

## **Review of IDL by the Scientific Advisory Committee Meeting of December 19-20, 2016**

December 20, 2016

### *Committee Members:*

Sierd Cloetingh (Netherlands Research Center for Integrated Solid Earth Science)

Christoph Schär (ETH Zürich, Switzerland)

Montserrat Torne (ICTJA-CSIC, Barcelona, Spain), unable to attend, but contacted for approval of the consensus report.

### *Proceedings*

The committee received the following documents prior to the evaluation:

- IDL Summary report from the director
- IDL Report for 2015/2016, including five reports of the research groups
- IDL Highlights 2016
- List of publications (2015-2016)
- FCT external review 2013 including response by IDL director
- Report on IDL communication strategy

Five presentations were provided by the coordinators of the research groups, followed by a presentation on the outreach strategy. The review committee attended the presentation by the Director of IDL, who reviewed past performance, current structure and a forward look. The panel also attended five presentations of young researchers some of which had recently been awarded personal FCT grants.

These presentations were followed by an open discussion. The meeting was well attended. In addition to senior staff, many young researchers attended. A poster session of PhD projects was organized, followed by a meeting with the PhD students. Subsequently, the committee met with the five research groups and addressed issues related to progress since the last evaluation, synergies between research groups, opportunities for the generation of added value, the optimal use of existing resources, and the need for new initiatives to attract funding.

The committee noted with pleasure that most of its previous recommendations had been partially or fully implemented with the encouragement of IDL's leadership. The committee noticed an overall consensus in the IDL scientific community to strive for further integration in earth system research and its applications for societally relevant issues related to climate change, forecasting of atmospheric extreme events, natural geohazards, as well as scarcity of georesources and energy. All these issues require an integrated approach linking fundamental process understanding to state of the art monitoring, observation systems, field studies and laboratory experiments, as well as numerical and analogue modeling. This also provides an attractive research and training environment for young researchers and students.

The current evaluation centers on the future structure of IDL and the plans offered by the IDL leadership to the committee for a critical assessment of and advise on potential, added value and feasibility. In doing so, the committee has attributed great importance to past and current performance of IDL and its research groups in terms of scientific excellence, societal relevance, and viability. In this context, the committee paid particular attention to the upcoming FCT evaluation in 2017. In doing so, the committee focused on the need to formulate a research strategy with clear overarching objectives for frontier research addressing societal challenges in energy, climate, and natural hazards.

## **Mission and structure of IDL**

The scientific mission of IDL is centered on its three thematic lines:

- 1) Climate Change: this research line focuses on Earth-system integrated approach, innovations in data analysis and process studies, integrations of national and regional priorities in the global agenda.
- 2) Earth Dynamics and Natural Hazards: The committee recommends to change the wording of the second thematic lines as indicated. It should include the integration across time and spatial scales, the study of the coupled Earth system and their implications for natural hazards, with the Iberian-Atlantic region as a prime natural laboratory;
- 3) Energy and Earth Resources: This includes resources and technologies in the transition towards a sustainable energy and Earth resource systems.

This mission is timely and particularly relevant for a country with significant natural hazards and extreme events, water stress, and a great potential for georesources and energy in its territory, both onshore and offshore. All these domains require geoscience expertise on the highest possible levels, also in view of the international research agenda and the priorities formulated in the EU Horizon 2020.

Currently, the society is facing a very challenging energy transition in the decades to come. The research portfolio of the existing IDL groups is strong in a number of geoenergy resources, crucial for this transition. These include knowledge on the formation of deep-water basins and continental margins, which are sites of active hydrocarbon exploration. In addition, high-level expertise exists at IDL on renewable energy sources, including geothermal energy, hydroelectric dams and water resources, as well as climatological information on wind power and solar energy.

The research carried out in research lines 1 and 2 with their primary focus on scientific excellence and novel process understanding have direct bearing for building up the scientific knowledge base in the domain of geoenergy and georesources.

The structure of IDL derives from its mission: Excellent science providing a know-how base for addressing grand societal challenges.

The committee feels that IDL has made progress in consolidating and self-organizing in the aftermath of a major and sometimes stressful restructuring. The presentations provided to the committee were of high to outstanding quality. The PhD and post-doctoral students are well integrated into the overall program.

The director and his management team have fulfilled their positions with great commitment, adequately supported by the high-level administrative capabilities of Mrs. Celia Lee.

Mobility of researchers is an important factor in this very competitive research domain with strong demands on international level for high-quality expertise. IDL researchers have gained important positions abroad, and a strong need exists to replace them with new talents, filling in the gaps. Crucial in this respect is to build out IDL as a top institute with a creative research environment attractive to future ERC grantees and other recipients of major prestigious external funding schemes, including Marie Curie and similar networks.

The committee was very pleased with the success of IDL in the recent FCT round for personal grants for early and mid-career researchers. From the presentations given it was apparent that they will contribute strongly to the mission of IDL.

The committee was also very pleased about the implementation of the new structure containing five research groups. Further efforts are needed to secure a high level of internal communication, both within and between the groups. To be effective at the highest international level, IDL must build on its strengths in a limited number of high-priority areas where it can excel and be of maximum societal benefit.

The committee reviewed in detail the performance of the 5 research groups:

*RG1: Atmosphere, Ocean and Climate.* This group is composed by 26 members and has attracted 1185 kEURO of external funding. They currently host 19 PhD students and have published 105 papers in high impact journals for the period 2015-2016 (including papers that have appeared online in final form).

The RG1 group conducts studies about climate variability, climate change, atmospheric and oceanic circulation, land-climate interactions, natural hazards and extreme events, atmosphere-ocean processes and dynamics, as well as remote sensing. The group participates in analysis of internationally available climate model data, and is also active in climate modeling itself, addressing ocean modeling, global climate modeling, as well as regional climate modeling. The group has a high international visibility and the committee identified a number of significant scientific advances made. The committee was very pleased about the high quality of the report and underlying research, the numerous workshops conducted following completion of individual projects, the demonstration of a high level of scientific leadership and team spirit. There were a number of high-impact papers in top journals that internationally recognized and were picked up by the media. The committee is also pleased with the successful establishment of strong scientific links to RG5 (on solar energy and climate) and RG2.

*RG2: Coast, Water and Surface Processes.* This group, consists of 17 members has attracted 252 kEURO and is hosting 21 PhD students. The group has published 61 papers and has a high societal impact.

The group focuses on Earth surface processes with strong expertise on field measurements, monitoring and modeling at the interface biosphere-lithosphere-hydrosphere. It also addresses environmental and paleoclimate reconstruction, forecasting environmental changes, assess natural and anthropogenic hazards and risks and impacts on hydrological resources.

This research is relevant in relation to a number of pressing issues, among these climate change and sea-level rise. The committee is pleased that the links between RG1 and RG2 have been further intensified in order to optimally exploit the joint potential. There is also a strong potential for synergy with RG4 for joint research on the coupling of surface processes and deep earth processes. The committee thus welcomes the intention of the group to sharpen its positioning under the label “surface processes” and bridge between climate and solid earth.

The committee recognizes that that RG2 is in a transition, and welcomes the intention of RG2 leadership to further raise its international profile by aiming towards more publications in international high-quality journals.

The discussions showed that there would be a great merit to connect the research on climate and the water cycle with consideration of surface hydrology in river catchments, enabling a more integrated consideration of the water cycle from the top of the atmosphere to bedrock, including aspects of flooding, erosion and droughts.

The group has a strong home base in Portugal with many links to national, regional and local authorities. This provides a strong asset and good starting point for strengthening the links to the ongoing development of climate services and the forthcoming programs of the EU, for instance on Earth environment.

*RG3: Marine Geology and Geophysics.* This group has 24 members, has attracted 872kEURO external funding and is hosting 11 PhD students. The group has published 63 papers and provides an important science base for responding to Portugal’s marine strategy in the years to come.

RG3 hosts researchers working in solid Earth geodynamics in the present day ocean environment, from the continental margin into the deep ocean. The group members have a background in geophysics, geology, and geochemistry, with expertise in maritime surveys, and in the exploration of ocean bottom observatories, besides a strong interest in deep ocean exploration. The group leads the Portuguese contribution for tsunami research.

Researchers in RG3 have strong ties with IPMA and the research opportunities have expanded significantly after the acquisition of a new research vessel by IPMA. The group participates in several ESFRI (European large-scale scientific infrastructure initiatives) projects, including EMSO (European Multidisciplinary Seafloor and water-column Observatory) and EPOS (European plate observing system). A major contribution from EU FP7 has been obtained through the BLUE MINING project. Several papers are published jointly with RG4. The group leader has a high international profile and was awarded the Arne Richter Young Scientist award. Care must be taken that the leadership role does not have detrimental impact on his scientific activity, especially in view of the need to attract a high level external funding from EU and the industry, in order to make this group less dependent upon FCT funding. The senior members of the research group should strongly contribute towards this aim.

*RG4: Continents, Islands and the underlying Mantle.* This group consists of 30 members, has attracted 890kEURO external funding, hosts 13 PhD students and has published 120 papers.

RG4 hosts researchers working on solid Earth geodynamics aiming at understanding mantle to surface processes across diverse temporal and spatial scales. The group encompasses researchers using mostly, but not exclusively, land observations. The group collaborates tightly with national/international partners and with other IDL research groups, in particular with RG3. The group is involved in EPOS. The group leader has a high level of participation in outreach activities. The committee recognizes the need to find the right balance between these laudable efforts and the need for efforts for further integration and community building within the group.

Research of the group has a strong component focusing on Iberia and the volcanic islands of the Azores and Cape Verde, as well as on Madeira, addressing both intra-plate and near mid-ocean ridge environment. The committee recognizes a strong potential for further developing cooperation with RG2 in high-resolution studies on palaeo-environments and sedimentary processes. The group is involved in research on earthquake, volcanic and tsunami hazards, some of this in collaboration with RG3. The division of research between RG4 and RG3 appears sometimes to be somewhat arbitrary, and there is space for further integration and coordination.

The group should make a special effort to ensure continuity in external research funding, requiring a stronger utilization and recognition of expertise of senior members of the group. The group has a high potential for links to the private sector in georesources and geoenergy.

*RG5: Renewable Energy.* This group consists of 11 members, has attracted 506 kEURO and published 35 papers and is hosting 18 PhD students. RG5 has joined IDL three years ago. In spite of its relatively modest size, the presence of this group is serving the profile of IDL in both the research lines on Energy and Georesources as well as Climate Change.

This group has a focus on the challenges faced with regard to the production and use of energy in a sustainable manner. The required complex energy transition requires multiple approaches in parallel. New energy conversion technologies such as renewables, its integration in the energy system, new mobility options and improved energy efficiency in buildings will thus play a major role.

The committee is pleased with the synergy between this group and RG1, in particular regarding the impact of climate and weather on efficiency of solar energy production, as well as the impacts of natural variations on building energy efficiency. The group has strong expertise in photovoltaics, and is moving into the field of energy storage and environmental engineering. The committee recognizes a significant potential for joint research on geothermal energy together with RG4, in particular in the context of a possible test site on Terceira (Azores island). The committee is pleased with the involvement of RG5 in the collaborative PhD program with MIT on sustainable energy systems. The leader of this research group is dedicated to his task and recognizes the opportunities offered for a stronger interaction with the IDL groups. At the same time it is recognized that collaboration beyond IDL are also of key importance, due to the engineering components in some of their research. A strength of this group is its easy access to a pool of competent PhD students.

## **Scientific infrastructure**

IDL is hosting a significant research infrastructure, including an advanced computing facility, analytical laboratories for Solid Earth studies, geophysics and geological field equipment, a geomagnetic laboratory, and a number of applied physics laboratories. This infrastructure is in many ways unique in Portugal and of great potential for the Portuguese participation in the European plate observing system (EPOS), selected for the EU-ESFRI road map for large-scale European research infrastructure. With the increasing role of numerical modeling studies, high-performance computing hardware and expertise will increasingly become important. The well-established connection between IDL and IPMA, provides easy access for IDL researchers to cost-intensive equipment, including research vessels and networks of geo-monitoring equipment, as well as access to unique meteorological and climate data sets through IPMA's partner institutions (e.g. ECMWF). Since the last report acquired a new research vessel, opening a new chapter in Portuguese marine sciences. Those research facilities enhance the scientific productivity of current and prospective IDL team members, and help attracting the best scientists in their fields.

## **The main overarching accomplishments of IDL**

The current IDL yielded an output of 340 papers in the period 2015-2016 in ISI-ranked journals. The committee noted that an increasing percentage of currently 9% of the scientific output is published in high-impact international journals. A substantial number of these publications are with international partners, demonstrating that IDL scientists are viewed by their colleagues as attractive collaborators.

IDL has also shown capability in attracting external funding from different sources, including FCT, EU funding, and industry. The total external funding amounts to 3.7M€ in project grants in the period 2015-2016 to which it should be added the 1M€ in the Associated Laboratory contracts in the same period.

A particularly important achievement of IDL has been its central role in bringing together scientists from different backgrounds and institutions. In this context, the linkage between FCUL (with primary missions in the areas of research and education) and IPMA (with many responsibilities in the areas of operational monitoring and forecasting) is an asset to mutual benefit of both organizations and vital for the functioning of research efforts and optimal use of research infrastructure in this area. This kind of linkage exists in most European countries and it appears to work particularly well in the current IDL.

IDL makes steps in the process towards strengthening the Portuguese know-how base in its research domain.

## **Recommendations**

Based on the above assessment, the committee is of the opinion that IDL has a high level of internationally acknowledged expertise and excellence in many key scientific areas relevant to the challenges of the next decades. Significant progress over the last years is well evident.

IDL has provided leadership in providing education and research opportunities to young PhD and post-doctoral researchers. This contribution is of crucial importance to the Portuguese society in light of the increasing importance of highly qualified individuals in

a number of scientific and industrial areas. The committee recognizes that IDL has implemented the bulk of the recommendations forwarded to the IDL by this committee in fall 2015.

The following recommendations need further attention:

- 1) The committee is pleased about the implementation of the new structure with 5 research groups centered on core expertise of IDL. The level of integration varies across the different research groups. A further continuous effort will be needed to move ahead and build a strong vision of and team spirit within the research groups. It is also recommended to secure stability in the leadership of the research groups. In addition, it is essential that the load of the research group does not only rest on the research group leader, but is shared with all senior staff members and in particular with an explicitly named co-leader.
- 2) Profiling the research mission around the three thematic research lines of IDL. To this aim, a task force should be set up to shape and implement a robust and convincing strategy and effective collaboration between research groups participating in the respective research lines. Regular meetings between the scientists from different groups participating in these research lines are important for prioritization of common research objectives and identification of key scientific questions and funding opportunities.
- 3) IDL and the individual research groups need a long-term strategy regarding funding.
- 4) The committee is pleased about the recent changes in the positioning of post doctoral positions in the research system. It recognizes the need to follow up what has been established with the EARTHSYSTEMS PhD program and the Sustainable Energy Systems PhD program. There were positive feedbacks from our discussions with the PhD students; and it appears that suitable measures are in place to ensure a high quality and timely submission of the theses. It appears that the PhD students require more detailed and earlier information regarding their medium-term planning. The committee also recommends encouraging forthcoming PhD students to write their PhD theses in English.
- 5) The committee recommends that IDL shares with other institutions a responsibility to engage in the public debate on the detection and attribution of climate change and seismic and volcanic hazards. The committee noticed a strong motivation in the IDL community to contribute to this activity. The Highlight Report is a major accomplishment in this area. Yet a considerate approach is needed to effectively balance the overall efforts required in the outreach area.
- 6) It appears that many staff are overloaded with teaching. The committee recommends to consider ingenious and innovative ways to reduce the teaching load, for instance, the introduction of block courses on the PhD level, and the involvement of guest lecturers.

The committee recommends the IDL leadership to give high priority in formulating its overarching strategy for addressing the critical point raised in the FCT review 2014. The thematic lines, although well chosen, need further development of their overall objectives. Priority should be given to develop a strong vision on interdisciplinary work. The recent restructuring has led the foundations for critical mass within the individual research groups, allowing now to give priority to define clear goals and pathways to

implement a fully coherent program centered on the challenges in the three thematic lines: climate change, earth dynamics and natural hazards, energy and earth resources. In each of these three thematic lines great opportunities exist to connect scientific excellence with societal challenges. A road map should be developed with a strategic plan how to realize the objectives for IDL at large in the coming 5 years

The IDL leadership should make a special effort to develop strong interfaces between its three thematic research lines.

IDL is probably one of the first organizations of its kind where research efforts connecting natural hazards, climate change and georesources are pursued in an integrated fashion. This is a prerequisite for future policy decisions on cost benefits of different scenarios figuring in the energy and climate transitions facing mankind in the coming decades.