CERIS : Civil Engineering Research and Innovation for Sustainability

CERIS - CIVIL ENGINEERING RESEARCH AND INNOVATION FOR SUSTAINABILITY

Scientific Report 2018

Programmed Research for 2019

EXECUTIVE BOARD

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TÉCNICO LISBOA | DECIVIL
DEPARTAMENTO DE ENGENHARIA CIVIL, ARQUITECTURA E GEORRECURSOS

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SUMMARY

CERIS - Civil Engineering Research and Innovation for Sustainability - is a research unit that operates in the Built and Natural Environment sector. In 2018, CERIS had 110 PhD members, 63 PhD collaborators and 216 Collaborators without PhD, and covered the following domains, with different levels of depth and breadth: Construction, Environment, Geotechnics, Hydraulics, Regional and Urban Planning, Structures, Systems and Management, Transport Systems and Water Resources.

CERIS was formally created in 2015 to integrate three centres, namely CEHIDRO, Centre of Hydraulics, Water Resources and Environment, CESUR, Centre for Urban and Regional Systems, and ICIST, Institute of Structural Engineering, Territory and Construction. They are hosted by the Department of Civil Engineering, Architecture and Georresources (DECivil), Instituto Superior Técnico (IST), University of Lisbon (UL). CERIS is a unit of the National Science and Technology System registered with Fundação para a Ciência e a Tecnologia (FCT), the Portuguese research-funding agency.

This is the fourth report on the scientific activity of CERIS after its creation. It defines the positioning of the new unit in the national context and addresses issues on organization and operation, particularly in what concerns the integration of scientific objectives and the promotion of internal cooperation. Equally important is to analyse the 2018 performance indices and to ponder on their evolution.

To that effect, this report is organized in four main parts. The first focuses on the unit description, including an overview of CERIS and a description of its internal organization, governance structure, technical and administrative staff and supporting laboratory facilities. The second part refers to research objectives, namely the general objectives of CERIS and the specific objectives of the research groups. The third part reports and discusses the main achievements in 2018. Global figures are presented in terms of publications in ISI/Scopus journals, concluded PhD theses and research and consultancy funding. The last part describes the programmed research for 2019 of each research group.

The main points the Executive Board wishes to stress are the following:

1) In terms of governance and operation, the merging of centres with different cultures and practices has been demanding, as expected, and confirmed the need to engage an expert in management of Science and Technology and to seed the organization of specialized supporting services.
2) In what regards the breadth and scope of the research, the activities reported by the research groups indicate the need to contain the number of topics and actions, in line with the proposed thematic strands and work areas.
3) In 2018, CERIS researchers maintained their levels of national and international visibility. They participated in the organization of 45 (21) international (national) events and in the scientific committees of 99 (52) events. Membership of editorial boards remained strong (181 roles), including 3 Editor-in-Chief and 23 Editors and Associate Editors in ISI-Scoups, as well as the participation in technical committees for drafting codes and standards (70 national and 60 international).
4) Publication in ISI/Scopus journals was increased relatively to 2017, retaking the growth of the previous 10-year period, with a ratio of 2.7 per PhD member. The ratios for publication in conference

proceedings were 1.5 and 2.4 per PhD member in national and international conferences, respectively.

5) The number of PhD theses concluded in 2018 (37, 28 of which in IST-UL doctoral programa), as well as the number of on-going supervised doctoral students (253 - 206 registered in IST-UL), have also been increasing over the last decade. The ratios per PhD member (0.3 concluded theses and 2.3 supervised or co-supervised doctoral students) are approaching target values. The distribution of PhD students is heterogeneous in terms of scientific areas and number of students per supervisor.
6) The overall trend for improvement results from the involvement of CERIS in doctoral programs (three coordinated by IST-UL, three in joint participation with other Portuguese universities and four under international consortia, namely through the Portugal-MIT and the IST-EPFL Lausanne Joint Doctoral Initiative). Six of these courses are FCT funded until 2021, mainly through doctoral grants.
7) The results summarized above reflect the success CERIS had in securing research and contract funding in the recent past. Maintaining or improving the 2018 performance in the near future may be influenced by the after effects of the economic crisis, by policies on regional funding that impair the Lisbon area and by the grading CERIS will be awarded in the 2017-18 FCT evaluation of the Portuguese research units, still in progress. The FCT grading determines the allocation of core funding, constrains the access to public competitions and conditions ranking in competitive bidding.
8) The impact of the economic crisis on the capacity of CERIS to secure consultancy projects still endures. Funding from contracted research remained relatively stable from 2011 to 2015 (with a reduction in 2014) and decreased since then, reaching a minimum in 2018, with 0.96 M€. Reduction of public investment in research may still be the root cause of these low values.
9) The 2018 budget (ca. 3.00 M€) is rather unbalanced, with R&D funding about twice the consultancy funding. It is worth mentioning that these values have been relatively unstable in the last few years.

1. UNIT DESCRIPTION

This section presents an overview of the CERIS research unit and defines the positioning of CERIS in the National Science and Technology System. The second part of the section defines the organization of CERIS, profiles its research, technical and administrative staff and identifies the supporting laboratory facilities and the main instruments used by CERIS to promote knowledge transfer activities. The section closes with the definition of the criteria used to analyse the scientific profiles and the performance indices presented in Sections 2 and 3.

1.1 General description

Statutorily, CERIS - Civil Engineering Research and Innovation for Sustainability - is a research unit of Instituto Superior Técnico (IST), University of Lisbon (UL), hosted by the Department of Civil Engineering, Architecture and Georresources (DECivil) and integrated in IST-ID, the Association of Instituto Superior Técnico for Research and Development. IST-ID is a private non-profit institution, which primarily aims at carrying out Science and Technology activities, fostering knowledge transfer and promoting the involvement of national and foreign researchers in RD&I activities and projects in their areas of expertise.

Although CERIS was formally created in 2015, through government dispatches 7822/2015 and 12360/2015, its formation as an RD&I unit registered with Fundação para a Ciência e a Tecnologia (FCT), the Portuguese research-funding agency, was proposed in the framework of the 2008-2012 evaluation of the National Science and Technology System, as the merge of three centres of DECivil, namely: CEHIDRO (Centre of Hydraulics, Water Resources and Environment), CESUR (Centre for Urban and Regional Systems) and ICIST (Institute of Structural Engineering, Territory and Construction). Their integration in CERIS enhances a comprehensive thematic coverage, in depth and scope, and promotes synergies in the inherently multidisciplinary Built and Natural Environment sector, which they previously addressed in a non-integrated manner.

At the end of 2018, CERIS joined the expertise of 110 PhD members and 63 PhD collaborators (this distinction is explained below) and 216 non-PhD colaborators. CERIS has no parallel in the national context in what regards size and scope, and has the profile and the critical mass needed to attain a strong international presence in the sector. This key-driver for the creation of CERIS was set on a wider vision of the national research system and results from discussions initiated in 2010 on national and international prospects. It was based on the ASCE report ‘The Vision for Civil Engineering in 2025’ and framed by three key documents: 'Europe 2020', 'Horizon 2020' and 'Portugal 2020'.

The mission and objectives of CERIS and the policy guidelines address the needs of the sector in research and knowledge transfer. They are set under the guiding principle of basing research and innovation on PhD programs while exploiting the diversity of profiles of its members. This diversity is instrumental to promote the different forms of knowledge transfer practiced by CERIS, ranging from continuous training and skills development to direct support to public institutions and industrial and service companies. The merging of the founding centres into CERIS is supported by new policies on membership, work organization and

restructuring of their research lines into thematic strands that directly derive from national and EU directives. Their research is typically based on mathematical modelling, experimentation and fieldwork.

1.2 Organization

The organic structure of CERIS meets the recommendations set by IST and FCT. It consists of the President, the Executive Board, the Scientific Council, the External Advisory Committee and the research units, as presented in Figure 1.

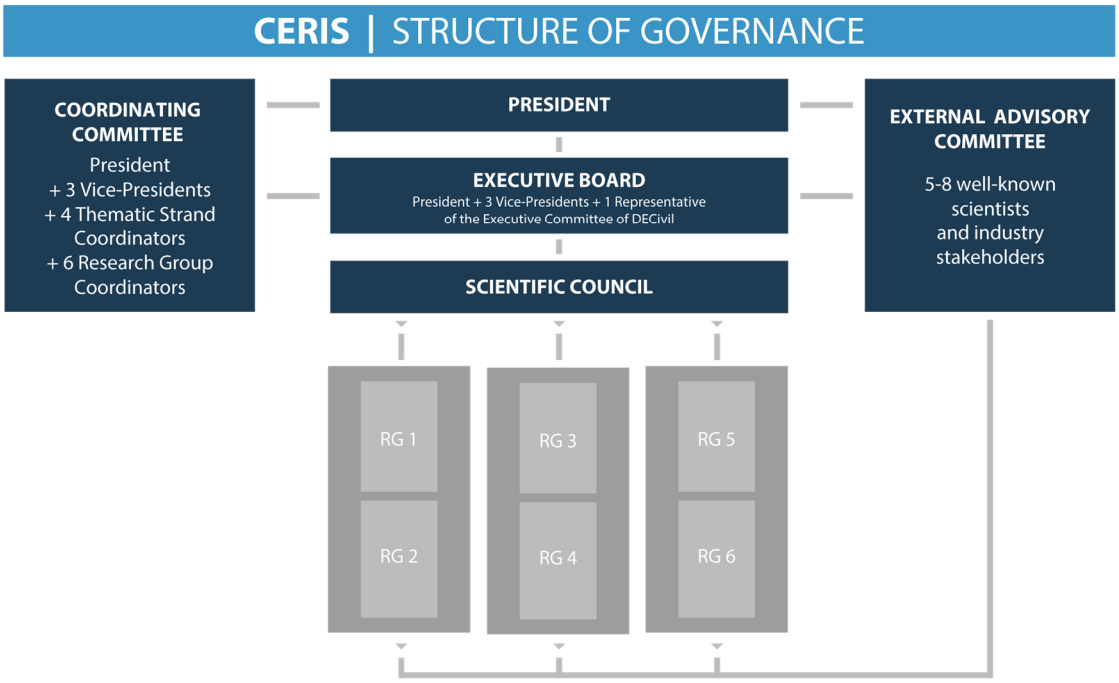

Figure 1 | Structure of governance

The President of CERIS is responsible for the overall CERIS management. He/she is assisted by the Executive Board and, whenever necessary, by the Scientific Council Advisory Board. He/she chairs the Executive Board, as well as the meetings of the Scientific Council Plenary and Advisory Board.

The Executive Board assesses, assists and promotes the policies on cooperation through coordination and is composed of five members: the President of CERIS, Vice Presidents that guarantee the representativity of all research groups and a member of the Excecutive Board of DECivil. In the current (2019-2020) Executive Board (Table 2), Luís Picado Santos, RG4, (the president) is responsible for administrative, financial and project management matters, and for the definition of the strategic plan. Rui Ferreira, RG1, is in charge of scientific affairs, Filipe Moura, RG4, is responsible for the promotion of R&D initiatives and internationalization, Inês Flores-Colen, RG5, is responsible for PhD activities, image, communication and dissemination and José Oliveira Pedro is in charge of the articulation with research laboratories and industry.

The Scientific Council is composed of researchers that comply with curricular selection criteria, mainly set on scientific production. Yearly, the Scientific Council approves scientific reports and plans, as well as financial reports and budgets. It may delegate competences on the Advisory and Executive Boards, but it ultimately rules all relevant matters of CERIS. The Scientific Council Advisory Board includes the members of the Executive Board and the Coordinators of Thematic Strands. Its main competence is to design and supervise the strategic program of CERIS. The thematic strands structure the scientific activity developed by the 6 research groups. Their coordinators for 2019-2020 period are identified in Tables 3 and 4.

Table 2 | Executive Board

Position	Researcher
CERIS President	Luís Picado Santos
CERIS Vice Presidents	Filipe Moura
	Inês Flores-Colen
	José Oliveira Pedro
	Rui Ferreira

Table 3 | Thematic Strands

Domain	Coordinator
Product Development in Civil Engineering Industries	Fernando Branco
Risk and Safety in Built and Natural Environments	João Abreu e Silva
Rehabilitation of Built and Natural Environments	João Azevedo
Response to Natural and Societal Changes	Francisco Nunes Correia

Table 4 | Research Groups

Group	Designation	Coordinator
RG1	Hydraulics	António Pinheiro
RG2	Environment and Water Resources	Maria Manuela Portela
RG3	Systems and Management	Rui Cunha Marques
RG4	Transportation Systems	Rosário Macário
RG5	Studies on Construction	António Moret Rodrigues
RG6	Structures and Geotechnics	Rita Bento

The External Advisory Committee of CERIS consists of well-known scientists and representatives from the industry with a recognized knowledge and experience of the challenges faced by institutions with similar missions and objectives. Besides advising on strategic planning and on long-term perspectives, its main competence is to periodically assess the quality and the relevance of the scientific activity of CERIS, the adequacy of its organization, the quality of the scientific environment, the level of internationalization of its activities and its performance in the transfer of knowledge and technology and dissemination. The current composition of the External Advisory Committee is defined in Table 5.

Table 5 | External Advisory Committee

Advisor	Institution
Alessandro Damiani	Former Director DG Research, European Commission | Italy
Anton Schleiss	École Polytechnique Fédérale de Lausanne | Switzerland
Kypros Pilakoutas	University of Sheffield | UK
Michael Forde	University of Edinburgh | UK
Rita Moura	Portuguese Construction Technology Platform | Portugal
Werner Rothengatter	Karlsruhe Institute of Technology | Germany

1.3 Research staff

According to CERIS rules and regulations, researchers are classified as *collaborators*, *members* and *integrated members*. Members are PhD researchers that meet the productivity criteria set by the Scientific Council of CERIS. Typically, collaborators are PhD students and specialists employed by firms and public services and agencies. This designation also includes PhD researchers that did not meet the productivity criteria set by the Scientific Council in each year. Integrated members are selected amongst PhD members to identify the core team of the unit, as requested by FCT in 2013.

The productivity criteria are based on the research component of the system of academic evaluation set by IST for each three-year period of evaluation, which basically values publication of papers (and the number of citations), supervision of PhD theses, coordination and participation in concluded competitive research projects and knowledge transfer. In 2015, the Scientific Council of CERIS decided to set the minimum requirement to be proportional to the grade of Excellent in the IST system of evaluation.

The current minimum requirements were increased by 30% in 2016 and again by 10% in 2017. Presently, and assuming that no other scientific activity is reported, a PhD researcher would reach the 2018 membership conditions publishing in a Quartile 1 (Q1) ISI journal an average of 1.1 single-author paper per year, or an average of 1.3 (1.6) two- (three-) author papers per year. The grading of the academic evaluation system strongly encourages publication in journals with high impact factors.

In this report, members of the Scientific Council are referred to as ‘Members’. They all hold a PhD title. The term ‘PhD researchers’ combines members and collaborators with PhD. PhD researchers may be permanent staff in their institutions, may be hired as reseachers, for instance under DL57, or may hold post-doc scholarships.

The term ‘non-PhD collaborator’ includes all collaborators that do not hold a PhD. The term ‘PhD students’ combines PhD students registered in IST-UL (identified as CERIS-IST PhD students) with PhD students registered in other institutions (identified as External PhD Students). Note that ‘PhD students’ is not a subgroup of ‘non-PhD collaborator’. There are PhD students that are not non-PhD collaborators; they may be collaborators in other research centres or stae laboratories.

The 2018 distribution of researchers is summarized in Table 6. They include academic staff of UL and of twelve

other universities and polytechnics[1], besides private companies and foundations.

Table 6 | Profile of research staff

Type	Permanent	Non-permanent		Total
		Contract	Scholarship	
Members	86	13	11	**110**
Collaborators with PhD	29	17	17	**63**
Collaborators without PhD	0	0	216	**216**

1.4 Administrative and technical staff

In 2018, CERIS and CERENA shared with DECivil the support of administrative staff, namely accounting services and secretariat, and technical staff assigned to computational and experimental laboratories.

The accounting service is staffed by three employees posted from the central services of IST and one employer from ADIST (a private not-for-profit IST association).The administrative staff is composed by one person and half of the work time of an IT. Researchers frequently invoke insufficient secretarial support. Despite the fact that some administrative support is been provided by the Department/School, the all together administrative pooling is harder to assess because it is difficult to isolate duties of staff formally assigned the Department/School.

Another difficulty CERIS faces, caused by a long-established freeze on hiring, is the inadequacy of the pool of technical staff assigned to the operation of its computational and experimental laboratories, as shown in Table 7 (one of them is 100 % paid by a technology transfer project). This staff is complemented by the DECivil Laboratories Coordinator, supported by a joint supervisor for the Structures, Construction and Geotechnics laboratories (LERM, LC and LABGEO). A good part of the day-to-day operation is supported by PhD researchers and students, well beyond training needs.

The major difficulty CERIS faces in the present context is the inexistence of administrative and technical staff adequately trained in management of science and technology activities. To mitigate the consequences of this limitation, CERIS created work groups, staffed by PhD researchers, which should originate the services to be set up when the freeze on hiring is waived.

[1] U. Algarve, U. Beira Interior, U. Évora, U. Nova de Lisboa, U. Madeira, Instituto Superior de Engenharia de Lisboa, Instituto Superior de Engenharia de Coimbra, Instituto Politécnico de Setúbal, Instituto Politécnico de Leiria, U. Estadual Campinas (Brazil), University College London, University of Western Australia.

Table 7 | Laboratories and technical staff

Laboratory	Staff (no.)
Laboratory of Computational Mechanics (LMC)	1
Laboratory of Construction (LC)	0,6+0,5
Laboratory of Geotechnics (LABGEO)	0,4
Laboratory of Hydraulics and Environment (LHE)	0,5
Laboratory of Strength of Materials and Structures (LERM)	1
Laboratory of Transport Infrastructures (LTI)	1

1.5 Facilities

The research methods adopted by CERIS include mathematical and numerical modelling, laboratory experimentation and *in situ* studies. CERIS is equipped with up-to-date hardware and software and the experimental facilities are adequately equipped. The main difficulties in this context are the heavy and limitative constraints on procurement, acquisition/renovation and maintenance/calibration of equipment caused by Government austerity measures.

Experimental PhD projects are supported by the laboratories identified in Table 7 and by the experimental facilities of Laboratório Nacional de Engenharia Civil (LNEC), one of the best-equipped Civil Engineering laboratories in Europe. CERIS does not duplicate costly equipment available there, because LNEC is located within 2 km of IST and institutional collaboration is duly protocolled.

1.6 Instruments for transfer of knowledge

Specialized consultancy and advanced training are the two main ways CERIS promotes knowledge transfer. CERIS members offer a large and diversified set of specialization courses through FUNDEC, the advanced training instrument of DECivil, a private partnership with the major companies operating in the Civil Engineering sector created in 1995. Consultancy is regulated in terms of conflicts of interest and unfair competition and can be directly contracted with CERIS or through FUNDEC or IST.

1.7 Analysis of the scientific activity

The analysis of the activity in 2018 presented in this report is set within the framework of the statutory objectives of CERIS and centred on the content of the research, the organization of the research and the evolution of scientific productivity indicators.

Content of the research is addressed in Section 2, where the thematic strands that structure the research activity are defined, as well as their main work areas. The areas of activity of the research groups in 2018 are also summarized to support the analysis of three key aspects in a new unit merging centres that used to operate independently: the 2018 profiles of the research groups, their organization and the existing and

planned forms of internal cooperation. The identification of these aspects should sustain internal policies on membership and internal funding initiatives to promote cooperation and focusing of the research.

The information summarized in Section 3 covers a wide range of research activity indicators, namely on theses and publications, visibility and recognition of the research, and research and consultancy contracts. The analysis of the 2018 results is set on the evolution in time (since 2008) of the number of researchers, of the capacity to secure research and consultancy funds and of two main activity indicators, namely completed PhD theses and publication of papers in ISI/Scopus journals, listed in Annexes A and B, respectively.

Performance of research units is usually assessed in terms of production rates per team member, which implies a clear definition of the population of the research team, namely Members and PhD researchers.

The production rates are presented in terms of Members and in some instances in terms of PhD researchers to stress the importance of the internal policies on membership. Those rates are presented in global terms and at unit level.

The same information at group level is available in Annex C. The diversity of the profiles of PhD collaborators can be high within a group and across groups, ranging from non-academic experts to young PhD researchers; therefore, the analysis at group level would imply an effort in detailing and justification that could easily fall into individual assessment, well out of the scope of this report.

2. RESEARCH OBJECTIVES

This section defines the institutional objectives of CERIS and the thematic strands that anchor the research activity. It is also used to characterize the areas of activity of CERIS research groups in 2018, as it is essential to assess the relevance and viability of the strategic and operational objectives.

Thematic strands have been defined in sufficiently broad terms and cover priority work areas. Their relevance in content and the adequacy of internal expertise should guide the progressive realignment of the activities planned at group level through the periodic reassessment of strategic and operational objectives and of the supporting internal seeding programs.

2.1 Institutional objectives

The research objectives of CERIS are set to comply with its statutory mission: “To create and disseminate scientific knowledge and to promote innovation in the Built and Natural Environment sector through the active involvement in fundamental and applied research, at both national and international levels, and to enhance higher education and research training”. To accomplish its mission, CERIS operates under a set of objectives and organizes its activity in thematic strands selected according to national and European policy guidelines.

CERIS coordinates, under the same host institution, knowledge and skills in the Built and Natural Environment sector under the following objectives: (i) to promote quality research based on PhD programs; (ii) to transfer its expertise by providing specialized training, services and consulting; (iii) to ensure a wide dissemination of its results.

To attain its main objective, the policy of CERIS is to organize the PhD programs in the framework of national and international networks and consortia and to integrate doctoral theses in competitive research funding projects. CERIS also benefits from the direct participation of IST in international networks and programs set up to promote the mobility of students and researchers.

In what regards on-going specialized training, CERIS participates in international initiatives promoted by IST and cooperates with national professional associations. To develop mutually beneficial relationships with industrial and engineering firms, central and local administration and with governmental agencies, CERIS focuses on the formulations of public and private policies and on innovation programs that address specific needs of the sector, namely through the Portuguese Technological Platform for Construction, the Portuguese Water Partnership and the Sustainable Habitat Cluster.

CERIS values the dissemination of research results through the best-ranked journals and the best-established conferences. They have a decisive impact on recognition and visibility and, consequently, on the engagement in contracted research and the recruiting of young researchers. The partnerships mentioned above play an important role in knowledge transfer initiatives and are instrumental to enable a closer relationship with public and private institutions.

2.2 Research groups

The research groups in 2018 are numbered as shown in Table 8.

Table 8 | Research Groups

Before	Designation
RG1	Hydraulics
RG2	Environment and Water Resources
RG3	Systems and Management
RG4	Transportation Systems
RG5	Studies on Construction
RG6	Structures and Geotechnics

2.3 Thematic strands

The interdisciplinary knowledge in the field of the Built and Natural Environment addresses issues centred on the Construction Industry, namely structural rehabilitation, safety and security and innovation regarding eco-efficient materials, solutions and technologies, and encompasses subjects such as urban and regional planning and management, mobility of people and freight, environment and water resources planning, management and policy, and water services, including drinking water distribution, sewage treatment and hydraulic infrastructure. Moreover, they include dimensions that cut across several areas, such as strategic environment assessment, systems modelling and optimization, as well as decision processes, relevant public policies and governance issues.

In this context, and taking into consideration national and European policy guidelines, the following thematic strands (TS) have been established in 2013 to structure the activities of CERIS:

- TS1: Product Development in Civil Engineering Industries;
- TS2: Risk and Safety in Built and Natural Environments;
- TS3: Rehabilitation of Built and Natural Environments;
- TS4: Response to Natural and Societal Changes.

Product Development in Civil Engineering Industries embraces research activities whose main purpose is to improve the competitiveness of civil engineering industries, by developing innovative products and procedures, and by improving the efficiency of existing ones. The applied research to be conducted focuses on the development of projects with a strong emphasis on "idea to business", implying a robust involvement of industrial partners and making use of the interdisciplinary nature of CERIS. The deepening of existing collaborations with Industry is encouraged. The Portuguese Technological Platform

for Construction (PTPC), whose university-industry work groups are already developing proposals for a wealth of new projects, is an important partner in this context.

Risk and Safety in Built and Natural Environments focuses on the reduction of risk to people, the environment, and natural and built heritage that may be affected by the occurrence of extreme events, either natural, such as floods, droughts, earthquakes, wind storms, and tsunamis, or due to man's activities, such as accidental pollution, deficient structures and infrastructures, blasts and fires. Both environmental hazards and manmade hazards may have devastating effects on the built and on the natural environment, namely on natural resources. Hazard and risk assessment, as well as the development of structural and non-structural safety measures is a major societal challenge in a rapidly changing world, with people concentrating in large urban centers and with growing exploitation of limited natural resources.

Rehabilitation of Built and Natural Environments stands out as the new paradigm of the construction sector. New knowledge and skills, gathered through interdisciplinary activity, are needed to respond to current demands. The main goals include reducing risks and ensuring safety, as well as promoting more efficient life cycle management of energy and natural resources, as a means to foster both urban cohesion and the protection of natural and cultural heritage. This thematic strand seeks to mobilize activity within the CERIS research groups in the field of rehabilitation, and to promote synergies between them to carry out research at the forefront of existing knowledge.

Response to Natural and Societal Changes addresses issues related to the characterization, mitigation and adaptation to natural and societal changes, as they induce stress or even ruptures in the “business as usual” approach to the built and natural environment, especially in what concerns the relevant policies, procedures and design and operation of infrastructures for a sustainable interaction between man and nature. Climatic change is of great importance as a driver, forcing adaptation measures in virtually all areas of economic activity and social life, and aggravating all the pre-existing problems caused by social and economic changes.

2.4 Research areas

The main areas of work selected in each thematic strand are the following, as defined by their coordinators:

Product Development in Civil Engineering Industries

(i) Development of eco-efficient, high-performance and durable cementitious materials and products, for both new construction and rehabilitation.
(ii) Advanced composite materials and products for civil engineering applications.
(iii) Development of components, devices and software to improve the seismic performance of civil infrastructure.
(iv) Sensors, intelligent systems and knowledge-based management infrastructure systems, in what concerns improved safety, maintenance and management procedures.

(v) Improvement of products and project efficiency, including procedures for life cycle analysis, procedures for conflict management and negotiation, analysis of private and public values and use of e-business and e-procurement platforms.

(vi) Development of synergic management to sustainable tourism destination - Lidera destinations (to improve product efficiency and performance).

(vii) Improvement of natural treatment systems, through pilot facilities, to define best procedures when facing seasonal interruptions and to determine maximum load capacity.

Risk and Safety in Built and Natural Environments

(i) Risk assessment of natural and man-made hazards, mainly to support of decision making on the allocation of budgets for safety improvement works.

(ii) Engineering expertise for improving safety of people and the environment, namely the development of solutions and techniques for improving construction robustness and resilience, as well as for the structural protection, strengthening and rehabilitation.

(iii) Prevention, preparedness and management of risk considering natural hazards and climate change scenarios, in what concerns non-structural measures related with management, elaboration of risk prevention, preparedness plans and operational and management procedures.

Rehabilitation of Built and Natural Environments

(i) Enhancement of the spatial functionality, energy efficiency and structural performance of civil infrastructures, including the improvement of seismic and fire resistance.

(ii) Study of deterioration processes and development of advanced inspection and monitoring techniques aiming at enhancing both durability and safety of civil infrastructures.

(iii) Development of urban management models to establish financing systems of urban rehabilitation and public investments, and flexibility and efficiency of the existing transport network infrastructure and management.

(iv) Rehabilitation of natural and transformed water bodies, namely rivers, lakes, reservoirs and aquifers, and improvement of the flexibility and efficiency of the existing water infrastructure and management systems, mainly in what concerns water supply and wastewater services.

Response to Natural and Societal Changes

(i) Understanding the complexity of natural and societal changes, mainly in what regards adaptation and resilience, competition and mitigation, path dependence, emergence, self-organization and metabolic mechanisms.

(ii) Improving governance, seeking better integration of policies, new flexible planning and management tools, searching for new methods, tools and devices for efficiency, economy and equity, concerning energy, resources and the used materials.

(iii) Enhancing the tools to respond adaptively to natural and societal changes, in what concerns information and communication technologies, computation and network systems, providing the platform for designing more intelligent and interconnected tools, and smarter buildings, infrastructures and services.

The main areas of work selected in each thematic strand reflect the number of research groups involved in core and complementary topics, as shown in Table 9. This information is complemented in the next section with data on existing and expected forms of cooperation at group level.

Table 9 | Groups participating in thematic strands

Thematic strand	RG1	RG2	RG3	RG4	RG5	RG6
Product Development	✓		✓	✓	✓	✓
Risk and Safety	✓	✓	✓	✓		✓
Rehabilitation	✓	✓	✓	✓	✓	✓
Response to Changes	✓	✓	✓	✓		

2.5 Activity of research groups

The following description describes, for each research group, its main areas of research and relative topics addressed in 2018, as defined by their coordinators. Details of main achivements can be consulted in Annex C.

RG1 | Hydraulics

7 Members | 9 PhD collaborators | 53 non-PhD collaborators

The activity of RG1 in 2018 was organized in the following major topics:

a) Pressurized water systems

Methodologies and software tools for the assessment and enhancement of water-use and energy efficiency in water supply systems (PD); Development of reliability analyses and risk management tools for different types of water and wastewater infrastructures (RS); Safety and risk analyses and establishment of design criteria in pressurized pipe systems based on the development of advanced 1D/2D transient solvers, CFD modelling of pressurized flows and data collection in experimental facilities and real-life systems, fluid structure inter action (RS).

b) Fluvial hydraulic structures

Development of mitigation strategies and pre-cast shelters for fish downstream of powerhouses with hydropeaking operation (RS); Numerical and experimental modelling of different flood release and related hydraulic structures (RS; RNBE); Study of the hydraulics of PKW weirs combined with spillways (RS, RNBE); Study of the pressure field and slab stability in a plunge poll lined with concrete slabs (RS).

c) River restoration and management

Monitoring tools, based on physically-based computational models, for water and sediment quality in rivers and estuaries (RNBE); Risk management in the valleys downstream of dams

(RS; RNSC); Environmental flows determination procedures and hydropower station operation rules to reduce ecological risk downstream of dams (RS, RNBE); River restoration and development of fish passes for low height river obstacles to improve ecological connection along regulated rivers (PD; RNBE; RNSC).

d) Environmental fluid mechanics

Laboratorial investigation of rough-wall open-channel turbulence (RNBE); CFD simulation of solid-fluid interactions in turbulent flows (RNBE); Laboratory investigation and mathematical simulation of transport of dissolved substances (RS, RNBE); Heat and mass transport in wetlands (RNBE).

e) Sediment transport and river morphodynamics

Hydrodynamics of river confluences in equilibrium (RS; RNBE); Hydrodynamics of river diversions in equilibrium (RS; RNBE); Sedimentation in shallow retention reservoirs: experimental study; Mathematical modelling of shallow-flows with mobile beds. Application to long term channel morphology evolution, dam-breaching, dam-break flows and overland tsunami propagation (RS); Mathematical simulation (Eulerian and Lagrangian) of transport processes (RS); Development of stabilization techniques for rivers meanders in equilibrium (RNBE).

f) Ocean waves, coastal morphodynamics and coastal and port structures

Studying extreme events like freak waves, near the coast, to improve navigation safety and support the offshore wind energy production industry (moored or floating) (RS; RNBE); Assessment of the vulnerability to flooding of the built environments on low-lying areas of estuaries, due to extreme ocean storm surges events and climate action (RNBE; RNSC); Life-cycle cost analysis of coastal and port structures (RNBE); Modular port facilities in rivers for bulk cargo; Morphological modelling of beach morphology in the presence of coastal structures. (RS). Turbulent transport processes in rivers and estuaries: experimental research on interaction between transported quantities (sediment, pollutants, nutrients, etc.) and turbulence (RS; RNBE). Air entrainment in wave breaking - laboratory experiments, infra-gravity waves – generation mechanisms and practical applications.

RG2 | Environment and Water Resources

11 PhD members | 2 PhD collaborators | 31 non-PhD collaborators

The activity of RG2 is focused on the following topics:

- Hydrology and water resources, including trend detection in hydrologic time series and modelling; drought analysis, and flood analysis, including joint probability cumulative distribution functions, empirical copulas and non-stationary models; development of rainfall-runoff models; artificial intelligence techniques applied to hydrologic modelling including artificial neuronal network; development of daily runoff modelling in very large watersheds based on satellite data;

development of regionalized impact scenarios for the water sector and climate change impact assessments; and risk assessment study on flash floods and debris

- Water services, covering water supply, sanitation and water pollution control, the following themes were included: dynamic simulation of the hydraulics and environmental performance of wastewater systems; wastewater transformations along sewer lines (in-sewer processes), with emphasis on improving the current knowledge on the influence of turbulence (drop falls) and ventilation on the release of hydrogen sulfide gas through laboratory and field experimentation; research on organic and microbiological processes in constructed wetlands WWTP.
- Water policy formulation and governance, including extensive work in the establishment of principles for good water governance and its application under different circumstances, namely in Portugal, Brazil, and Cabo Verde. The definition of indices for assessing water governance is pursuing with review and analysis of previous attempts reported in the literature
- Environmental issues, including the themes of assessment and analysis of climate change impacts on natural and man-made water resource systems, sustainable governance, and the environmental management applied to sustainable construction
- Hydrogeology and groundwater services, including: groundwater pollution and risk assessment; groundwater and ecosystems; aquifer recharge and discharge; water and climate change; decision support systems for water catchment management and development of effective methods for risk-based environmental decision-making.

RG3 | Systems and Management

11 PhD members | 10 PhD collaborators | 33 non-PhD collaborators

RG3 has relevant results in specific topics as:

1) Regulatory and contracting policies, pricing and performance assessment, including: Efficiency and productivity of public services and infrastructure; Regulatory governance and substance; Tariffs and pricing of public utilities and transportation; Economics of water and waste services; Governance models in local government
2) Decision-making and systems design, operations and management and project management, including: Decision aiding and MCDA methods; Logistics and supply chain management; Systems modelling and optimization; Procurement models of PPPs; Infrastructure contract management; Risk assessment and management.
3) Information modelling and technologies, including: Ground deformation measure with advanced SAR interferometric methods; 3D city information models and its application; Spatial analysis problems; Building information modelling and systems interoperability; Construction innovation and information management; E-business and e-procurement in construction.

RG4 | Transportation Systems

13 PhD members | 7 PhD collaborators | 33 non-PhD collaborators

RG4 research focused on the following three main topics:

a. Road, Airport and Rail Infrastructure Systems, including methodologies and models to predict degradation and improve maintenance, renewal and investment decisions within the different transport infrastructure systems and across them (integrated asset management) and Retrofitting transport systems: changing and adapting "old to like-new" transport systems to meet new performance standards while extending the existing ones
b. Transport Systems Planning and Operations, including transport systems and policies for an ageing society
c. Strategy and Policy in Transport Systems, including new types of integration of public and private transportation modes and services (among each type and across the types) as vehicle-sharing systems including the modelling and testing of demand response transportation, multi-modal systems, shared-taxis, car-sharing, bike-sharing and freight services supported by new types of business models and by the development of appropriate ITS tools

RG5 | Studies on Construction

33 PhD members | 14 PhD collaborators | 51 non-PhD collaborators

RG5 developed research projects in the following domains:

a) Innovative applications of materials such as GFRP, CFRP and GRC: breakthroughs in concrete and mortars technology were experimentally validated; mortars and concrete formulations with nanomaterials were performed; studies on energy efficiency of different materials, building components and construction systems such as active and glazing facades, shading devices and green roofs and walls were conducted; risk informed quality, safety and environmental management in construction related research was included in various national and international actions, including normative work;
b) New theories on sustainability and construction: the use of traditional techniques and materials (earth, wood, stone, brick), implementation of selective demolition and recycling maximization (namely recycled aggregates in concrete and mortars production), and strategies of passive design and acclimatization;
c) Life-cycle management systems (inspection, diagnosis, maintenance and rehabilitation); conservation of historical building heritage (within various European research projects); other projects included sensors in structures, technological innovation and assessment of complex structures; The summary of the main achievements are indicated in the above table;
d) Seismic rehabilitation of masonry buildings; experimental and numerical analysis of timber-framed masonry walls subjected to monotonic and cyclic loading; reinforcement of timber-framed masonry walls with elastoplastic dampers, reinforced render or steel plates. Experimental and numerical analysis of ordinary masonry walls subjected to in-plane and out-of-plane loading.

Seismic reinforcement of ordinary masonry walls with carbon fibre reinforced render or with transverse hinge connectors.

RG6 | Structures and Geotechnics

34 PhD members | 23 PhD collaborators | 15 non-PhD collaborators

The research activity of RG6 for 2018 was planned to focus on six major research areas:

1) Mechanics, Modelling and Analysis of Structures;

   Dynamic instabilities and algorithms for the numerical analysis of the mechanical behaviour of non-smooth structures with frictional or elastoplastic components; Modelling of moving loads on beams on nonlinear foundations.

2) Earthquake Engineering and Seismology;

   History of construction and structural behaviour and construction techniques of traditional masonry tile vaults; Assessment of existing structures (e.g. dynamic characterization, seismic vulnerability and seismic risk assessment); Update and improve a model for quick evaluation of the potential seismic performance of masonry and reinforced concrete buildings based on its application to existing buildings; Structural rehabilitation (e.g. seismic strengthening techniques, passive protection); Development of tools to improve preparedness and community resilience, aiming to reduce the seismic risk through non-structural elements (Dissemination of a Practical Guide, a Short Guide for Students, a Portfolio of Solution and a Earthquake Awareness Campaign “Move, Protect and Secure” - the campaign is composed by a main short length film, accompanied by four teaser-spots); Seismic design of new masonry constructions.

3) Structural Concrete;

   Advanced cementitious materials; (High-performance ordinary and prestress reinforcement; Enhanced durability; Sustainable and eco-efficient solutions; Modellng and design models (e.g. stress-fields models, FEM-based software with embedded strong discontinuities, concrete reinforced with embedded fibres); Assessment of existing structures (e.g. reliability, structural robustness, monitoring, seismic vulnerability); Structural rehabilitation (e.g. repairing and strengthening techniques, seismic strengthening, passive protection); Prefabrication and innovation.

4) Steel and Composite Structures;

   GBT formulations to perform buckling, post-buckling and vibration analyses of isolated members and structural systems (e.g. continuous beams or simple frames) prone to local, distortional and global deformations; In-depth investigations on the non-linear behaviour, ultimate strength and design of cold-formed steel open-section and tubular members experiencing coupling phenomena involving local and/or distortional buckling; Novel rational approaches for the design of cold-formed and hot-rolled steel angle columns; Development and implementation of (iv_1) a displacement-based finite element for the linear analysis of curved members (circular axis), (iv_2) a

finite element formulation for the bifurcation analysis of composite steel-concrete beams; In-depth investigations on steel subassemblages with bolted and welded dissipative fuses; Proposal of design rules for composite structural members and parts; Applications to steel and composite bridges.

5) Bridge Design

Buckling resistance of steel plated girders considering M-V interaction with high compression forces (application to cable-stayed bridges); Curved steel plates on bridge deck beams: Post buckling behaviour and ultimate strength; The use of high strength steels in bridge deck; Fatigue assessment of composite steel-concrete cable-stayed bridge decks; Higher order beam theory (developments and applications to steel structures and bridges analysis); Analysis of the distortion effect on the dynamic behaviour of high-speed railway bridges; Analysis of substructures of offshore wind turbines.

6) Geotechnics.

Dynamic characterization of soils from small to large strains, including liquefaction; Studies on the elastic response measured in resonant column and using bender elements; Characterization of the chemo-hydro-mechanical behaviour of clayey and treated soils considering their structure and degree of saturation; Characterization of soils treated with jet grouting and bacteria; Numerical analysis of geotechnical structures involving strong soil structure interaction (e.g tunnels, retaining structures, piles and thermoactive structures); Studies on soils decontamination techniques (e.g. electro osmosis).

3. MAIN ACHIEVEMENTS

Because research in CERIS is statutorily based on doctoral training, this section opens with the identification of the doctoral programs staffed by members of CERIS in 2018. The second part of this section summarizes the 2018 activity indicators and the third one the evolution of the main indicators in three main periods: (i) the expansion of the public investment in RD&I, up to 2009; (ii) the economic crisis, since 2010-2011; (iii) the combination of that crisis with the 2013 FCT evaluation of CERIS, from 2013 to 2018. Section 3 closes with the summary of the 2018 research group results.

3.1 Doctoral programs

Besides five Master courses promoted by IST, CERIS researchers are presently engaged in PhD courses leading to nine Doctoral degrees. Students and their supervisors can either select structured, thematic PhD programs or select a combination of PhD-level subjects offered by IST or any other school of UL, or by other universities under protocolled agreements.

The doctoral degrees and the structured PhD programs CERIS is engaged with are listed in Table 10, which includes information on coordination and funding, mostly allocated to doctoral grants. Four PhD programs are offered under international protocols and three under national consortia. One PhD program is IST-interdepartmental and another is jointly promoted by schools of UL.

Table 10 | Participation in doctoral programs

Doctoral degree	Structured PhD programs	Observations
Civil Engineering (F. Branco)(1)	Eco-Construction and Rehabilitation (Coordinator: J. de Brito)(1,2)	Consortium of 5 universities and LNEC
	Analysis and Mitigation of Risks in Infrastructures (R. Bento)(1,2)	Consortium of 4 universities and LNEC
	Environmental Hydraulics and Hydrology (A.H. Cardoso)(1,2)	IST-EPFL initiative and LNEC
Climate Change and Sustainable Development Policies (J.S. Matos)(1)	Climate Change and Sustainable Development Policies(1,2)	Consortium of 3 universities (involving 7 schools)
Earth-Resources		
Environment Engineering		Involves 4 IST departments
River Restoration and Management (A. Pinheiro)(1)	River Restoration and Management(3)	Involves 4 UL schools
Territorial Engineering (F.N. Silva)(1)		
Transportation Systems (L.P. Santos)(1)	Transportation Systems(1,2)	Portugal-MIT initiative

(1) Coordinated by CERIS members; (2) Funding until 2021; (3) Funding until 2020.

CERIS also participates in a structured PhD program on Computational Engineering, originally funded through the Portugal-U. Texas (Austin) initiative. It is not listed in Table 10 because the participation of CERIS is marginal.

3.2 Activity indicators

The main scientific outputs of CERIS in 2018 are presented in Table 11:

(i) 37 concluded PhD theses and 253 in progress (206 developed by CERIS-IST PhD students registered in IST);
(ii) 216 concluded MSc theses;
(iii) 48 books (6 as entire book author, 35 as author of book chapters and 7 as book editor);
(iv) 299 papers published in included in ISI Web of Knowledge or Scopus databases, plus 20 papers in international peer-reviewed journals (non-ISI, non-SCOPUS);
(v) 265 papers published in international conference proceedings;
(vi) 168 papers published in national conference proceedings.

Table 11 | 2018 activity indicators: theses and publications

ACTIVITIES			CERIS
Academic research work	PhD theses	Concluded	37
		In progress	253
	MSc theses	Concluded	216
Publications	Papers in peer-reviewed journals	International journals: ISI or Scopus	299
		International journals: non-ISI, non-Scopus	20
		National peer-reviewed journals	13
	Papers in other journals	International	4
		National	29
	Papers in proceedings	International	265
		National	168
	Books	Entire	6
		Chapters	35
		As editor	7
Reports			29

The number of papers published in international peer-reviewed journals (324 in total) is now larger than the number of papers published in proceedings of international conferences (265). Some years back this relation was of the order of 1 (journal paper) -to- 4 (conference papers). The change is due to the emphasis placed on the publication in international journals.

The indicators frequently used to assess national and international visibility are summarized in Table 12, namely:

(i) Editor and Associate Editor of ISI or SCOPUS indexed journals (28);
(ii) Membership of editorial boards of other international and national journals (190);
(iii) Participation in organizing committees of international conferences (99);
(iv) Participation in organizing committees of national conferences (52).

Other indicators that reflect the visibility and recognition of the scientific activity of CERIS members are:

(i) 47 invited lectures in international and national conferences, workshops, seminars, symposis, etc;
(ii) 11 recognition awards (national and international);
(iii) Sustained academic and scientific cooperation with leading national and foreign universities and institutions.

Table 12 | 2018 activity indicators: visibility and recognition of the research

ACTIVITIES			**CERIS**
Membership of bodies for collective guidance of scientific work	Editor/Associate Editor	ISI-SCOPUS	28
		Other journals	9
	Membership Editorial Boards	International	153
		National	31
	Conference scientific committees	International	99
		National	52
	Drafting of codes, recommendations	International	70
		National	60
Organization of scientific events - membership of organizing committees		International	42
		National	20
Refereeing for funding agencies (national and international)			27
Lectures by invitation in international conferences (plenary, keynote)			47
Awards (national and international)			18

The information presented in Table 13 summarizes the 2018 initiatives to obtain funding through competitive research and consultancy. As shown below in Figure 6, in 2018 the budget secured through competitive research projects (close to 2.02 M€) was nearly twice of the budget secured through consultancy (close to 1.00 M€). This means that it is expected some recovery in R&D funding. While funding secured through specialized consultancy and industry-funded projects has slightly increased in 2017, it fell again in 2018.

Table 13 | 2018 activity indicators: research and consultancy contracts

ACTIVITIES			CERIS
Research grants for projects, sabbaticals, post-doc	International research grants	Awarded	9
		In progress	32
	National research grants	Awarded	39
		In progress	42
Individual PhD grants		Awarded	15
		In progress	114
Consultancy projects and industry contract research projects			52

The indicators presented in Table 14 (Other initiatives) justify the following clarifications: a) Models typically are laboratory test-rigs; b) The software applications listed are limited to those accessible in the internet for public use; c) Registration as a national patent must be ensured before submission to international registration in the annual, internal calls promoted by IST.

Table 14 | 2018 activity indicators: other initiatives

ACTIVITIES		CERIS
Models		0
Software applications		3
Pilot plants		2
Patents	National	2
	International	0

3.3 Evolution in the number of researchers

The evolution in the number of Members and PhD researchers is presented in Figure 2 and Figure 3, respectively. The increase in 2015 mainly reflects the integration in ICIST of academic staff of U. Nova de Lisboa, and the internal reclassification of PhD members and collaborators. The number of PhD researchers remained stable afterwards. However, an increase in the internal numerical criterion for selection of members in 2017 offset the increase of members that occurred in 2016. In 2018 there was a slight decrease of both, mostly because of the departure of the former RG to form a new Architecture and Urban Planning research Centre.

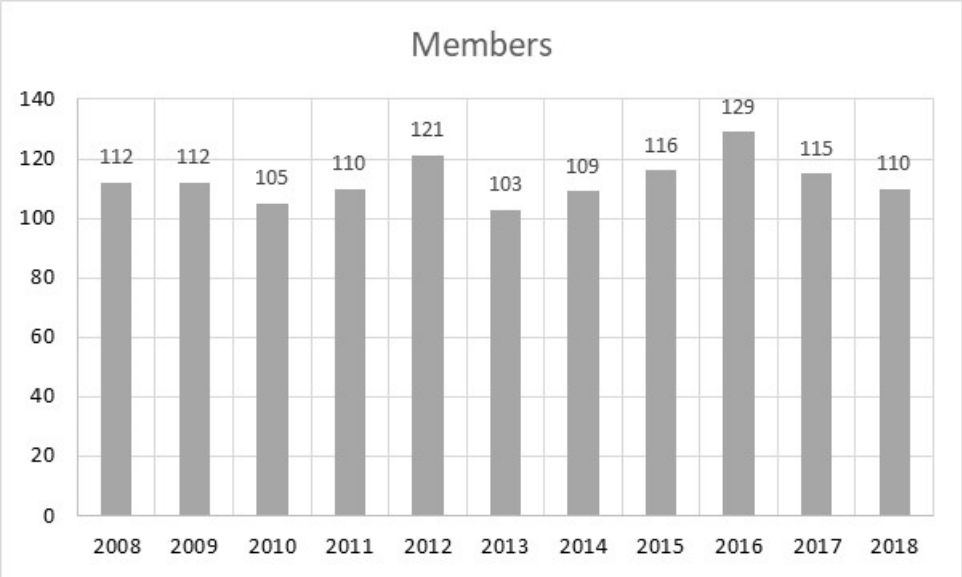

Figure 2 | Evolution of Members

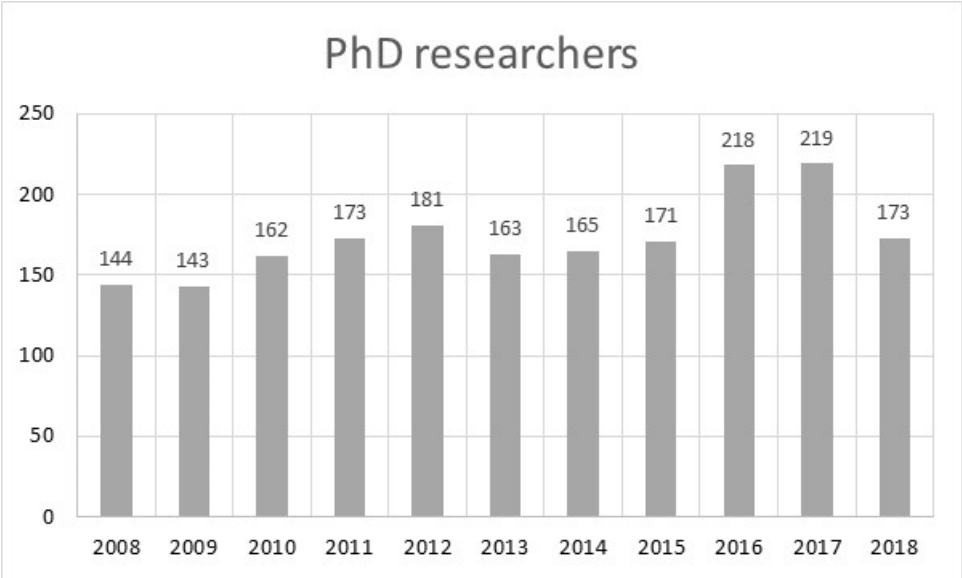

Figure 3 | Evolution of PhD researchers (Members and PhD collaborators)

The evolution of the number of researchers - combining Members, PhD collaborators and non-PhD researchers (PhD students and scholarships) - is presented in Figure 4. The overall increase in the 2008-2011 period is mainly due to the expansion of the national program for doctoral grants. The ensuing economic crisis justifies the subsequent stabilization. However, from 2016 onwards a quite significant increase occurred, which is explained by three main reasons: (i) the fulfilment of the last calls of the various FCT funded doctoral programmes, most of which led by CERIS; (ii) an increase of international PhD students, namely from Brazil; (iii) a more exact collection of the data concerning PhD supervision by CERIS researchers, namely of external students. In 2018 the observed decrease of non-PhD collaborators is mostly explained by the departure of the RG group of Arcuitecture and Urban Planning.

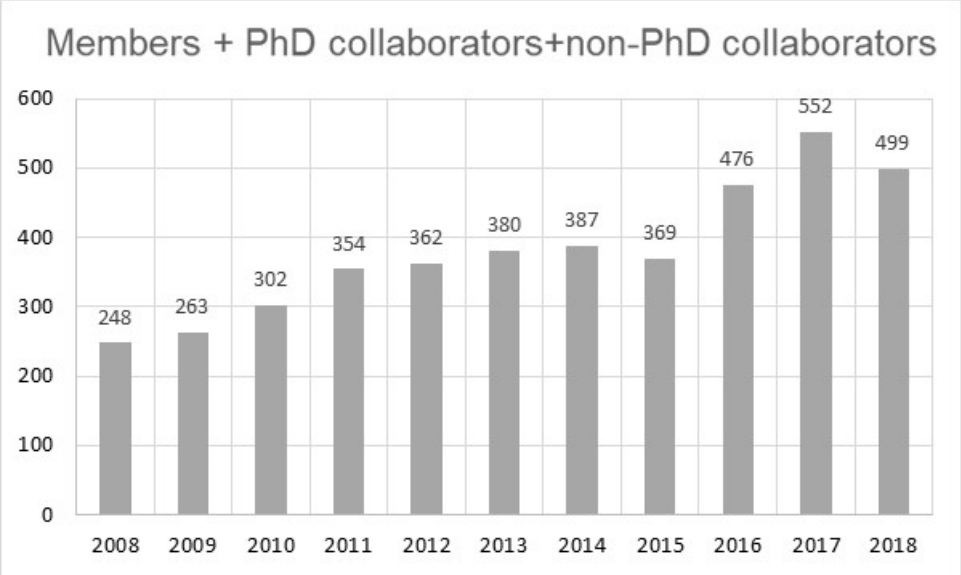

Figure 4 | Evolution of the Members and PhD collaborators and non-PhD collaborators

3.4 Evolution of research and consultancy funding

The aspects of the national economic scenario that are relevant in the present context are the following:

(i) Austerity policies started to be implemented in 2010-2011 and induced an economic recession in 2013-2014 followed by a weak recovery after 2015;
(ii) Public investment in RD&I, which had peaked in 2009, steadily decreased to the present day;
(iii) Local and regional authorities and public agencies also suffered budget cuts in the same period;
(iv) From 2007-2008 onwards, the largest contractors in the Civil Engineering sector invested in the internationalization of their activity, as the national infrastructure approached completion;
(v) The economic crisis virtually paralyzed the Construction sector throughout this period, with a recent recovery based on the rehabilitation sector.

In the 2008-2012 evaluation period, the structure of the combined budget of the founding centres averaged 48% secured through research funding and 52% secured through consultancy funding. The latter form of funding combines all knowledge transfer activities, namely specialized consultancy and advanced on-going training. The decomposition of research funding was as follows: 21% allocated to the strategic program, the centre core funding yearly allocated by FCT; 52% secured through national competitions for research projects and research training programs (mostly promoted by FCT) and 27% through international competitions (mostly EU programs).

The numbers given above refer to a period when the effect of the economic crisis was already strong and were very much influenced by the results of the 2007 FCT evaluation of the research units (all founding centres of CERIS were ranked in the second best position at national level and first in the area of Civil Engineering). In fact, grading was directly linked to core funding, was valued in all FCT competitions for research funding and conferred the prestige essential to secure contracts with companies and public agencies. These policies remained active to the present day.

The results presented in Figure 5 show how seriously CERIS was affected by the 2008-2012 evaluation (strategic funding), by the limitations imposed on the Lisbon region in P2020 calls in terms of research (national projects other than FCT funded), and by the economic crisis, in terms of consultancy: the budget decreased to 41% of the 2008-2012 average; consultancy funding fell 60% and the research funding fell to 43% of the 2008-2012 average. In 2017, was the worst year in the last decade, 46% of the budget was sourced through research funding and 54% through consultancy funding.

In 2018 there was a recovery of the R&D funding, influenced by the success CERIS researcher in funding their research through FCT funded national projects. Consultancy, however, remains at low values, if compared with pre-2013 standards. The imbalance is at its highest point since 2013: 67% of the budget was sourced through research funding and 32% through consultancy funding, that is the latter was about 47% of the former.

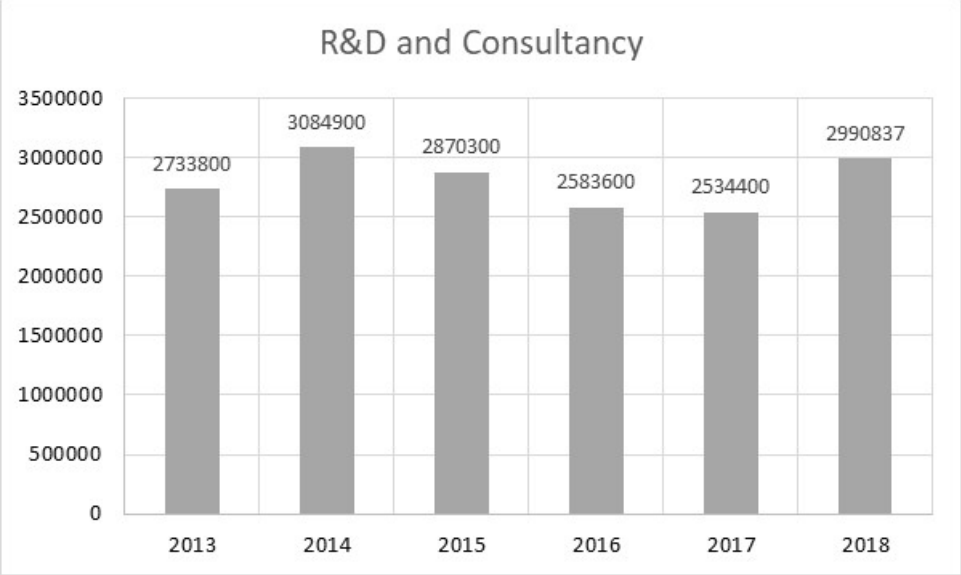

Figure 5 | Total annual funding per research centre (research and consultancy)

The break out of funding in research and in consultancy is presented in Figure 6. The graph reflects the austerity measures taken throughout the 2010-2014 period. The results in 2014-2017 combine two effects: a stagnation of the economy (with an oscillation in 2015), the research funding losses caused by the last evaluation of CERIS and by the P2020 calls limitations for entities from the Lisbon region, and also by the irregularity of the disclosure of the results of applications to FCT funded projects. The total funding value in 2017 (1.9 M€) is the worst in many years, with a significant loss in both consultancy and a research funding relative to previous period. In 2018 there was a clear recovery in R&D funds, mostly due to the initiation of national projects funded by FCT. This trend is expected to be sustained in 2019 and 2020, the peak years for financial execution of these projects. However, R&D funds due to EU-funded projects has not increased (not shown in graphics). Funding from consultancy activities was, in 2018, at its lowest since 2013. This indicates that the economic recovery of the construction sector has had a limited impact on the activities of CERIS members.

As the number of PhD researchers (combining PhD members and PhD collaborators) did not substantially

change in the period under analysis, a similar pattern is found in Figure 7, which illustrates the evolution of the capacity of PhD members to secure either forms of funding. In 2018, the average total funding was 17 k€ per PhD researcher and 27 k€ per PhD member.

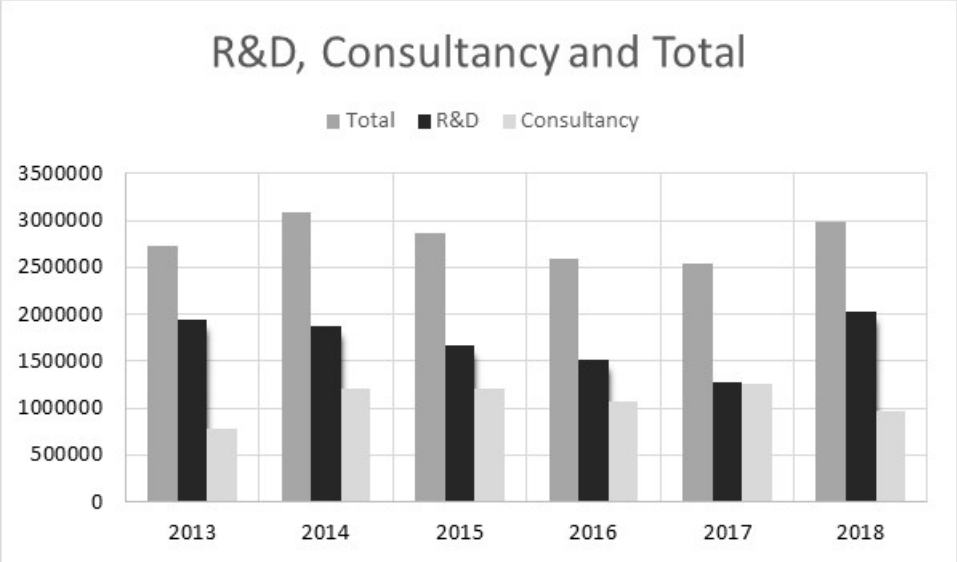

Figure 6 | Annual funding in research and in consultancy

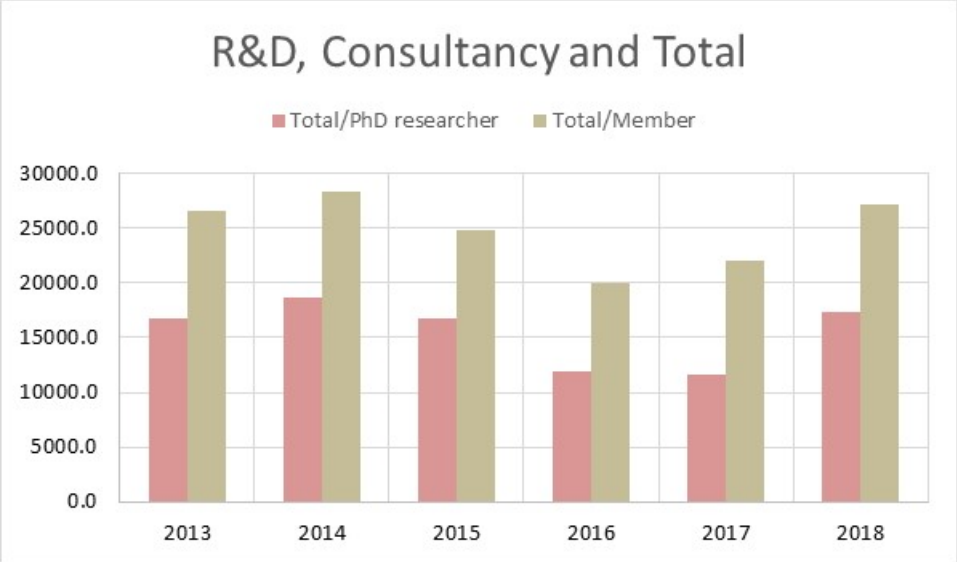

Figure 7 | Total annual funding per PhD researcher and per PhD member

The capacity of CERIS to secure research funding decreased in 2014-2017. This trend was inverted in 2018. Table 13 shows a relatively high success rate in competitive research projects and grants (especially at national level, where members have been very active in submitting proposals in 2017), apparently contradicting the fall registered in the national success rates substantially caused by the cuts introduced in public funding of research.

3.5 Evolution of the main activity indicators

The evolution of the number of completed PhD theses is shown in Figure 8. The number of completed PhD theses is similar to that of the previous years and slightly higher than the values up to 2014. This should reflect the relevance of the PhD programs headed by CERIS researchers. The oscillations are associated with differences in completion caused by PhD programs with dissimilar requirements in mandatory courses and, consequently, in breadth and depth of the research project. They are also affected by the cuts in the national program for PhD grants, which were attenuated by the engagement of CERIS in independently funded international bilateral consortia (namely through the Portugal-MIT and Portugal-U. Texas Programs) and FCT-funded PhD programs.

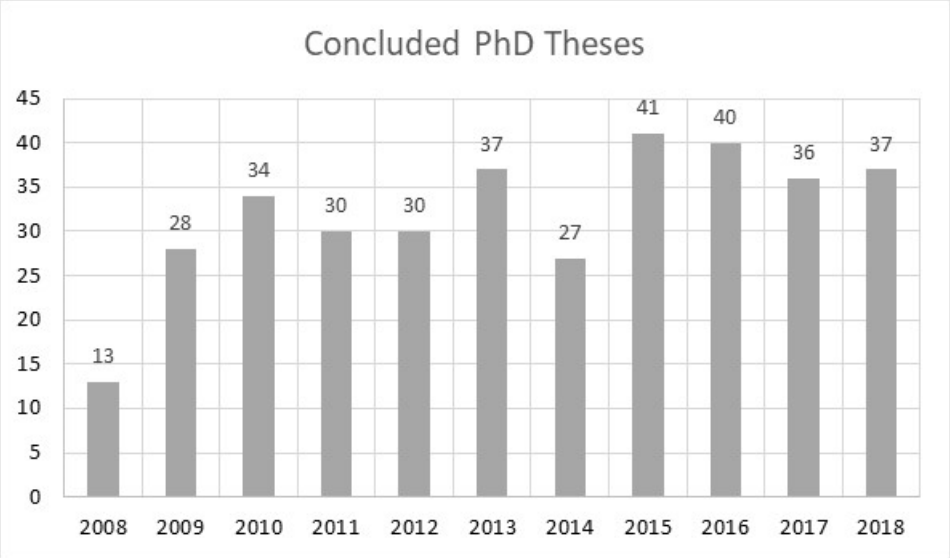

Figure 8 | Concluded PhD theses

The success in securing PhD contracts under FCT-funded doctoral programs is one of the key reasons why CERIS kept improving the main activity indicators under otherwise adverse conditions. CERIS succeeded in coordinating five and participating in another PhD program selected for funding in an internationally evaluated national competition held by FCT. No remotely similar rate of success was registered in the area of Engineering.

The evolution of the total number of papers published by CERIS researchers is presented in Figure 9.. The graph shows a consistent increase in the scientific activity from 2008, with the exception of 2012 (possibly caused by a previous decrease in the number of concluded PhD theses), and a stabilization plateau in 2015-17. In 2018 there is an evident increase in all indicators – bulk numer of papers, papers per PhD researcher and papers per member. This may be attributed to cumulative effect of the increase in completed PhD theses and the incorporation of highly productive young researchers at post-doc level.

The publication ratios per PhD researcher and per PhD member are presented in Figure 10 and Figure 11, respectively.

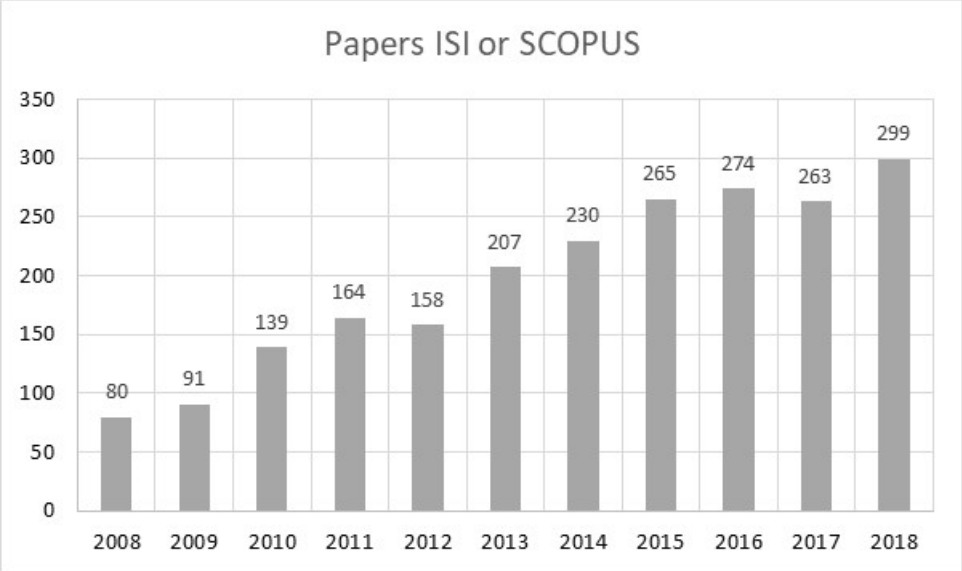

Figure 9 | Papers published in international journals (ISI and Scopus)

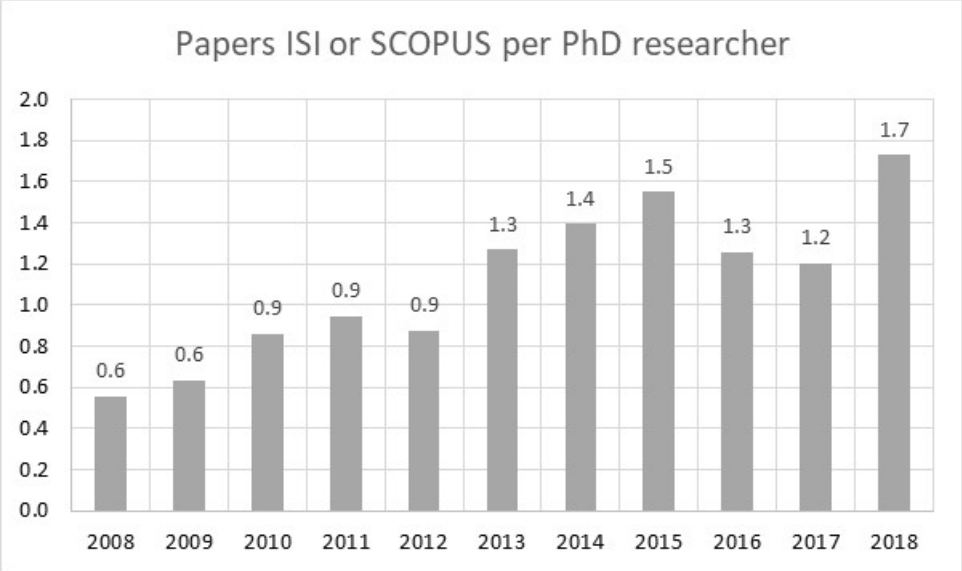

Figure 10 | Publication in ISI/Scopus journals per PhD researcher

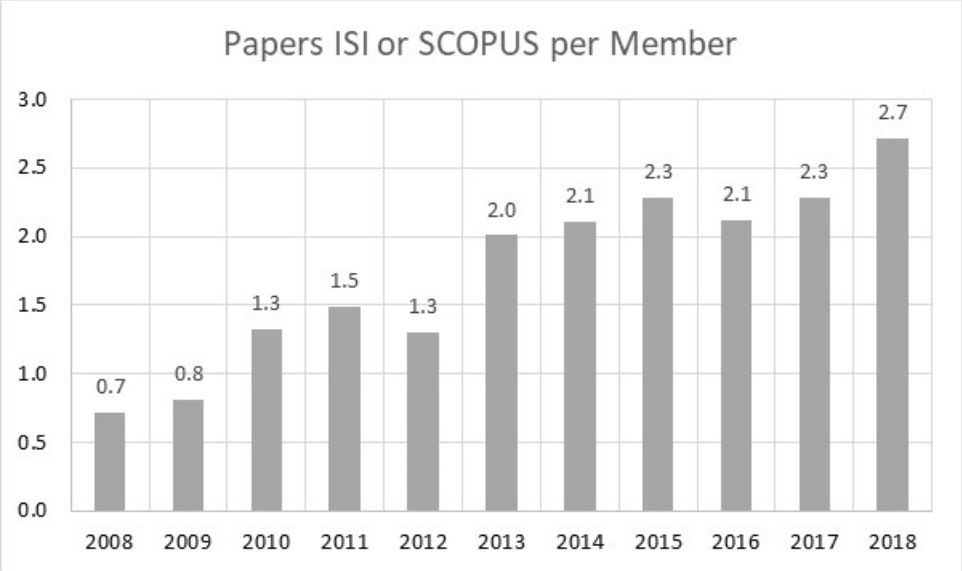

Figure 11 | Publication in ISI/Scopus journals per PhD member

The 2018 ratios were 1.7 papers per PhD researcher and 2.7 per PhD member. Publications in international conference proceedings did not increase in 2018. On the contrary, publication in national conferences almost doubled, with 2018 ratios per PhD member of 2.4 and 1.5 for international and national conferences, respectively.

Figure 12 depicts the distribution of the papers published in ISI journals per quartile of impact factor.

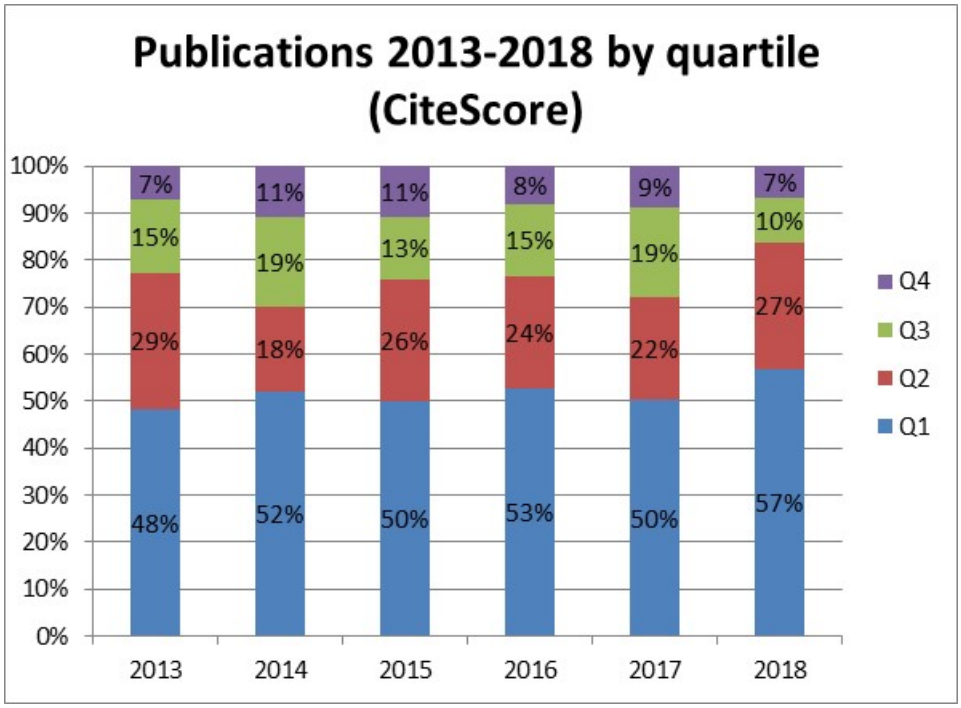

Figure 12 | Distribution of papers published in ISI journals per quartile (Q1 to Q4) of impact factor

In the 2013-2017 period, more than 50% of the papers were published in Q1 journals. This number was relatively stable during this period. In 2018 this figure was 57% showing a significant increase. Moreover,

76% of the papers were published in Q1 and Q2 journals, attesting the relatively high average quality of the journal publications of CERIS members. This trend was accentuated in 2018 with about 82% of the papers published in Q1 or Q2 journals.

Figure 13 shows the distribution of the papers published in ISI/Scopus journals according to the collaboration in terms of co-authorship: (i) only CERIS co-authors; (ii) co-authors from other national institutions; (iii) co-authors from international institutions. The numbers fluctuate over the years, but there is a general increasing trend of both types of collaborations, especially after 2015, with about 65% of publications resulting from effective external collaborations. In 2018 thre is a significant decrease of the number of CERIS only papers but not associated to an increase of external collaboration – it is mostly due to national collaborations wich may, again, be caused by the dynamics of the PhD programs in which CERIS researchers lead or participated.

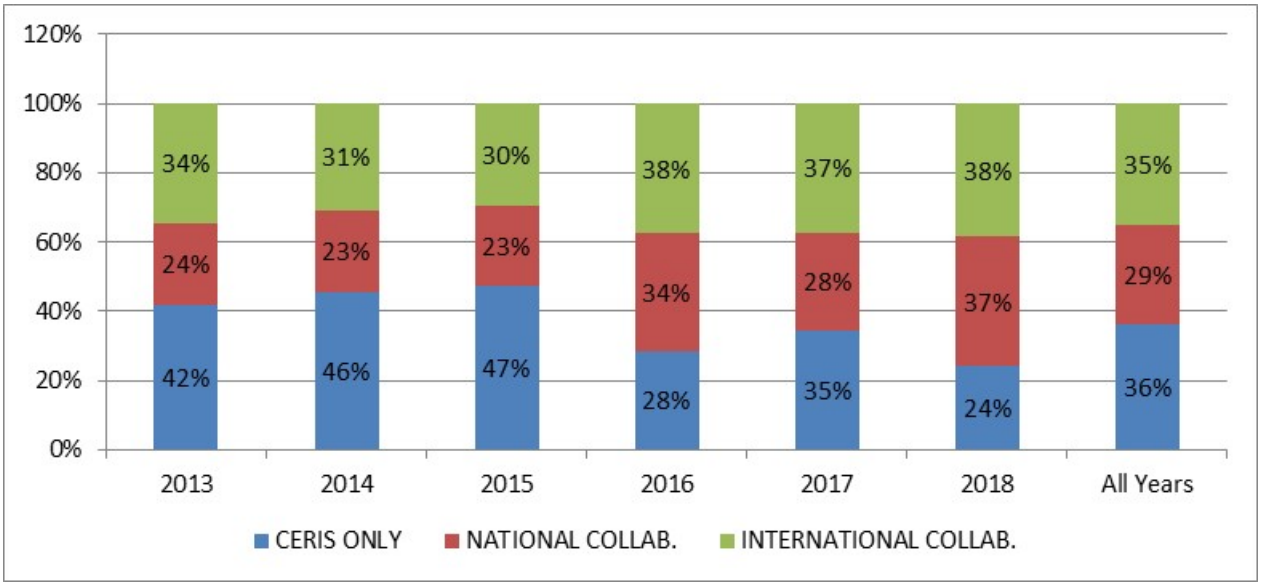

Figure 14 | Distribution of papers published in ISI journals in accordance to the type of participation

3.6 Research group results

The contribution of the research groups to the activity indicators presented above is presented in Annex C.

4. FUTURE RESEARCH

The CERIS activities planned for 2019 are a natural follow-up of the research carried out in 2018, as summarized in Section 2.4. The proposed activity, as submitted by the coordinators of the research groups, will benefit from the internal program to promote cooperation in research, as framed by the thematic strands and the work areas presented in Sections 2.2 and 2.3.

RG1 | Hydraulics

The RG activities in 2018 will be a natural follow-up of the research carried out in 2017. These activities will cover research objectives that include different cross-cutting issues with branches in the four thematic strands: Product development in Civil Engineering industries (PD); Risk and safety in natural and built environments (RS); Rehabilitation of natural and built environments (RNBE); Response to natural and societal changes (RNSC).

The RG activities for 2018 will be organized according to major research topics as follows:

a) Pressurized water systems

- Methodologies and software tools for the assessment and enhancement of water-use and energy efficiency in water supply systems (*e.g.*, water and energy auditing, leak detection and location, optimization of pump scheduling, use of variable speed pumps, microturbines and pump-turbines) (PD).
- Development of reliability analyses and risk management tools for different types of water and wastewater infrastructures (RS).
- Safety and risk analyses and establishment of design criteria in pressurized pipe systems based on the development of advanced 1D/2D transient solvers, CFD modelling of pressurized flows and data collection in experimental facilities and real-life systems, fluid structure inter action (RS).

b) Fluvial hydraulic structures

- Development of mitigation strategies and pre-cast shelters for fish downstream of powerhouses with hydropeaking operation (RS).
- Numerical and experimental modelling of different flood release and related hydraulic structures (RS; RNBE).
- Study of the hydraulics of PKW weirs combined with spillways (RS, RNBE).
- Study of the pressure field and slab stability in a plunge poll lined with concrete slabs (RS).

c) River restoration and management

- Monitoring tools, based on physically-based computational models, for water and sediment quality in rivers and estuaries (RNBE).

- Risk management in the valleys downstream of dams (RS; RNSC).
- Environmental flows determination procedures and hydropower station operation rules to reduce ecological risk downstream of dams (RS, RNBE).
- River restoration and development of fish passes for low height river obstacles to improve ecological connection along regulated rivers (PD; RNBE; RNSC).

d) Environmental fluid mechanics

- Laboratorial investigation of rough-wall open-channel turbulence (RNBE).
- CFD simulation of solid-fluid interactions in turbulent flows (RNBE).
- Laboratory investigation and mathematical simulation of transport of dissolved substances (RS, RNBE).
- Heat and mass transport in wetlands (RNBE)

e) Sediment transport and river morphodynamics

- Hydrodynamics of river confluences in equilibrium (RS; RNBE).
- Hydrodynamics of river diversions in equilibrium (RS; RNBE).
- Sedimentation in shallow retention reservoirs: experimental study.
- Mathematical modelling of shallow-flows with mobile beds. Application to long term channel morphology evolution, dam-breaching, dam-break flows and overland tsunami propagation (RS).
- Mathematical simulation (Eulerian and Lagrangian) of transport processes (RS).
- Development of stabilization techniques for rivers meanders in equilibrium (RNBE).

f) Ocean waves, coastal morphodynamics and coastal and port structures

- Studying extreme events like freak waves, near the coast, to improve navigation safety and support the offshore wind energy production industry (moored or floating) (RS; RNBE).
- Assessment of the vulnerability to flooding of the built environments on low-lying areas of estuaries, due to extreme ocean storm surges events and climate action (RNBE; RNSC).
- Life-cycle cost analysis of coastal and port structures (RNBE).
- Modular port facilities in rivers for bulk cargo;
- Morphological modelling of beach morphology in the presence of coastal structures. (RS).
- Turbulent transport processes in rivers and estuaries: experimental research on interaction between transported quantities (sediment, pollutants, nutrients, etc.) and turbulence (RS; RNBE).

- Air entrainment in wave breaking - laboratory experiments, infra-gravity waves – generation mechanisms and practical applications

RG2 | Environment and Water Resources

The group RG2 will continue to focus on research activities in the areas of the environment and water resources, with the objective of developing approaches, methodologies and tools that cut across these areas, improving knowledge and capabilities to manage natural and built environments in a sustainable way.

The research objectives will cover different cross-cutting issues related with the thematic strands defined for CERIS, with the main activities focused on “Natural and Societal Changes”, and on “Risk and Safety in Natural and Built Environments”, with more limited contributions to the other two thematic strands.

In the near future, the E&WR will continue concentrating its activities in the following major topics:

a) Hydrology and water resources: characterisation and modelling of hydrologic variables and processes, including extreme event analysis, planning and management of water resources, and water policy formulation;

b) Assessment and analysis of climate change impacts on natural and man-made systems, with special emphasis on water resource systems, including the formulation of measures and policies for promoting adaptation and mitigation;

c) Water governance indicators: the establishment of a sound set of indicators for water governance that reflect the i) existing framework conditions, ii) recent evolution, and iii) impact on society, for all principles and overarching goals of water governance;

d) Sewer systems, including water quality along the lines and in in-sewer processes;

e) Integrated sustainable wastewater solutions, including hydraulic and environmental performance of treatment systems such as constructed wetlands, and sanitation approaches and solutions for low income countries;

f) Environmental management of natural and built environments and approaches to the transition of cities to greener economies, including, sustainable infrastructures and construction, energy efficiency, eco-efficiency, mobility, with special emphasis on life-cycle analysis, certification procedures and sustainability criteria;

g) Monitoring and aquifer testing and assessment of groundwater pollution and Ecosystems in groundwater;

h) Numerical and stochastic groundwater modelling and Geophysics and SSD applieded to hydrogeology and groundwater management.

i) Application of NBS in groundwater management.

j) Drone images acquisition by using several bands, namely visible bands, near infrared and thermal images obtained at low altitude, for the delimitation of recharge zones and aquifer discharge by mapping the soil moisture and its relationship with land use (project DRONEWATER funded by FCT, PTDC/CTA-OHR/32360/2017).

RG3 | Systems and Management

In line with the activity developed in the previous period, the planned research activities of the group can be placed under 3 major domains:

1. Regulatory and contracting policies, pricing and performance assessment;
2. Decision-making and systems design, operations and management and project management;
3. Information modelling and technologies.

Furthermore, closer coordination with CEris strategy and the general orientations stemming from its thematic strands will be promoted. The horizontal character of the S&M group skills and competences creates opportunities for synergetic cooperation and interactions with other CEris research groups and to make relevant contributions closely linked to the objectives of all the thematic strands.

Regarding Strand 1, the group will be focused on the improvement of the processes and infrastructure projects through the development of better models for project management and the procurement of goods, services and works. Particularly, the group has an extensive work developed in the scope of public-private partnerships arrangements with several models and contributions for the literature and the empirical world. Therefore, in the coming years new solutions will be proposed to achieve higher levels of efficiency and effectiveness of these two activities widely recognized as critical to achieving successful results in infrastructure and other civil engineering areas.

The team in particular has a remarkable tradition of open and comprehensive search for understanding new societal problems. Many of these challenges are directly related to the performance of complex organizations serving communities and cities. The S&M research group will promote the development of:

a) models of complex organizations providing public goods or services, such as water supply, waste schooling, logistics and health networks;

b) regulatory frameworks and adaptive approaches to propose better pricing and performance evaluation systems, allowing for benchmarking and rankings, particularly in infrastructure and other public services.

In Strand 2, the study of risk in any natural or built environment requires modelling complex systems, namely urban networks, designed to guarantee the fulfilment of societal needs expressed in terms of information, energy, water, mobility and supplies of a wide spectrum of goods and services. The group

will pursue the development of advanced tools to design and to optimize such complex systems, increasing safety and resilience. The group particularly will provide contributions in the development of models applied to Civil Engineering using as multicriteria decision analysis (MCDA), logistics and supply chain, systems modelling and optimization, contracts and project management in infrastructure.

Concerning the Strand 3, the main research scope are the areas of Geographical Information Science and Information and Communication Technologies applied to Geomatics, Building Information Modelling and Information Technology in Construction. The contribution of the members leads to a more effective sustainability, greater economy in the construction and energy efficiency and on streamlining the process of implementation of the project, based on innovative tools used in the field of Civil Engineering.

The activity of the group will be mostly focused on emergent areas of the H2020 program. The Geomatics research main subjects will be focused on: disaster-resilience; satellite imagery in the detection and mapping of vertical displacements and natural hazards; Interferometry via persistent scatters in the detection and measurement of ground subsidence; development of methodologies for volcanic hazard and risk mapping; Information for disaster mapping and management; geoid undulation at local and regional scales; ground deformation with advanced SAR methods; applications of spatial analysis, namely in location problems for meters in supply networks, measurement of walkability scores; and 3D virtual city models – GeoBIM environment.

The focus of the Information Technology in Construction will be mainly digital construction: e-business and e-procurement platforms to support construction project lifecycle; research on innovative approaches to e-business in construction, where social networks and collaborative work play a central role; intelligent buildings; building Information modeling (BIM); construction information management and optimization to improve buildings performance; BIM implementation in projects and organizations; and Asset Information Model (AIM).

RG4 | Transportation Systems

The RG4 for 2019 pursue the objectives described in the Annex C, using the means and the routes offered by EU (Horizon 2020) and national (Portugal 2020 and FCT) financed research projects, by the research involved in each going on PhD works integrated on the doctoral program in Transportation Systems, by the innovation, the technology and the development transfer to society and industry, by supporting the training professional programs set with several stakeholders on the transportation and infrastructure systems, and by the improvement of the results achieved within the international networks already established and the ones to enhance if the opportunity comes.

RG5 | Studies on Construction

The general objectives of the group for 2019 are:

- To develop research projects in the general domains of Construction Materials, Technology and Management Innovation; Sustainable Construction; Monitoring, Rehabilitation and Conservation of the Built Heritage. An effort will be made to concentrate efforts in increasingly less wide and more specific fields to produce relevant results in national and international forums (measured in a significant increase in the number and impact factor of papers in peer reviewed international journals, the supervision of PhD Theses and the approval of national and international research grants): advanced materials and technologies also focusing on nanomaterials - establish international cooperation and be a national leader in the field of composites (GFRP and GRC); concrete and mortars technology - proceed with PhD and MSc studies under way (in strong collaboration with LNEC) and improve the Mortars Section of the Construction Laboratory; risk informed quality, safety and environmental management in construction - increase the already large international cooperation via technical committees and international conferences; sustainability and deconstruction strategies and technology - proceed with PhD and MSc studies under way and be a national and international reference in the field of recycled aggregates for concrete and mortars production; building physics and passive design - continue the very good results in the near past and expand its potential through studies on energy efficiency and acoustics of innovative materials, components and construction systems; building acclimatization and mechanical systems - continue collaboration with the Mechanics and Physics Departments of IST Department of IST, strategically important in terms of sustainable construction in terms of energy-saving; inspection, diagnosis, maintenance and rehabilitation systems - proceed with PhD and MSc studies under way and be a national and international reference in the field of inspection and diagnosis systems; conservation of historical building heritage - continue and strengthen national and international cooperation projects, namely within the Construction Technological Portuguese Platform (PTPC);
- To continue participating in national and international committees, participating / organizing national and international conferences, teaching in Graduation and Post-Graduation courses in the field of construction (namely in the recently awarded FCT Doctoral Program Eco Construction and Rehabilitation, launched in 2014 and participate in academic events and performing consultancy work.

RG6 | Structures and Geotechnics

As in previous years, in 2019, it is planned that the members of the RG6 continue working in the same major research topics of the area, taking into account most relevant issues according to reference international organizations and the current priorities of the country.

An effort will be made to promote a deeper and effective collaboration between RG members, as well as between these and internationally renowned researchers, to deliver relevant contributions to the sector and increase the participation in research projects funded by the European Union. The main general purpose is to improve the construction sector competitiveness, supporting the development of economical and eco-efficient materials and products, as well as new technologies to design, build and maintain high-quality and long-lasting structures. This embraces (i) the development of industrialized cementitious materials, geomaterials and products, (ii) the development and implementation of advanced computational tools for geotechnical and structural assessment, safety verifications (new and existing structures and their foundations) and design of strengthening solutions, (iii) the health monitoring and life-cycle management of structures and their foundations, and (iv) the develop of tools for the analysis and mitigation of risks in infrastructures.

Other more general objectives are the increase of the group internationalization and the links to industry, namely through:

a) improvement of the competitive funding capacity in international and national research projects calls

b) participation in national and international standardization committees,

c) organization of academic national and international events,

d) participation in national and international Graduation and Post-Graduation courses (namely FCT Doctoral Programs) in the field of Structures and Geotechnics,

e) expert consultancy work to partially fund research and provide practical applications to the results of research,

f) collaboration with design offices.

5. CLOSURE

CERIS merged in 2015 three research centres of DECivil, namely CEHIDRO (Centre of Hydraulics, Water Resources and Environment), CESUR (Centre for Urban and Regional Systems) and ICIST (Institute of Structural Engineering, Territory and Construction).

Their integration in CERIS was designed to exploit a comprehensive thematic coverage, in depth and scope, promoting synergies in the multidisciplinary sector of Built and Natural Environment. Indeed, CERIS was created to address the main issues identified in key documents on the prospects of the sector and to respond thus to recommendations to enhance strengths and to overcome weaknesses identified by the external advisory boards and the international evaluation panels of its founding centres when they operated independently.

In 2018, CERIS joined the expertise of 173 PhD researchers and 216 no-PhD researchers, having the profile and the critical mass needed to sustain a leading national position and to attain a strong international presence in the sector. The feasibility of these central objectives was confirmed in the first four years of formal operation of CERIS, which also confirmed the need to face the challenges and solve the difficulties foreseen in the discussions that led to its creation.

CERIS is classified by FCT as the only ‘large research unit’ in the area of Civil Engineering. In terms of day-to-day operation, one set of difficulties relates to inherited weaknesses in technical staff in what regards the operation of laboratories and, especially, the creation of an administrative structure competent in the management of Science and Technology. As the merging of the centres must yield an improved use of human resources, CERIS should use its own resources to engage and train the necessary technical staff in preparation of the announced waiving of the current freeze on recruiting.

The discussion that led to the creation of CERIS was mainly focused on the dual challenge of respecting the identity of the founding centres while actively promoting internal cooperation in a new unit rich in synergies in the main areas of Built and Natural Environment. The first four years of operation have shown that loss of identity is not an issue and confirmed that the core challenge of the merge was the progressive realignment of the activity of the research groups in the framework of the main work areas of the common thematic strands. It was not expected, and it should not be expected, that groups with long-established areas of operation would immediately readjust and start new forms of cooperation. Previous commitments must be met and new opportunities cannot be lightly discarded. Moreover, it takes time and sustained internal proactive policies to prove that individual- and group-level performances directly benefit from cooperation.

The number of CERIS Members, of PhD collaborators and of non-PhD collaborators has decreased in 2018. This is mostly because of the former Architecture and Urban Planning group has left CERIS to form a new research Centre. The number of concluded PhD theses remaind stable. However, it is necessary to be attentive, in the next years, to the impact of end of FCT-funded PhD programmes.

In spite of the reduction of the number of researchers, the number of papers increased and, therefore, the number of papers per researcher registred a significat increase. The raw increase should be due to the

success of PhD programs led by CERIS members and to the high productivity of early career researchers, most of them with no tenure contracts. The quality of the papers has increased, with about 82% published in Q1 and Q2 journals. The percentage of papers with national parterships has increased but not those steming from international partnerhips, an issue to be addressed with specific measures to increase internationalization.

International regognition remained high in 2018, as seen by the strong participation in editorial boards and number of invited talks, but this has not materialized in stable cooperations leading to international projects.

In what concerns funding, 2018 results show that the economic recovery has not yed resulted in appositive impact on the consultancy activity of CERIS members. On the other hand, research funding through FCT projects reached a maximum. However, it should be noted that this type of funding is very irregular. The more stable funding from EU has not increased in 2018, an issue that should be addressed.

Other difficultis in securing funding are related to the discouraging conditions the universities located in the Lisbon area have to face when applying to Portugal 2020 calls. In addition, and as a direct consequence of the downgrading suffered in the 2013 evaluation, core funding was substantially reduced and the funding necessary to launch the internal cooperation program was denied.

Based on the high-level of the activities of CERIS in the 2013-18 period, CERIS expects to regain the leading position in the Civil Engineering area. Such a result would be coherent with all main international scientific rankings where the University of Lisbon (in which CERIS is the only research unit in Civil Engineering) ranks 1st in the country in that subject.

ANNEX A - PHD THESES COMPLETED IN 2018

A. PhD theses completed

Supervisors	Title of PhD thesis	PhD student	PhD programme
Inês Flores-Colen; Jorge de Brito	Performance of cladding mortars with silica nanoaerogels Desempenho de argamassas de revestimento com nano aerogéis de sílica	António Armando Ortiz Soares	Civil Engineering
Jorge de Brito, Eduardo Júlio	Resistance and ductility of composite tubular columns steel-concrete with recycled rubber aggregates to be used in seismic regions	António Pedro Carones Duarte	Civil Engineering
Ana Paula Ferreira Pinto	Development of new consolidation products for porous carbonate stones	Bruno Sena da Fonseca	Civil Engineering
Rui M.L. Ferreira	Mathematical Modelling of Tsunami Impacts on Built Environments	Daniel André Silva Conde	Civil Engineering
António Pinheiro	Assessment and development of vertical slot fishways for Iberian cyprinids	Filipe Alexandre Silva Romão	River Restoration and Management
Miguel Amado	Energy Efficiency and Renewable Energy in Rural Areas	Francesca Poggi	Geography and Regional Planning
Rui M.L. Ferreira	Dam break over mobile bed: Experimental and numerical study	Ilaria Fent	PhD program in Engineering Sciences
Dídia Covas	Pumps running as turbine for energy recovery in water supply systems	João Nuno Gomes Borga Delgado	Civil Engineering (H2Doc)
Supervisor: João Ramôa Correia/Co-supervisor: Fernando Branco	Durability of GFRP pultruded profiles and adhesively bonded connections between GFRP adherends	João Pedro Girão Meireles de Sousa	Civil Engineering
Rui M.L. Ferreira	Experimental investigation of the flow force on cylinders in a compound-channel shear-layer	Miltiadis Gymnopoulos	Civil Engineering
Rui M.L. Ferreira	Modeling and experimental testing of an oscillating wave surge converter	Moisés Gonçalves de Brito	Civil Engineering (H2Doc)
Jorge Matos	Blocking probability of large wood and resulting head increase at ogee crested spillways	Paloma Furlan	Civil Engineering (H2Doc)
António Pinheiro	Exploring Riparian Vegetation Interactions with Flow Regime and Fluvial Processes for an Improved River Management and Conservation,	Rui Pedro Guerreiro Duarte Rivaes da Silva	River Restoration and Management
Ana Tomé; Francisco Regateiro	Application of Theory of Inventive Problem Solving (TRIZ) in Architectural Design Studio	Sajjad Nazidjazi	Architecture
João Ramôa Correia; Fernando Branco	Fire behaviour of GFRP pultruded profiles	Tiago Miguel Rodrigues Morgado	Civil Engineering
Jorge Matos	Skimming flow over stepped spillways with non-converging and converging sidewalls using Smoothed Particles Hydrodynamics Method		Joint EESC-USP and IST-UL degree (Erasmus Mundus Smart²Project)
Rita Bento	Evaluation of the seismic vulnerability of the unreinforced masonry buildings constructed in the transition between the 19th and 20th centuries in Lisbon, Portugal	Ana Simões	Civil Engineering / INFRARISK-Analysis and Mitigation of Risks in Infrastructures
Dinar Camotim; Pedro Dinis?	Cold-formed steel members affected by distortional mode interaction: behaviour, strength and design	André Rafael Dias Martins	Civil Engineering

Carlos Tiago	Comparison and coupling of continuous and discontinuous Galerkin methods: application to multi-physics problems	Mahendra Paipuri	Computational Engineering / Erasmus Mundus Joint Doctorate em Simulation in Engineering and Entrepreneurship Development (SEED)
António M. Pinho Ramos	Comportamento ao Punçoamento de Lajes Fungiformes em BRF sujeitas a Ações Monotónicas e Cíclicas	Nuno Dinarte Gouveia	Civil Engineering
António Sousa Gago / Helena Ribeiro dos Santos	Entre a tradição e a inovação: Estudo do edificado a Nascente do Plano da Baixa de Lisboa depois do terramoto - Between tradition and innovation: Plan for reconstruction of east Lisbon downtown after the 1775 earthquake	Joana Rosa Graça da Mota Fernandes Alegria	PhD in Architecture
Luís Guerreiro	Reforço sísmico de estruturas de alvenaria usando dispositivos com ligas de memória de forma (SMA - Shape Memory Alloys)	Miguel Branco	Civil Engineering
António M. Pinho Ramos; Válter José da Guia Lúcio	Seismic behaviour of flat slabs with punching shear reinforcement	Brisid Isufi	Civil Engineering
Vasco Reis (IST); Rosário Macário (IST)	A Decision Support Tool for Flexible Development of Constrained Airports	Liliana Alexandra das Neves Magalhães	Transportation Systems
Rosário Macário (IST)	Modelação de Políticas Integradas para a Redução do Congestionamento Rodoviário através do Conceito de Responsabilidade Partilhada	Paulo José de Matos Martins	Civil Engineering
José Neves (IST)	Development of an Accelerated Asphalt Concrete Aging Method and Utilization of Nano-Modifiers to Improve Durability of Asphalt Concrete	João Miguel Lopes Crucho	Transportation Systems
Rosário Macário (IST)	Understanding the Effects of the Competitive Acess to the European Union Financial Support Policies on the Traffic Forecast Overestimation in Transport Infrastructure Projects	Matheus Henrique de Sousa Oliveira	Transportation Systems
José Manuel Viegas (IST)	Transport Needs for an Ageing Society: Long-term Drivers and Generational Effect	Rafaela Gonçalves da Silva Arriaga Oliveira Andrade de Sousa	Transportation Systems
Rui Cunha Marques	Tariff Structure in Water Supply and Wastewater Utilities in Critical Situations	Francisco Silva Pinto	Engineering and Management
Rui Cunha Marques	Efficiency of Hospitals Facilities. New approaches.	Diogo Filipe da Cunha Ferreira	Engineering and Management
Rui Cunha Marques	How to advance in the decision-making process regulatory choices for the provision	Bruno Eustáquio Carvalho	Civil Engineering
José Saldanha Matos	Planning Guidelines Principles for Improoving Sanitation Services in Urban Areas of Developing Countries – Case Study Application in Maputo.	Ana Rita Ramôa	Climate Change and Sustainable Development Policies
Fernando Simões	Structural dynamics modelization of one-dimensional elements on elastic foundations under fast moving load	Diego Froio	Engineering and Applied Sciences
Manuel Duarte Pinheiro (IST).	Análise da sustentabilidade na construção de habitação a custos controlados em Angola.	José Alberto Fernandes Martins	Doutoramento Engenharia Civil pela Universidade de Aveiro
Rodrigo Proença de Oliveira	Process-based river restoration for heavily modified sections of European large rivers: reference conditions, ecological deficits and target states	Maria Diaz	Gestão e Restauro Fluvial

Rodrigo Proença de Oliveira	Modelagem concentrada e semi-distribuída para a simulação da vazão, produção de sedimentos e concentração de nutrientesem bacias hidrográficas do interior de São Paulo.	Franciane Santos	Engenharia Civil

ANNEX B - PAPERS PUBLISHED IN ISI/SCOPUS JOURNALS IN 2018

Abreu e Silva, J. (2018): "The effects of land-use patterns on home-based tour complexity and total distances traveled: a path analysis", Sustainability, V. 10, n.º 3, 830, March 2018. DOI:10.3390/su10030830 (ISI, Q2, IF=2,075, N.Cit=1)

Abreu e Silva, J.; Melo, P.C. (2018): "Does home-based telework reduce household total travel? A path analysis using single and two worker British households", Journal of Transport Geography, V. 73, 148-162, December 2018. DOI:10.1016/j.jtrangeo.2018.10.009 (ISI, Q1, IF=2,699, N.Cit=0)

Abreu, V.; Evangelista, L.; de Brito, J. (2018): "The effect of multi-recycling on the mechanical performance of coarse recycled aggregates concrete", Construction and Building Materials, V. 188, 480-489, November 2018. DOI:10.1016/j.conbuildmat.2018.07.178 (ISI, Q1, IF=3,485, N.Cit=5)

Acciaro, M.; Ferrari, C.; Lam, J.S.L.; Macário, R.; Roumboutsos, A.; Sys, C.; Tei, A.; Vanelslander, T. (2018): "Are the innovation processes in seaport terminal operations successful?", Maritime Policy & Management, V. 45, n.º 6, 787-802, 2018. DOI:10.1080/03088839.2018.1466062 (ISI, Q3, IF=1,741, N.Cit=1)

Aguiar, F.C.; Segurado, P.; Martins, M.J.; Bejarano, M.D.; Nilsson, C.; Portela, M.M.; Merritt, D.M. (2018): "The abundance and distribution of guilds of riparian woody plants change in response to land use and flow regulation", Journal of Applied Ecology, V. 55, n.º 5, 2227-2240, September 2018. DOI:10.1111/1365-2664.13110 (ISI, Q1, IF=5,742, N.Cit=3)

Ahmed, H.; Bogas, J.A.; Guedes, M. (2018): "Mechanical behavior and transport properties of cementitious composites reinforced with carbon nanotubes", Journal of Materials in Civil Engineering, V. 30, n.º 10, -, October 2018. DOI:10.1061/(ASCE)MT.1943-5533.0002470 (ISI, Q2, IF=1,763, N.Cit=4)

Alegre, A. (2018): "Children's Parks in Lisbon's urban spaces: a childhood education and assistance programme during the Portuguese dictatorial regime (1933–1974)", Planning Perspectives, V. 33, n.º 2, 229-248, 2018. DOI:10.1080/02665433.2017.1348970 (ISI, Q3, IF=0,368, N.Cit=0)

Alfaiate, J.; Sluys, L.J. (2018): "On the use of non-iterative methods in cohesive fracture", International Journal of Fracture, V. 210, n.º 1-2, 167-186, March 2018. DOI:10.1007/s10704-018-0270-2 (ISI, Q2, IF=2,175, N.Cit=0)

Alho, A.R.; Abreu e Silva, J.; Sousa, J.P.; Blanco, E. (2018): "Improving mobility by optimizing the number, location and usage of loading/unloading bays for urban freight vehicles", Transportation Research Part D: Transport and Environment, V. 61, Part A, 3-18, June 2018. DOI:10.1016/j.trd.2017.05.014 (ISI, Q1, IF=3,445, N.Cit=2)

Allard, R.F.; Moura, F. (2018): "Effect of transport transfer quality on intercity passenger mode choice", Transportation Research Part A: Policy and Practice, V. 109, 89-107, March 2018. DOI:10.1016/j.tra.2018.01.018 (ISI, Q1, IF=3,026, N.Cit=1)

Al-Mansoori, T.; Norambuena-Contreras, J.; Micaelo, R.; Garcia, A. (2018): "Self-healing of asphalt mastic by the action of polymeric capsules containing rejuvenators", Construction and Building Materials, V. 161, 330-339, February 2018. DOI:10.1016/j.conbuildmat.2017.11.125 (ISI, Q1, IF=3,485, N.Cit=14)

Almeida, C.; Ramos, T.B.; Segurado, P.; Branco, P.; Neves, R.; de Oliveira, R.P. (2018): "Water quantity and quality under future climate and societal scenarios: A basin-wide approach applied to the Sorraia River, Portugal", Water, V. 10, n.º 9, art. 1186, September 2018. DOI:10.3390/w10091186 (ISI, Q2, IF=2,069, N.Cit=3)

Alves, D.; Santos, Z.; Amado, M.; Craveiro, I.; Delgado, A.P.; Correia, A.; Gonçalves, L. (2018): "Low potassium and high sodium intakes: a double health threat to Cape Verdeans", BMC Public Health, V. 18, art. 995, August 2018. DOI:10.1186/s12889-018-5911-x (ISI, Q2, IF=2,42, N.Cit=0)

Amado, A.R.; Amado, M.; da Silva, F.N.; Heitor, T.; Rodrigues, E.; Ramalhete, I.; Freitas, J.C.; Silva, A.A.; Cambra, P.; Fernandes, L.B.; Lopes, R.; Pinto, R.S.; Miranda, S. (2018): "Planning without baseline information: Delimitation of urban and rural settlements in Oé-Cusse Ambeno, Timor-Leste", Journal

of Urban Planning and Development, V. 144, n.º 3, art. 05018016, September 2018. DOI:10.1061/(asce)up.1943-5444.0000462 (ISI, Q2, IF=0,946, N.Cit=1)

Amado, M. (2018): "Wall-Up: Method for the regeneration of settlements and housing in the Developing World", Sustainable Cities and Society, V. 41, 22-34, August 2018. DOI:10.1016/j.scs.2018.05.024 (ISI, Q1, IF=3,073, N.Cit=1)

Amado, M.; Poggi, F.; Amado, A.R.; Breu, S. (2018): "E-City Web Platform: A Tool for Energy Efficiency at Urban Level", Energies, V. 11, n.º 7, 1-14, July 2018. DOI:10.3390/en11071857 (ISI, Q2, IF=2,676, N.Cit=3)

Amado, M.; Poggi, F.; Martins, A.; Vieira, N.; Amado, A.R. (2018): "Transforming Cape Vert informal settlements", Sustainability, V. 10, n.º 7, art. 2751, July 2018. DOI:10.3390/su10072571 (ISI, Q2, IF=2,075, N.Cit=1)

Amaral, S.D.; Branco, P.; Katopodis, C.; Ferreira, M.T.; Pinheiro, A.N.; Santos, J.M. (2018): "To swim or to jump? Passage behaviour of a potamodromous cyprinid over an experimental broad-crested weir", River Research and Applications, V. 34, n.º 2, 174-182, February 2018. DOI:10.1002/rra.3232 (ISI, Q2, IF=2,067, N.Cit=4)

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ANNEX C – RESEARCH GROUP ACTIVITIES IN 2018