SEVENTH FRAMEWORK PROGRAMME

Marie Curie Actions

People

International Research Staff Exchange Scheme

1. *Grant agreement* details

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Acronym: COMPASS

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Final Report Summary - COMPASS (Comparative Assessment of Coastal Vulnerability to Sea-Level Rise at Continental Scale)

Vafeidis, A., Sterr, H., Hinkel, J., Symeonakis, E., Schnack, E., Scalise, A., Fucks, E., Szlafsztein, C., Ferreira de França, C., Morales, M. Avagiannou, T., 2013.

Objectives and relevance of the exchange programme

Climate induced sea-level rise and associated hazards impose a severe threat on coastal ecosystems and societies. The Fourth Assessment Report of the IPCC predicts a global mean sea-level rise of 0.09 to 0.88 m by 2100, with sea level rising at rates *circa* 2 to 4 times faster than those of the present day (EEA, 2004; Meehl et al., 2007). Furthermore, SLR is expected to continue beyond that point in time, even when assuming drastic greenhouse gas emission reductions, as a result of the long response times of the ocean system. The implications of sea-level rise on coastal regions have been studied extensively since the 1990s and although most coastal regions have been found vulnerable to sea-level rise there is significant variation in the results when assessing possible impacts. Furthermore, recent coastal disasters, such as Katrina in New Orleans, demonstrate the need for integrated assessments of vulnerability.

Despite a significant amount of work on coastal vulnerability and impact assessment, the constantly changing and dynamic nature of the coast and the forecasted increase in the magnitude of hazards poses a major challenge to societies and decision makers for the forthcoming years. The constant increase in the concentration of people and resources in the coastal zone and the fact that 10% of the world population lives below the 10m contour (McGranahan et al., 2007) while more than 140 million people live within 1m of mean high water and more than 190 million people live below the 1 to 1000 year storm-surge level (Hoozemans, 1993; Baarse, 1995) highlights the need for dynamic and consistent assessments of coastal vulnerability across space and time. Modelling tools offering such possibilities have recently been developed and have been used for assessing coastal vulnerability in an integrated manner (Hinkel, 2005). These tools can be of great assistance in decision and policy making for coping with the increasing exposure of coastal regions to the above mentioned hazards.

Such a modelling tool is the DIVA (Dynamic Interactive Vulnerability Assessment) integrated assessment model. Developed within the context of the EU-funded DINAS-COAST project, DIVA is a flexible assessment tool, within which a range of mitigation and adaptation policies can be analyzed in terms of coastal vulnerability (DINAS-COAST Project Team, 2001). DIVA enables its users to produce quantitative data on a range of coastal vulnerability indicators, for user-selected climatic and socio-economic scenarios and adaptation strategies at national, regional and global scales, covering all coastal nations. It includes three distinct elements: (1) a global coastal database (Vafeidis et al., In press), (2) a series of impact and adaptation modules, and (3) a graphical user interface. Spatially, DIVA is unique as it operates on about 12,000 independent linear coastal segments rather than a raster grid as all other global and regional models operate. The segments have been defined based on longshore variations in natural and socio-economic parameters, as well as administrative boundaries (McFadden et al., 2007) and form the basis for the regional analysis of impacts and adaptation to sea-level rise.

Within the context described above, the objectives of COMPASS were:

- To conduct continental-scale analyses of coastal impacts and vulnerability in Europe and South America with the use of the DIVA modelling tool
- To evaluate the performance of DIVA in areas where data availability is limited based on local field-study results and expert knowledge
- To comparatively assess the results obtained with the use of DIVA in these regions and compare these results with results obtained based on commonly employed methods of vulnerability assessment in the countries involved
- To explore the possibility of developing regional versions of DIVA, based on the particularities and requirements of the study regions

The objectives of COMPASS were achieved in a series of exchange visits which aimed towards

- The transfer of knowledge and expertise on the DIVA model to the partners from Argentina, Brazil and Chile
- The application of DIVA in the study areas
- The evaluation of the results obtained from the DIVA runs, employing data acquired from local study sites and with the use of expert knowledge on local conditions
- Comparatively assessing the results of DIVA for the different regions
- Exploring the possibility for developing regional, more detailed, versions of DIVA

The first step involved the training of the overseas partners on the background and on the application of the DIVA integrated-assessment model. This was achieved in two phases: First, in-depth training on DIVA was given to the experts from the overseas institutions. This training included all three elements of DIVA: (i) the geographical database, for which the training took place at CAU; (ii) the integrated model, for which the training took place in PIK and (iii) the graphical user interface (GUI) and the application of DIVA, for which the training took place at the UoA. After completing these three training steps, partners developed a thorough understanding of the structure of the DIVA model and of the underlying database and received hands-on experience with the tool. In the second phase, experts from the European institutions travelled to Argentina, Brazil and Chile to introduce the DIVA modelling tool to a wider audience, focussing on the application of the integrated assessment model.

In the second step of the project the focus shifted on conducting continent-scale analyses of coastal vulnerability for a wide range of DIVA runs. This analysis provided an overview of possible impacts of sea-level rise in Europe and South America and of possible adaptation responses. Using the standard DIVA settings the impacts and adaptation costs under different emission, socio-economic and climatic scenarios were determined. These results were used to highlight major patterns about impacts and vulnerability in the afore-mentioned regions. This part of the project was performed from joint groups of experts involving scientists from both the European and the South America institutions. This step provided a unique comparison, from a regional/continental perspective, of the impacts of sea-level rise, including a range of adaptation options. Hence, a wide range of quantitative physical and socio-economic impacts of sea-level rise were identified , including damage and adaptation costs.

The third step of COMPASS involved the evaluation of the DIVA results. Partners exchanged local knowledge and data, provided from findings of the ongoing research on coastal issues at the participating institutes, and evaluated the results of the analysis. This exchange also included field visits and extensive work on assessing the performance of the model in different environments. The most

appropriate adaptation options were considered, including implementing more site-specific options, which have been related to ground truth.

In the final step of COMPASS, specific elements of DIVA were reviewed, thus exploring the possibility of developing regional versions of DIVA. Issues that were considered included; (i) the possibility of providing database updates with the inclusion of more detailed datasets; (ii) the tuning of impact and adaptation algorithms of DIVA to better fit the particularities of the different environments. This analysis also benefited from ongoing work in further developing DIVA that is currently taking place at PIK, CAU and UoA. Such work includes improving and developing the impact and adaptation algorithms that are included in DIVA, database updates with new and more detailed data and adapting DIVA to operate within GIS.

Result in Brief

Better predictions for sea-level rise

There is concern about the potential impact of sea-level rise on coastal regions around the globe. An EU-funded initiative collaborated with South American partners to assess vulnerability of coastal areas to sea-level rise on a continental scale.


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Although the effects of sea-level rise are expected to be significant, their magnitude is uncertain due to a lack of information about the level and rate of the rise. Furthermore, it is not known how coastal communities will respond. The 'Comparative assessment of coastal vulnerability to sea-level rise at continental scale' (COMPASS) project designed a tool for estimating the future impacts of rising sea levels. Knowledge on the development and application of the tool, called the Dynamic and interactive vulnerability assessment (DIVA) model, was transferred to countries in South America. A complete overview of the DIVA tool and its component database, models and graphical user interface was given to partners in Argentina, Brazil and Chile. Hands-on training on DIVA was conducted in South America by researchers from European institutions. Further training in Greece and Germany was carried out for seconded researchers. DIVA was used to quantitatively assess the impact of sea-level rise in Europe and South America. The knowledge base of the DIVA tool was expanded using local knowledge and data collected during studies carried out in South America. The information was evaluated to gain a better understanding of the institutional frameworks in which DIVA results could be used to support decision makers. This will help to develop more detailed regional versions of DIVA. Results revealed that large numbers of people in South America can expect flooding, with poorer countries being affected most. Although adaptation measures could reduce the impacts, they would require significant levels of investment and effective adaptation techniques. Preliminary results for Europe indicated that adaptation in

the face of sea-level rise would be both beneficial and affordable. Experts from participating institutions conducted an evaluation of the DIVA tool to determine potential limitations and identify areas for further development. An updated version of the DIVA database was produced for South America and work on further development of DIVA algorithms commenced. COMPASS activities have led to the development of strong links and a solid basis for long-term collaboration between the participating European and South American institutions.

Keywords

Sea-level rise, coastal regions, continental scale, coastal communities, coastal vulnerability, rising sea level, DIVA tool, flooding, adaptation measures

Final Report Summary

There is currently increasing concern among scientists and policy makers regarding the potential impacts of sea-level rise in coastal regions. Although these impacts are expected to be significant, their magnitude is uncertain due to, among others, the lack of sufficient knowledge regarding the actual amount and rates of rise; but also due to uncertainties regarding the response of coastal societies and systems to rising sea levels.

It is therefore important for decision makers to be informed on the potential costs and benefits of adaptation as well as on the costs of inaction, in order to develop sustainable adaptation strategies. However, there is generally a lack of adequate tools designed to provide policy makers with estimates of potential future impacts of sea-level rise under a range of scenarios and adaptation strategies. This lack is more pronounced in developing countries, where such tools are seldom available, and even when they exist, their use is often limited by issues such as incomplete data, computing power or the scale of application.

The aim of COMPASS has been the transfer of knowledge on the development and application of such a tool, namely the Dynamic and Interactive Vulnerability Assessment (DIVA) model,; while at the same time expanding the knowledge base of the model with local data and experience on relevant processes from regional experts. In this context, the project has undertaken a number of work packages to accomplish the following key objectives:

1. To provide a complete overview of the DIVA tool and its elements (database, models, GUI) to the South American partners.
2. To apply DIVA at continental scale and conduct analyses for Europe and South America, aiming to quantitatively assess the impacts of sea-level rise in the two continents
3. To evaluate and validate the outputs from the application of DIVA for South America, using local expert knowledge and data collected during studies conducted in the region; and to understand the institutional framework in which DIVA results could be used to support policy makers.
4. To explore the potential for the further development of DIVA, by addressing limitations related to data and algorithms

COMPASS has provided an extensive training programme on the development of the elements of the DIVA integrated assessment tool to all South American institutions involved

in the project.

In a series of training sessions, lead by researchers from the European institutions, which took place in Argentina, Brazil and Chile, the basic principles for the development of the database and models were presented and hands-on training on the DIVA tool was provided to audiences of academics and students. Further training took place in the European institutions (in Germany and Greece) for seconded researchers.

Applications of DIVA for Europe and South America were then carried out and updated assessments of impacts and costs of sea-level rise were produced for the two continents. Results indicate high damage costs and show that large numbers of people flooded are expected for South American countries, with poorer countries being affected most. Adaptation was found to reduce these impacts, however substantial investment in adaptation measures will be required. Moreover, high salinity intrusion and loss of wetlands will be more difficult to deal with due to the lack of effective adaptation methods. Europe will also face high damage and adaptation costs. However, adaptation appears to be highly beneficial in reducing impacts and is also expected to be affordable in terms of proportion of the annual GDP. The evaluation of the outputs with experts from all institutions has helped to evaluate potential limitations in the results and to identify areas for further development. Following this work, an updated version of the DIVA database was produced for South America and work on further development of DIVA algorithms was initiated

Finally, in the context of the above work, new objectives were established during the course of the project. These include a review of previous assessment of coastal vulnerability to sea-level rise that have been conducted in South America and an analysis of the implementation of coastal adaptation in Argentina. Although this work is still underway, preliminary results indicate the lack of consistent and comparable vulnerability analyses to sea-level rise in the region and, in the case of Argentina, the implementation of a wide range of hard adaptation measures but also very complex and, in many cases, not clearly defined institutional structures for the planning of those measures.

We anticipate that the knowledge transferred during COMPASS will assist in the development of tools to address the above limitations and to provide support for policy making regarding long-term sea-level rise and associated impacts. Lastly but equally important, the work carried out in COMPASS has led to the development of strong links and a solid basis for long-term collaboration between the participating European and South American institutions. This is already demonstrated in a series of new co-operations, in the form of research projects and research visits, funded by the national research organisations of the participating countries.