



Civil Engineering  
Department

# University of Porto Faculty of Engineering

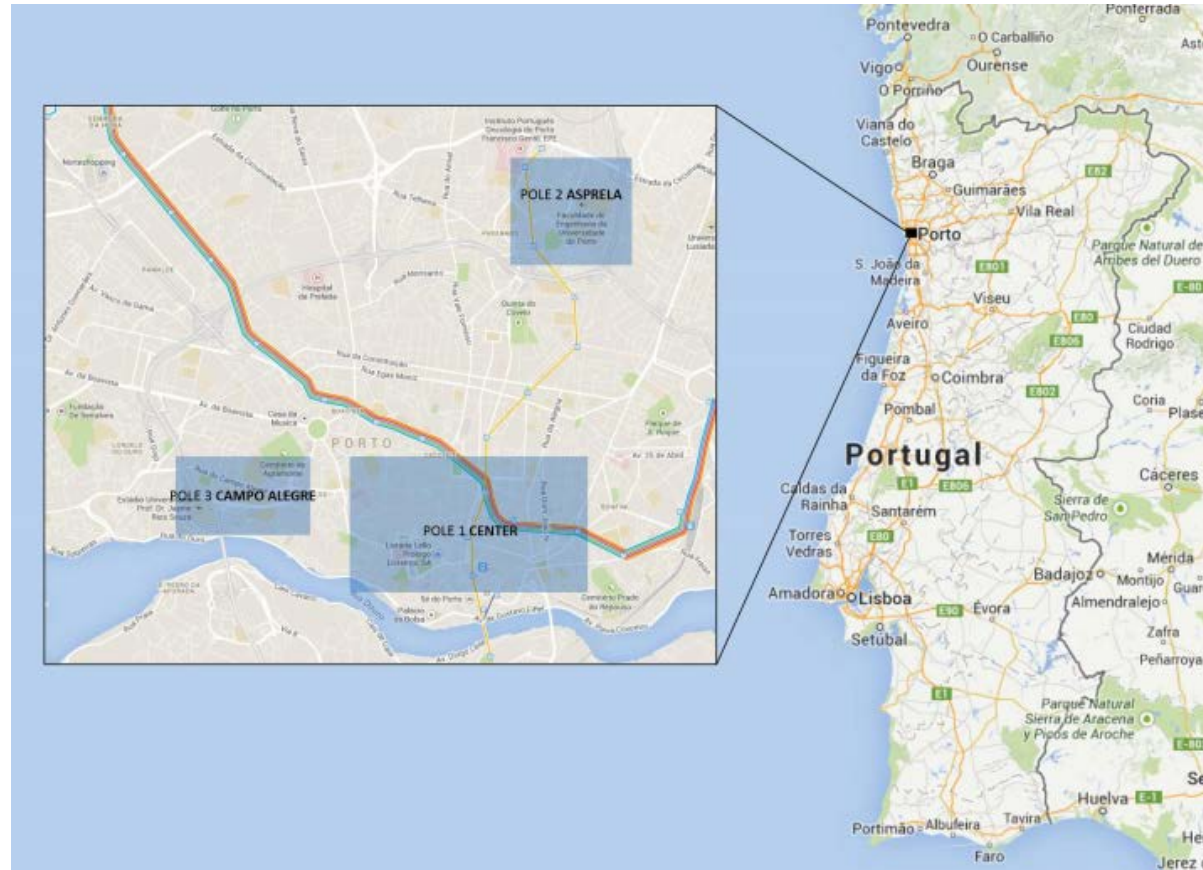
# University of Porto

Foundation: **1911**

**3** campus

**14** Faculties

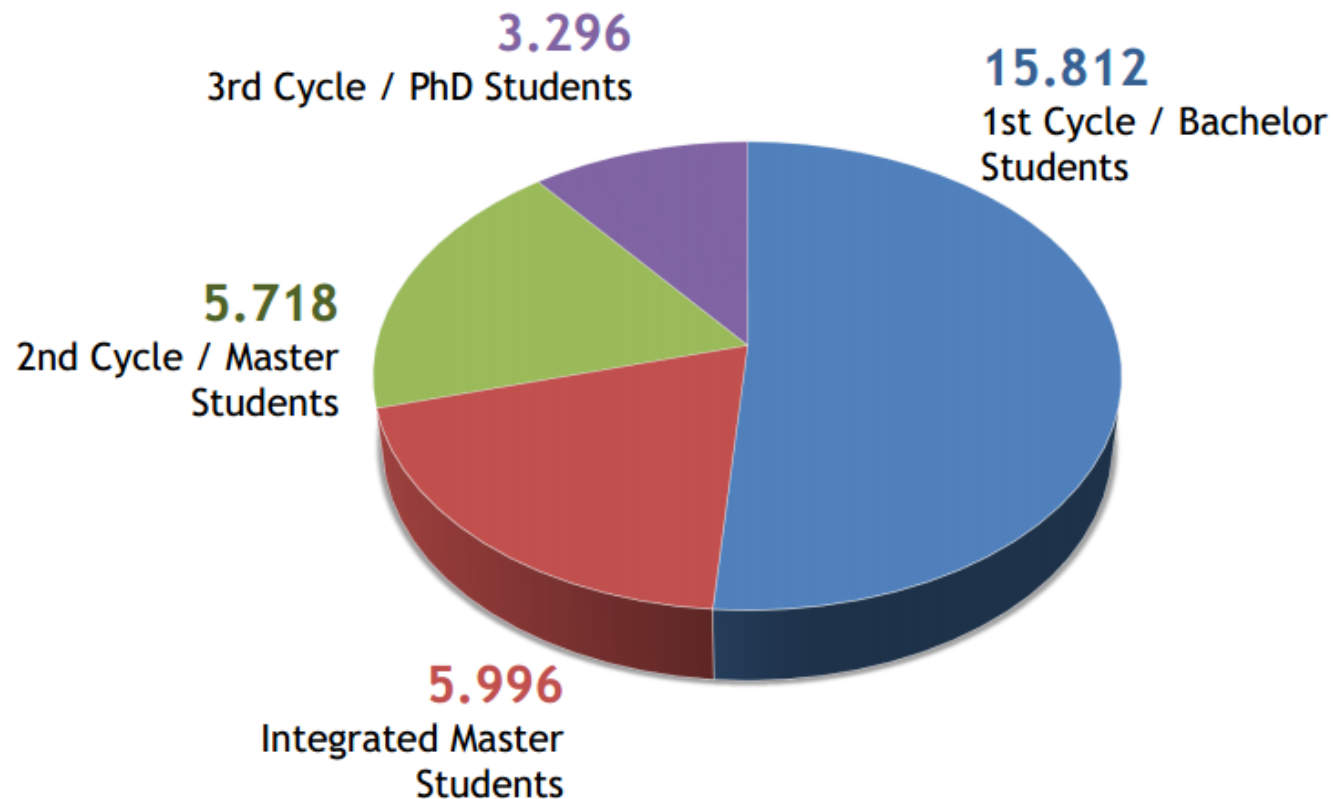
**1** Business School



# University of Porto

One of the portuguese largest Universities:

**30.822 Students** (2013), 13% of which are international



# University of Porto



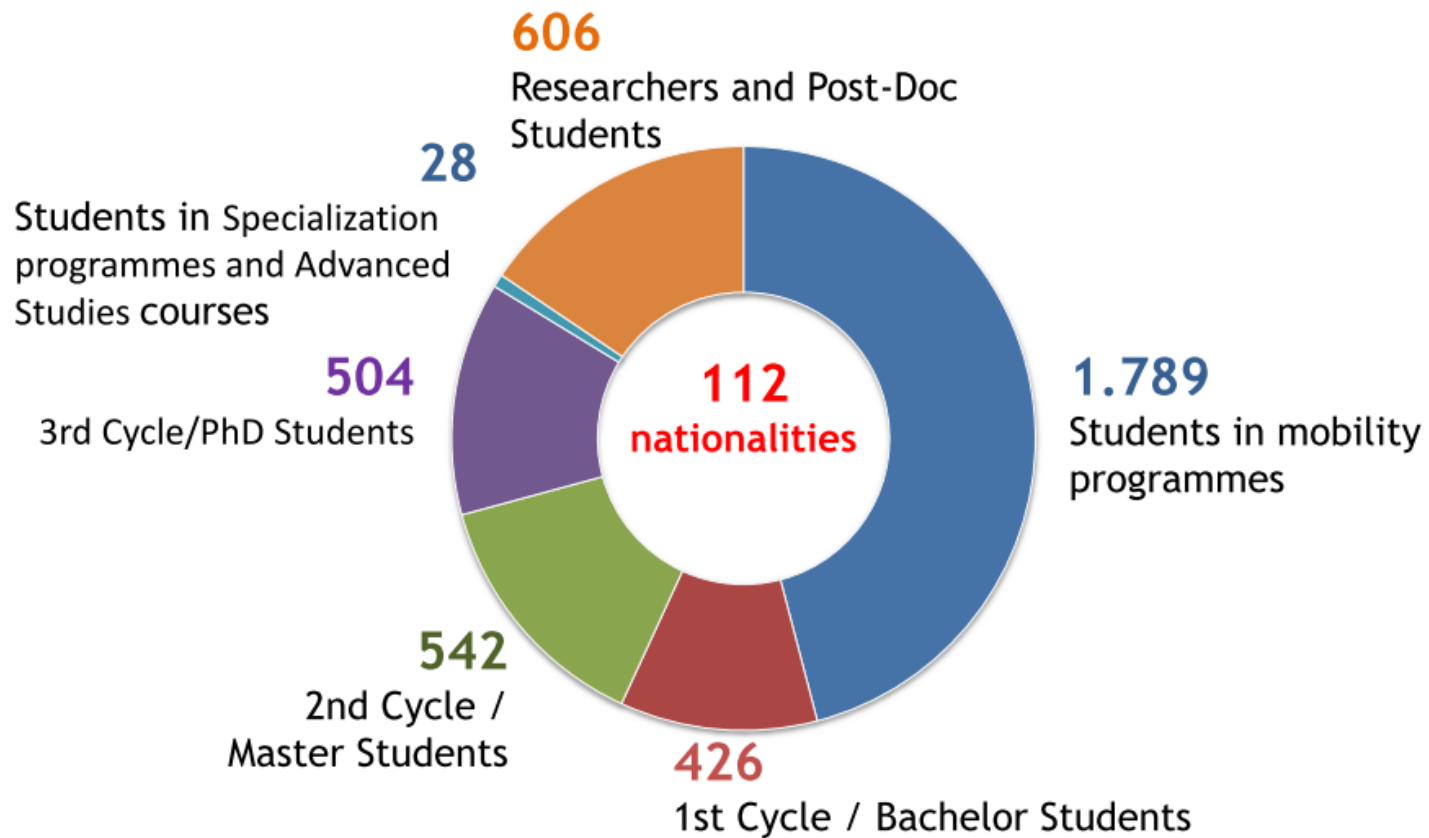
**2365 Teaching staff and researchers (2015)**

82% Teaching staff and researchers have PhD

1577 Non teaching staff

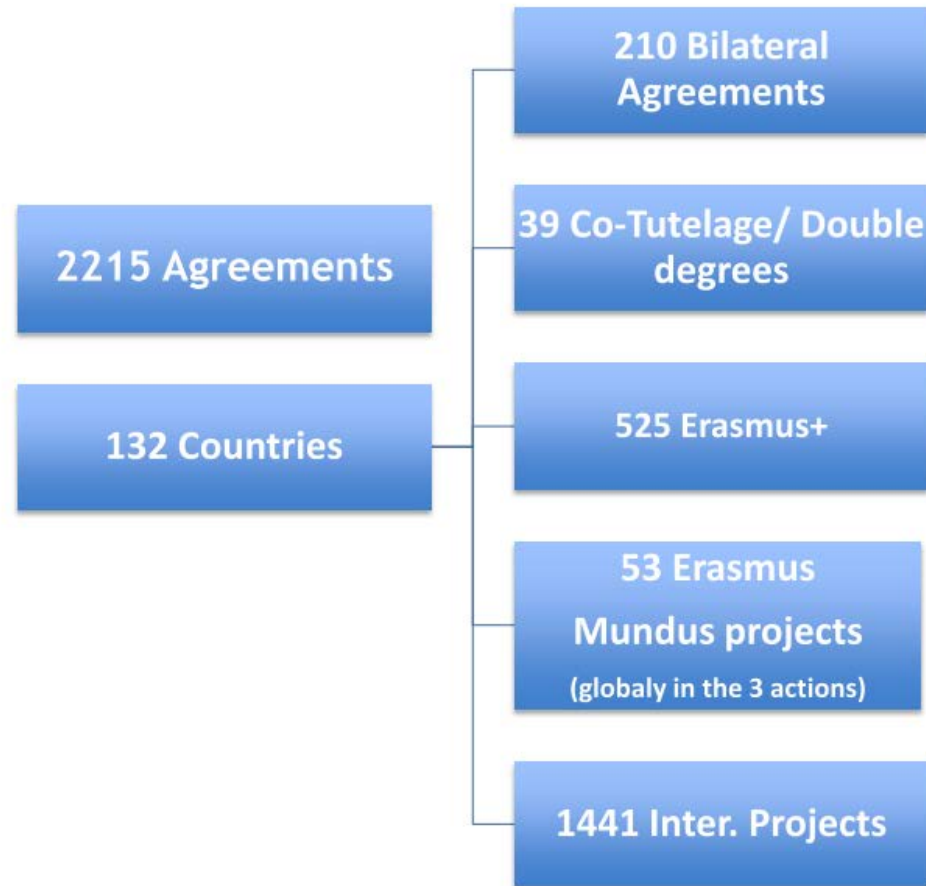
# University of Porto

3.895 International students and researchers  
(13% of the total, 2013)



# University of Porto

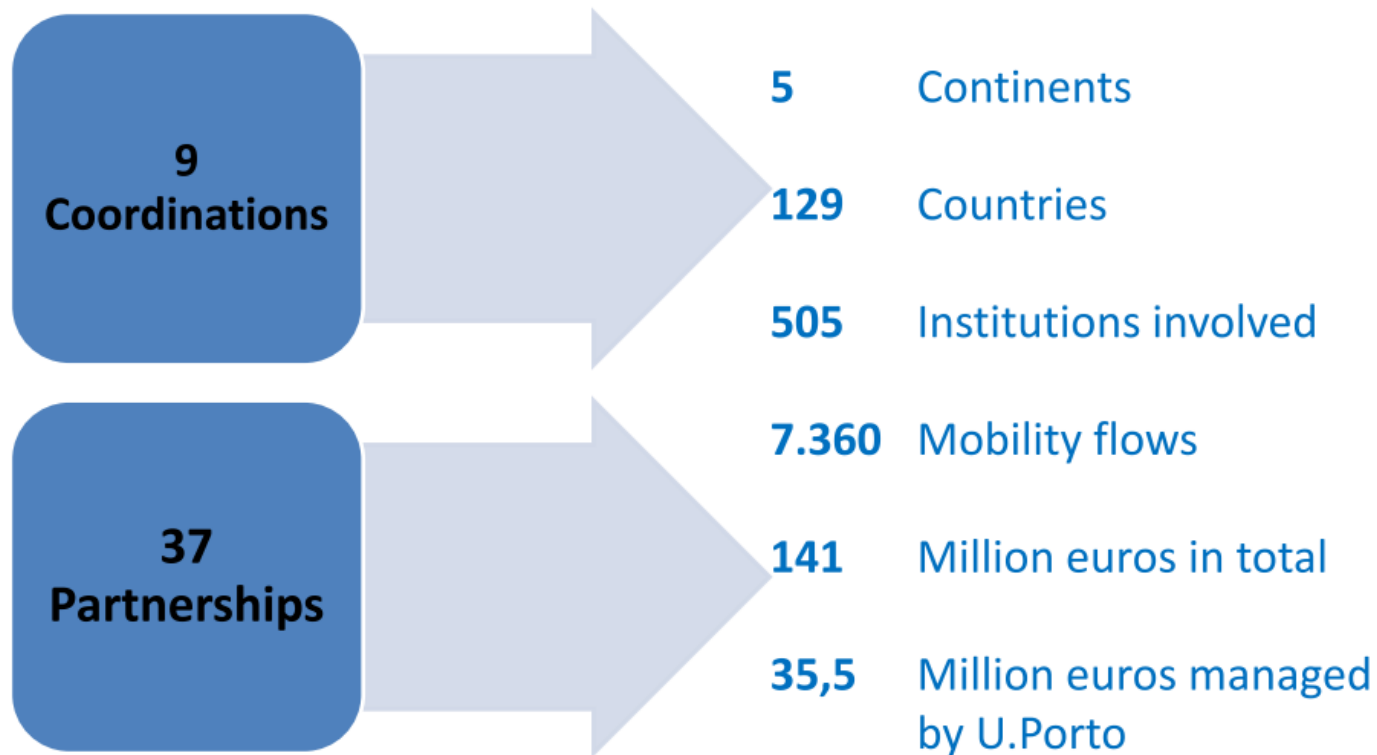
- **International cooperation**



# University of Porto

- **International cooperation**

## Erasmus Mundus Projects (Action 2) involving CPLP

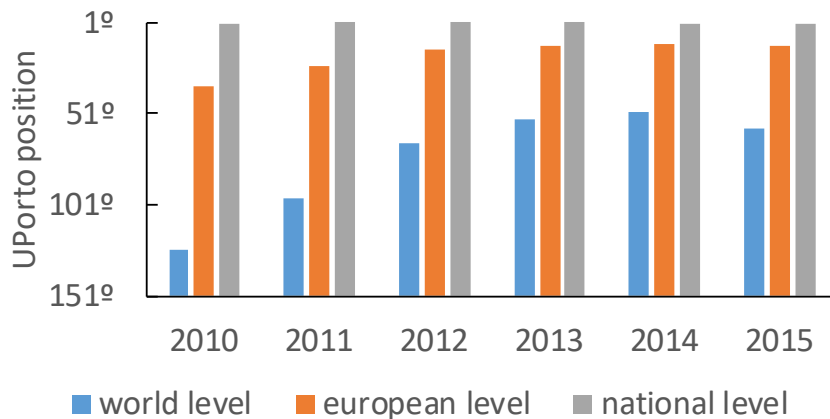


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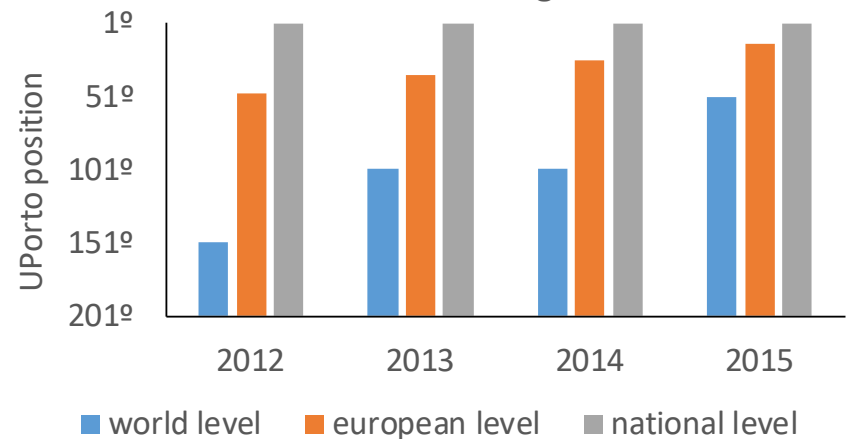
## Rankings in the Civil Engineering area – UPorto position

	at World level	at European level	at National level
NTU (2015)	59	14	2
QS (2015)	51-100	15-33	1

NTU Ranking



QS Ranking





# University of Porto

## National Taiwan University (NTU) research ranking – Civil Engineering

Position	2010	2011	2012	2013	2014	2015	2016
National	2	1	1	1	2	2	2
Europe	36	25	16	14	13	14	13
World	126	97	67	54	50	59	58

## Ranking QS (Civil Engineering)

	2014	2015	2016
Portugal	1-2	1	1
Europe	27-48	16-30	15-33
Ibero-America	4-8	3-5	2-5
World	101-150	51-100	51-100

# Faculty of Engineering – Dept. Civil Eng.

- **89** faculty members
- Around **1100 students (1027 +74 +9 +11)**
  - Undergraduates: **≈ 1050**
  - PhD students: **≈ 85**
- **Research groups**
  - Structural Concrete and Materials Testing
  - Earthquake and Structural Engineering
  - Vibrations and Structural Monitoring
  - **Geotechnics**
  - Physics of Constructions
  - Management, Quality and Technology
  - **Modelling of coastal management**

# Faculty of Engineering – Dept. Civil Eng.

Laboratory facilities with an overall area larger than 3500 m<sup>2</sup>, accommodating equipment evaluated in more than 5M €

- **In situ tests**



# Faculty of Engineering – Dept. Civil Eng.

Laboratory facilities with an overall area larger than 3500 m<sup>2</sup>, accommodating equipment evaluated in more than 5M €

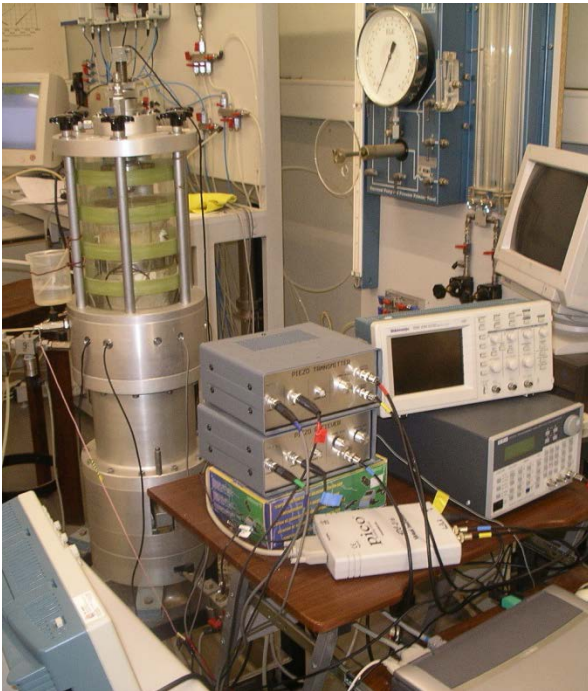
- **Laboratory tests**



# Faculty of Engineering – Dept. Civil Eng.

Laboratory facilities with an overall area larger than 3500 m<sup>2</sup>, accommodating equipment evaluated in more than 5M €

- **Laboratory tests**



# Faculty of Engineering – Dept. Civil Eng.

Laboratory facilities with an overall area larger than 3500 m<sup>2</sup>, accommodating equipment evaluated in more than 5M €

## • Open channel

- The open channel is included into the recirculation water system of the Laboratory;
- Constant rectangular section: 1.0 m x 1.30 m;
- Slope: 0.5%;
- Length; 32.3 m long;
- Glass windows (2 m long and 1.0 m height) for visual access;
- Flow rate control by means of an upstream valve located at the feeding pipe and measured by an electromagnetic flow-meter;
- A sluice gate located at the downstream channel section allows the control of the flow depth in the channel.



# Faculty of Engineering – Dept. Civil Eng.

Laboratory facilities with an overall area larger than 3500 m<sup>2</sup>, accommodating equipment evaluated in more than 5M €

## • Multidirectional Wave Basin



The wave basin is 28.0 m long, 12.0 m wide and 1.2 m deep. If needed, a central pit allows the reproduction of deeper water conditions (4.5x2.0x1.5m<sup>3</sup>).

The multidirectional, piston-type wavemaker is composed of 16 paddles and equipped with an active wave absorption module (HR Wallingford, UK), being able to simulate either regular or irregular waves. A dissipation beach, 8 m long and with a 5% slope is installed on the opposite side of the wavemaker to dissipate the incident wave energy.



A wide variety of equipment is available, namely:

- Resistive-type wave probes (300 mm and 600 mm length);
- Force transducers;
- Infrared motion capture system (Qualisys);
- 2D bed profiler;
- Laser scanner;
- Acoustic Doppler Velocimeters (ADV);
- Digital cameras;
- Among other.



# CONSTRUCT

CONSTRUCT - *Institute of R&D in Structures and Construction* organized in 6 research groups.

LABEST – Laboratory of concrete technology and structural behaviour

LESE – Laboratory of earthquake and structural engineering

VIBEST – Laboratory of vibrations and monitoring

GEO – Geotechnics

LFC – Laboratory of Building physics

GEQUALTEC – Management and technology of building construction

## Team:

45 integrated members, 8 Post-doc and 69 PhD students

## Research outcomes from 2008 to 2015

111 PhD thesis

569 papers (404 in ISI journals)

6 patents

60 research projects

45 organised conferences

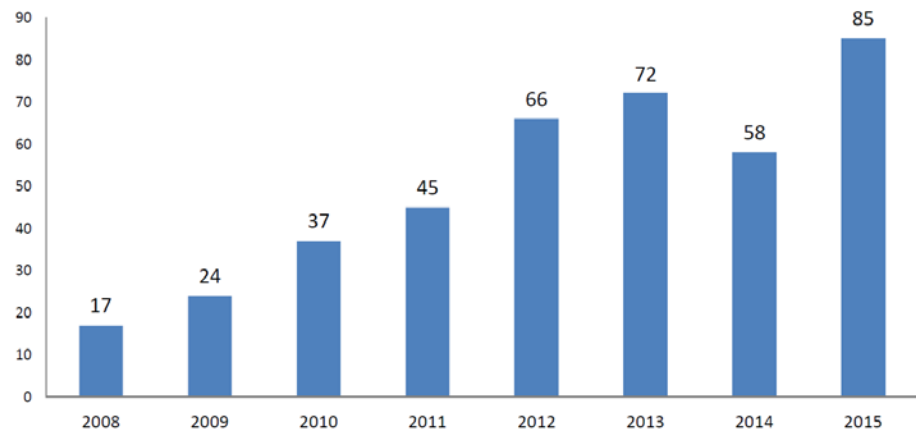
## Only in 2015

18 PhD thesis

120 papers (85 in ISI journals)

International journals - ISI 2008-15

Total: 404





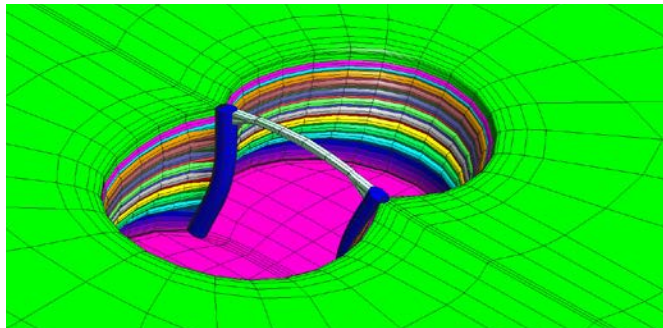


# CONSTRUCT

CONSTRUCT - *Institute of R&D in Structures and Construction*

## CONSTRUCT - GEO

- Solid background and international recognition in the areas:
  - Lab and field characterization of natural soils, earthfill, tailings and soil-cement-lime mixtures, in monotonic, cyclic and dynamic conditions
  - Numerical modelling of geotechnical structures
  - Characterization of geosynthetics and studies of reinforced earthworks
- High quality applied research consultancy:
  - Research projects and high-level consultancy link the group to relevant national and





CIIMAR is a leading research and advanced training institution of the UPorto, working on the frontier of knowledge and innovation. The centre develops transdisciplinary and transnational research, promotes technological development and innovation and supports public policies and governance for sustainable development.

The aim is to contribute to the knowledge of the ocean and coastal areas as a basis for the sustainable management and exploitation of resources.

- 460 researchers (215 PhD/144 ETI)
- Annually production of 375 ISI publications (60% Q1)
- 120 PhD and MSc thesis in european and national training programmes
- Funding from regional and national agencies (ON2, FCT, QREN, Ciencia Viva), from EU programmes (H2020, INTERREG, EEA Grants).
- It has been recently granted with 5 H2020 projects related with blue growth.

CIIMAR expertise is framed in priority areas of the Portuguese National Strategy for R&I for Smart Specialisation, articulating national and regional levels, particularly in the areas of Economy of the Sea, Water and Environment, and Agro-Food.

# Recent research projects

- 1) **NATURAL SOILS BEHAVIOUR AND MODELLING** - Experimental characterization and modeling of geomechanical behaviour of sensitive or non-textbook soils (ex. residual soils). Management of sampling quality on natural soils using in situ and laboratory seismic waves velocities. Dynamic properties in residual soils from granite: strain-rate, frequency & time effects. FCT 2005-2008 (90k euros)
- 2) **SOIL-CEMENT** - Characterisation and constitutive modelling of cyclic and dynamic behaviour of soil-cement mixtures for application in infrastructures for transportation. FCT 2010-2013. (175K euros)
- 3) **LIQUEFACT** - Liquefaction Assessment Protocols to Protect Critical Infrastructures against Earthquake Damage; and, Assessment and mitigation of liquefaction potential across Europe: a holistic approach to protect structures / infrastructures for improved resilience to earthquake-induced liquefaction disasters (<http://www.liquefact.eu/>) Horizon 2020. 2016-2020 (5M euros)

# Recent research projects

## 4) **MORPHEUS** - River bed MORPHology and Erosion studies.

This project is dedicated to study the fundamentals of **sediment transport** proposing a combined theoretical and experimental approach.

Involving 3 major universities it aims also to strength the cooperation between the participating institutions. FCT 2016-2019. (200K euros).

## 5) **HYDRALAB+** Adapting to **climate change**: Advanced network of environmental hydraulic institutes in Europe. A multi-disciplinary approach will be used to prepare environmental hydraulic modelling for the upcoming urgent technical challenges associated with adaptations for climate change. The issues associated with climate change impacts on **rivers and coasts** are significant enough to ask the scientific community to which we open up our facilities to focus their research efforts on adaptations for climate change (10M euros).

# LIQUEFACTION RISK ASSESSMENT



H2020 LIQUEFACT  
RIA - Research and Innovation action  
Contract Number: 700748

**ASSESSMENT AND MITIGATION OF LIQUEFACTION  
POTENTIAL ACROSS EUROPE**

*A holistic approach to protect structures /  
infrastructures for improved resilience to  
earthquake-induced liquefaction disasters*

## Main objectives:

- Identify causes of earthquake induced liquefaction disasters;
- Implement practical mitigation strategies to reduce the consequences of liquefaction;
- Development of more appropriate techniques tailored to each specific scenario



# LIQUEFACTION RISK ASSESSMENT

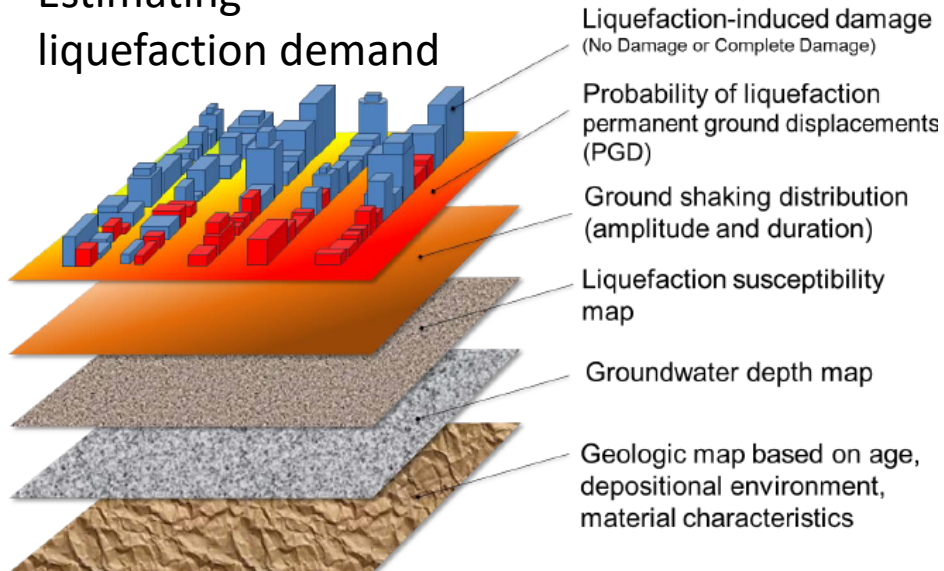


H2020 LIQUEFACT  
RIA - Research and Innovation action  
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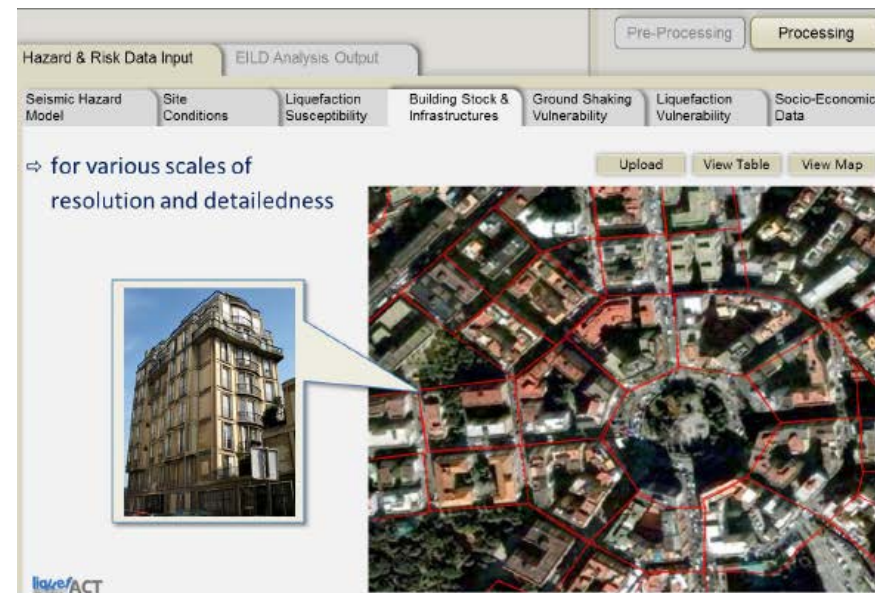
ASSESSMENT AND MITIGATION OF LIQUEFACTION  
POTENTIAL ACROSS EUROPE

*A holistic approach to protect structures /  
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## Estimating liquefaction demand



## Development of liquefaction mitigation planning software



# Overtopping measurement and analysis

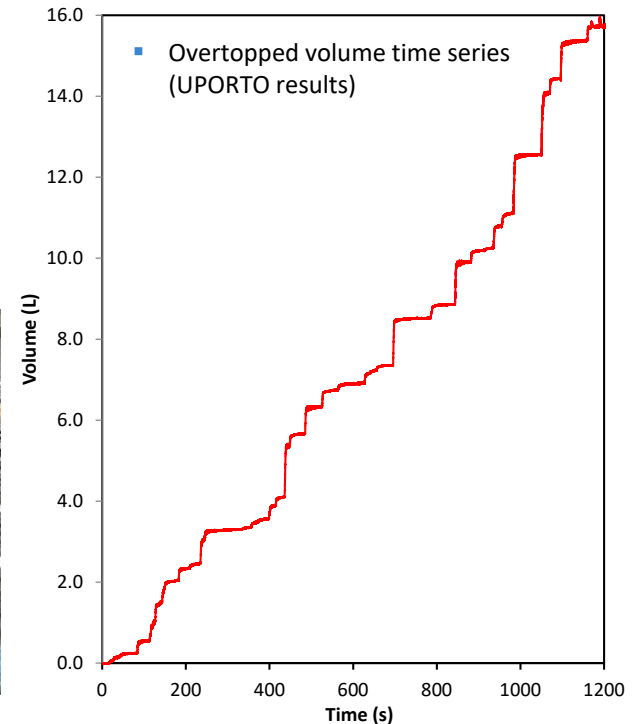
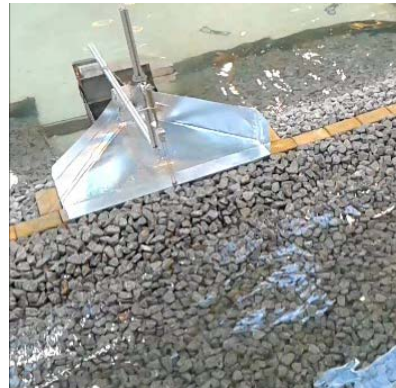
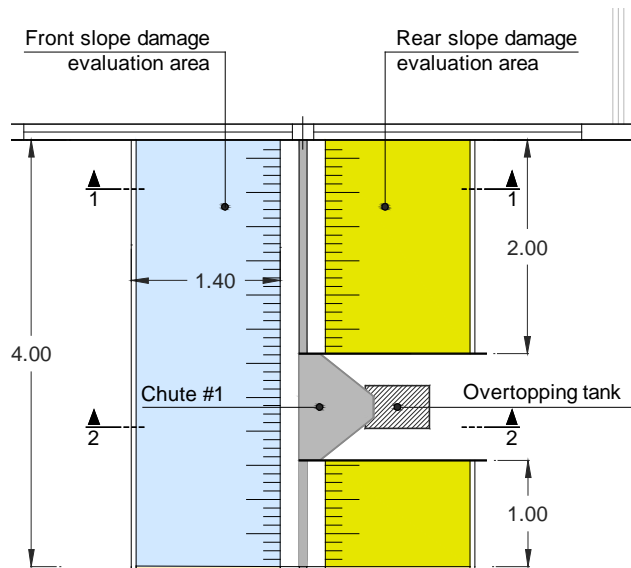


H2020 Hydralab+  
RIA - Research and Innovation action  
Contract Number: 261520



Overtopping: event by event analysis

- 4 overtopping chutes (1.0, 0.6, 0.4, 0.2 m);
- 3 overtopping tanks (2, 16, 80 L) with level gauges.



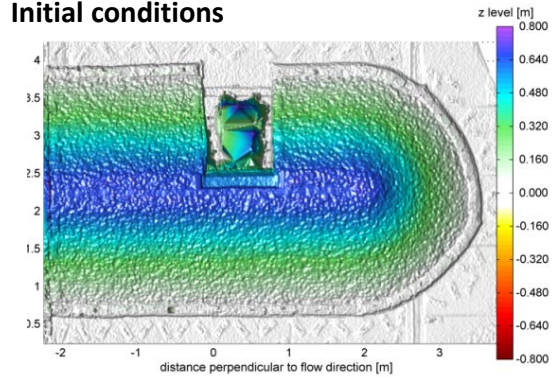
# Damage measurement and analysis



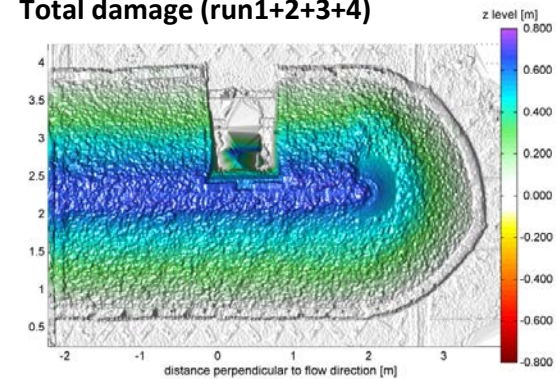
H2020 Hydralab+  
RIA - Research and Innovation action  
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A stereophotogrammetry equipment used to map the 3D damage progression in the armor layer (front slope, rear slope and roundhead) of the rubble mound breakwater.

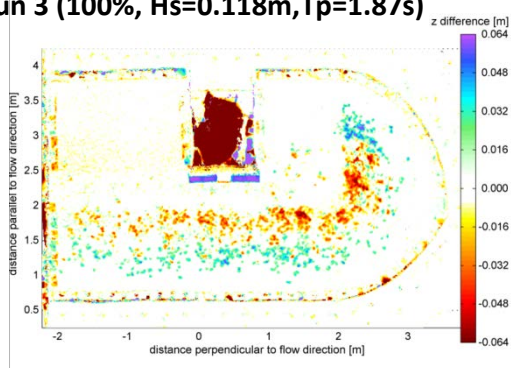
Initial conditions



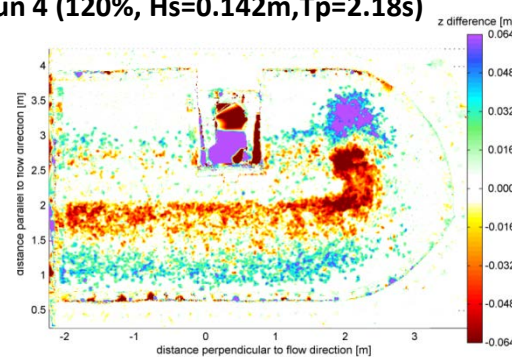
Total damage (run1+2+3+4)



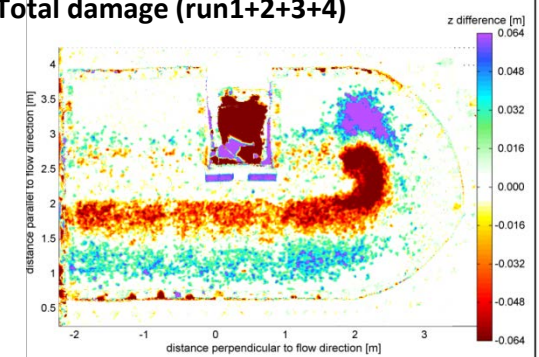
Run 3 (100%, Hs=0.118m, Tp=1.87s)



Run 4 (120%, Hs=0.142m, Tp=2.18s)



Total damage (run1+2+3+4)

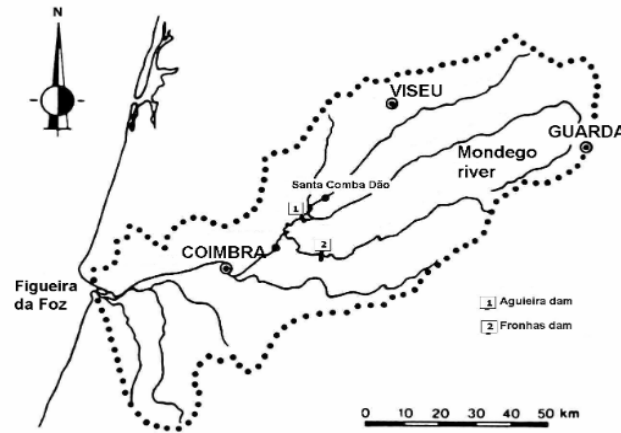




# UPorto possible contribution to DERELE

## Case study in Portugal

Mondego river is a Portuguese river with origin in Estrela mountains that flows through a narrow valley until Coimbra town, where the river valley consists of a vast alluvial plain, and reaches the Atlantic ocean near the town of Figueira da Foz. Due to a very irregular hydrological regime, the Mondego river basin, with 6671 km<sup>2</sup>, was subject to periodic flooding.

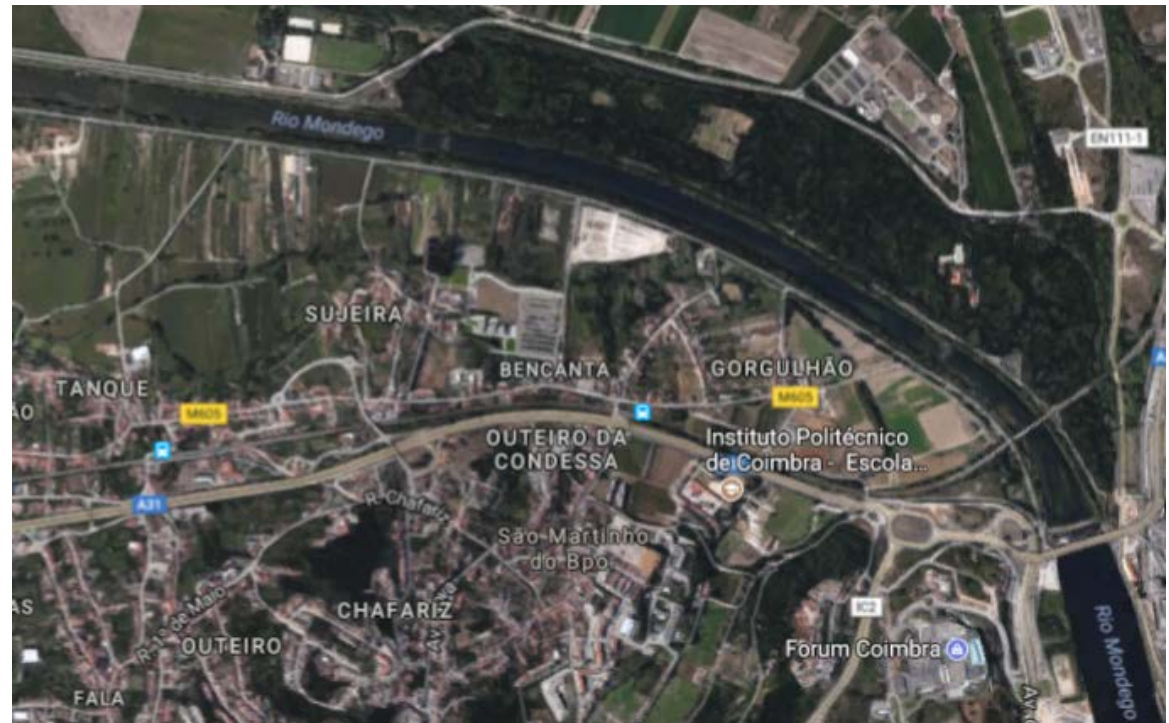


# UPorto possible contribution to DERELE

## Case study in Portugal

The Mondego plain levees are part of the Mondego river regulation project, implemented on the 80's of last century.

This project included the construction of three dams and fluvial regularization along approximately 36km .

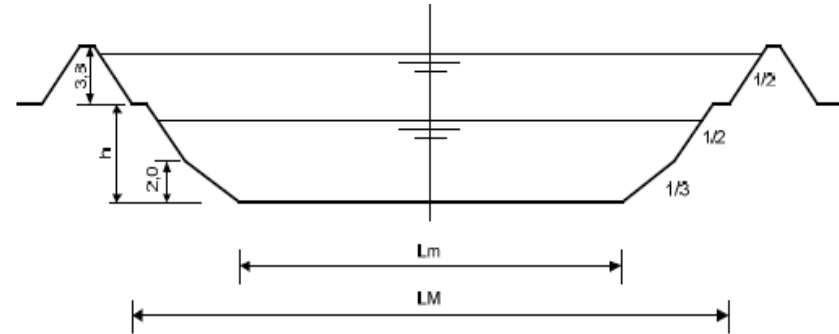


# UPorto possible contribution to DERELE

## Case study in Portugal

- The bottom width varies from 88 to 142.2 m;
- The maximum depth is approximately 6.5 m.
- The height of the levees varies from 2.7 to 4.6 m;
- Levees are protected by vegetation except on the curves (rockfill was used in this case).
- The main channel was designed for a flood of 340 m<sup>3</sup>/s (at Coimbra).
- The two side channels were designed for a flood of 1200 m<sup>3</sup>/s (at Coimbra) - modified 100-year flood.
- The levees along the main channel have lateral fuse-plug weirs to permit controlled flooding.
- The maximum registered flood in Coimbra was 2457 m<sup>3</sup>/s, in 1962.
- In 2001 the levees have broken, by overtopping (for a flood of 1990 m<sup>3</sup>/s at Coimbra).

Typical cross section of the regulated river bed



# UPorto possible contribution to DERELE

## Possible tasks

- Identification and characterization of levees in Portugal and collection and synthetization of data to further analysis of floods impact.
- Geo-mechanical characterization of existing levees which combines geophysical testing and specially devised CPTu
- Installation of the monitoring system in the case study selected levee
- Acquisition and statistical treatment of the data from monitoring systems
- Contribution on numerical approaches for predicting the achievement of possible ultimate limit states (loss of strength because of full saturation, critical hydraulic conditions, internal erosion, etc.)
- Development of experimental approaches for predicting the achievement of possible ultimate limit states (e.g. overtopping) using 2D and 3D levees' scale models
- Development of expeditious and economical methodologies for the reinforcement of existing levees

# DeReLe possible H2020 calls

**CIP-01-2016-2017:** Prevention, detection, response and mitigation of the combination of physical and cyber threats to the critical infrastructure of Europe.

Deadline: 24/8/2017

**SMEInst-11-2016-2017** - Boosting the potential of small businesses in the areas of climate action, environment, resource efficiency and raw materials

Deadline: 8/11/2017

**PowerWaterPrize-01-2017** - Inducement prize: Zero Power Water Infrastructure Monitoring

Deadline: 11/9/2018

# KIC Climate

(<http://www.climate-kic.org/partners>)

## Core Partners:

Deltares, Ferrovial, Imperial College, KLM, INRA (Institut national de la recherche agronomique), DTU, TUDelft, Utrecht Uni., Veolia, etc... and **ASTER (Italy)** ([www.aster.it](http://www.aster.it))

ASTER is the consortium among the Emilia-Romagna Regional Government, **the six Universities**, the National Research Centres located in the region – the National Research Council (CNR) and the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) – the Regional Union of Chambers of Commerce and the regional Entrepreneurial Associations.

<http://www.climate-kic.org/partners/aster/>

One of the projects is about floods:

<https://dailyplanet.climate-kic.org/open-innovation-challenge-finds-solutions-reduce-glasgows-flood-risk/>