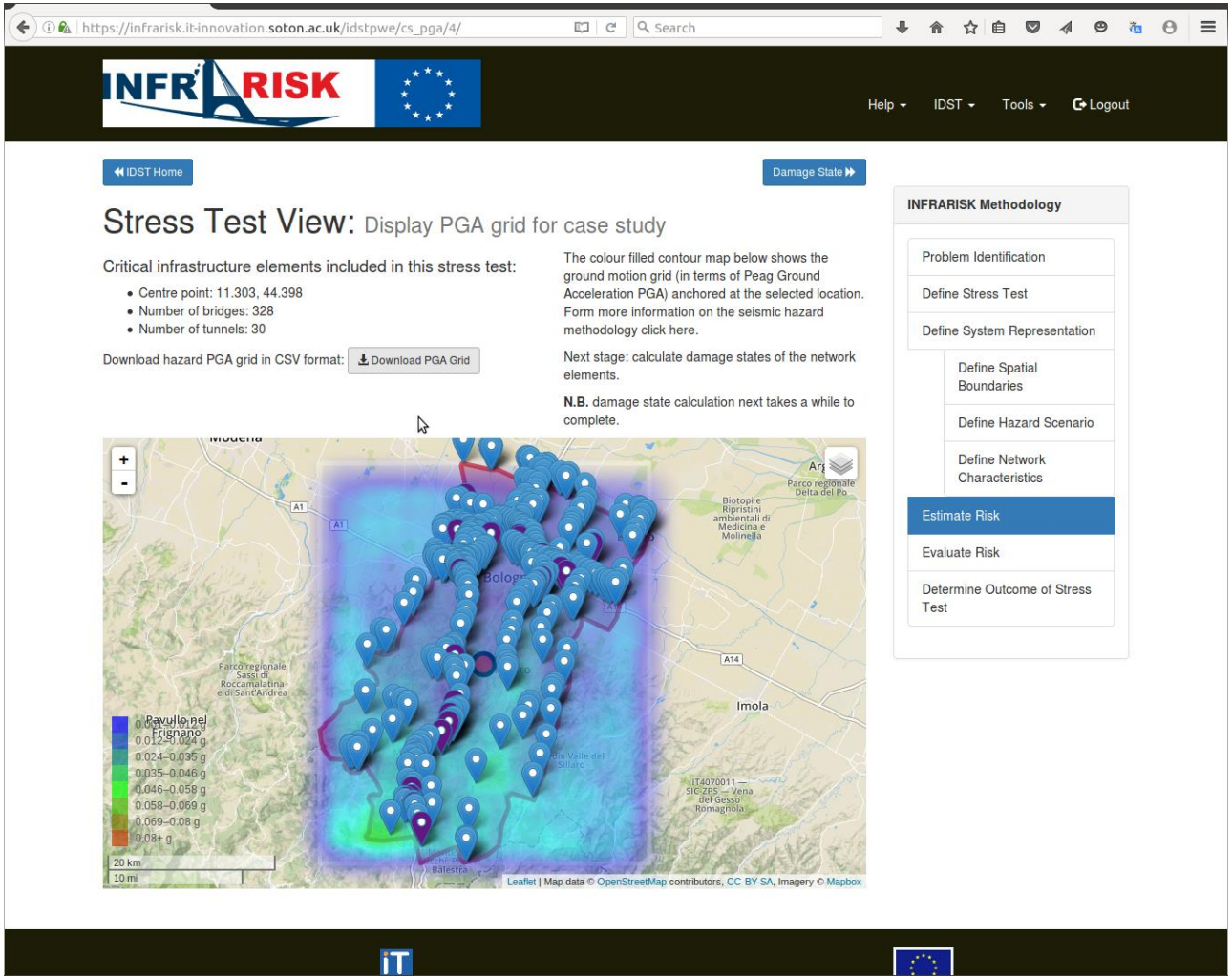
Tunnel summary with assigned Fragility Curves



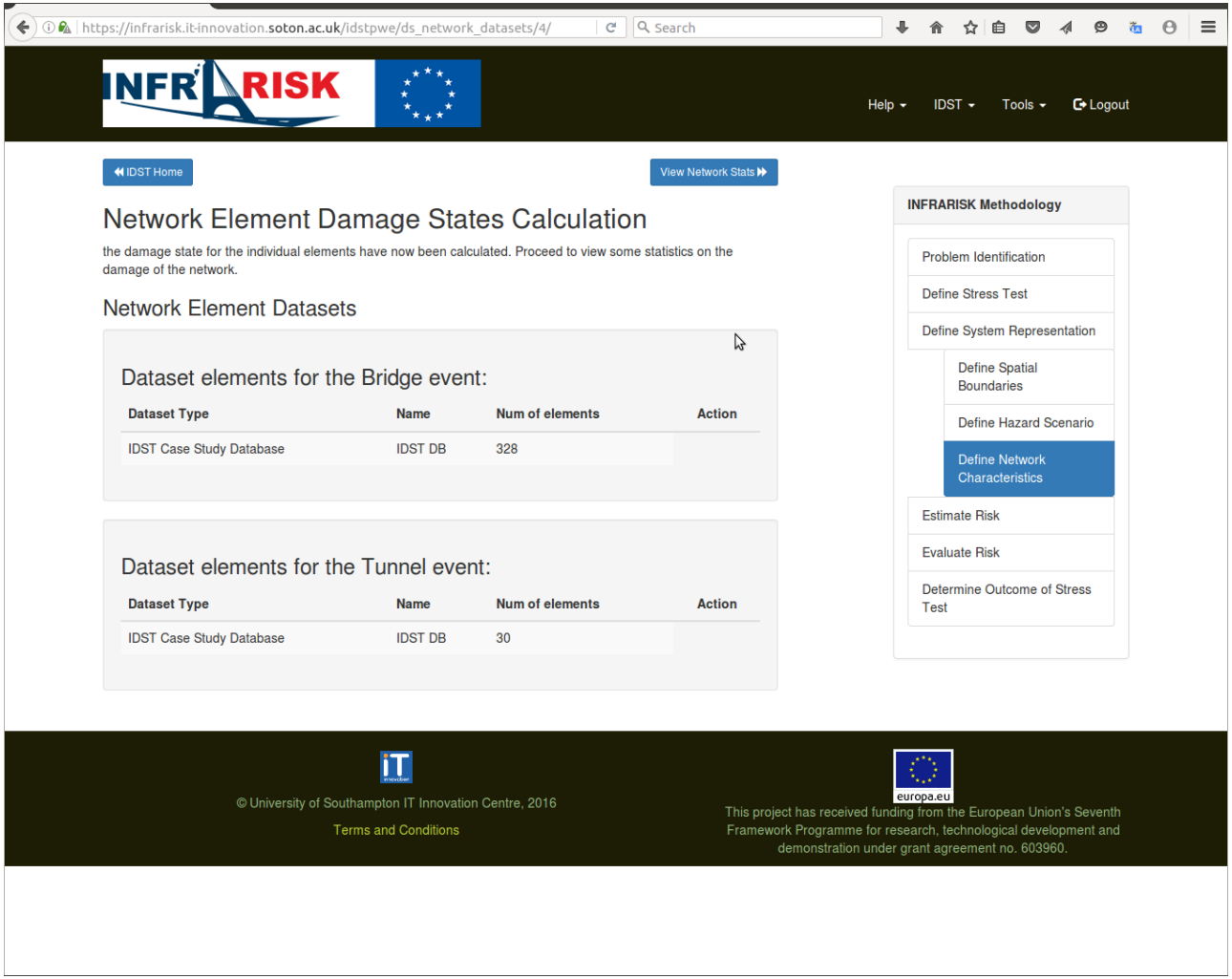
IDST: Choose centre point of interest



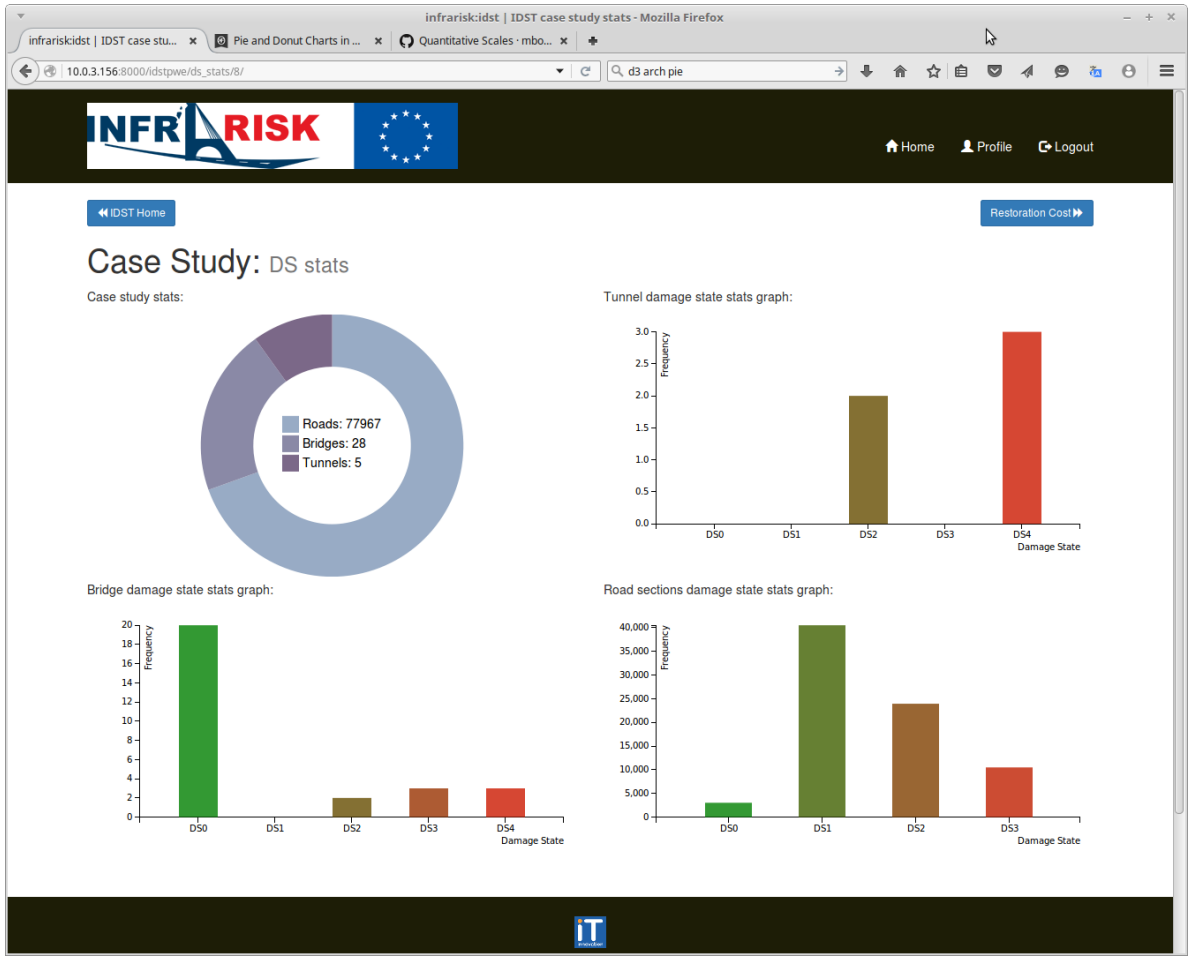
IDST: Anchor PGA grid on centre point



IDST: Calculate Damage States



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

Acknowledgement

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 603960