A WARMER WORLD

The EGSIEM project utilises Earth observation data to develop tools for alerting the public to the effects of global warming

Observations indicate that global warming is affecting the water cycle. Here in Europe, predictions forecast more frequent high precipitation events, wetter winters, and longer and drier summers. The consequences of these changes include the decreasing availability of fresh water resources in some regions, as well as flooding and erosion of coastal and low-lying areas. These weather-related effects impose heavy costs on society and the economy. For example, between 1980 and 2011, 5.5 million people were affected by flooding, causing economic losses of more than €90bn (ec.europa.eu/clima/change/consequences/index_en.htm). We cannot stop the immediate effects of global warming on the water cycle. But there may be measures that we can take to mitigate the costs to society.

Earth observation (EO) satellites provide a wealth of data for scientific, observational and commercial exploitation. In most cases, the raw data are difficult for non-specialists to access, let alone interpret. Take GPS as a case in point. For the first ten years of observations, only the military, government, and academic specialists could exploit the signals. But after years of software and hardware development, GPS positioning has revolutionised emergency services, commerce and agriculture, and has allowed anyone with a navigation system in their car or even a smartphone to locate themselves and get directions.

In the same way, the Horizon 2020-supported project EGSIEM (European Gravity Service for Improved Emergency Management) will add value to EO of variations in the Earth's gravity field. In particular, the EGSIEM project will interpret the observations of gravity field changes in terms of fluctuations in continental water storage. But how can we use gravity to predict flooding or drought? When the ground in a particular river basin is full of water, no more water can be absorbed and any subsequent big precipitation event could result in flooding. As the basin fills up with water, the gravity signal increases due to the increasing water mass. Similarly, when a basin is very dry, the gravity signal over the basin decreases.

Artist's concept of the twin GRACE satellites
www.csr.utexas.edu/grace/gallery/other/posters/1999-06_graceposter.JPG

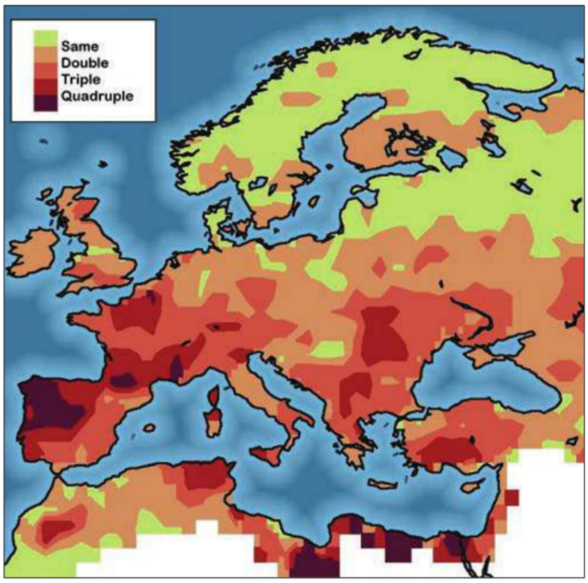
The project team will develop tools to alert the public if water storage conditions could indicate the onset of regional flooding or drought.

Monitoring environmental mass

Up until the end of the last century, monitoring temporal changes in the redistribution of environmental mass had been quite challenging. However, since 2002, the German-American Gravity Recovery and Climate Experiment (GRACE), a satellite gravity mission, has demonstrated the potential and value of globally observing mass variations. GRACE observations are providing fundamental insights into the global water cycle, polar and mountain ice mass loss, changes in ocean currents, sea level rise, as well as many other mass redistribution processes, as evidenced by the nearly 2,000 scientific publications related to the mission.

In fact, GRACE has been so successful that a follow-on mission, the German-American GRACE-FO, is already in its implementation phase and is scheduled for launch sometime in 2017. To get GRACE-FO into orbit as quickly as possible, it will essentially be a

Flooding, Bosnia. May 2014



Change in the likelihood of summer season drought (defined as a once in ten years event for the late 20th Century) by the end of the 21st Century, according to multi-decade simulations with the operation model of the European Centre for Medium-range Weather Forecasts based on the A1b scenario of the Intergovernmental Panel on Climate Change

Dirmeyer P: Floods and Droughts in a Changing Climate – now and the Future, Earthzine, 29 April 2011

earthzine.org/2011/04/29/floods-and-droughts-in-a-changing-climate-now-and-the-future/

copy of GRACE. However, it will be equipped with an innovative laser ranging interferometer to improve measurement precision as compared to GRACE. Another mission designed to significantly increase the accuracy and temporal/spatial resolution of these missions is also currently being studied at the European Space Agency and NASA.

Despite the clear value of GRACE data for monitoring the redistribution of continental water in time, they have not yet been optimised to serve the needs of the general public, i.e. using the data to assess the likelihood of flooding or droughts in a particular region. Two big problems here that must be overcome are the up to three-month latency of the data and their one-month temporal resolution. EGSIEM will develop techniques to reduce the latency to near real time (about five days) and improve the resolution to a single day. As the timeliness of information is the primary concern for any monitoring/early warning system, these proposed changes will add significant value to gravity field data for monitoring the evolution of potentially extreme hydrological events, as well as for improving the value of the data for warning and forecasting.

Analysis and interpretation

The EGSIEM team plans to critically analyse the more than a decade's worth of GRACE data to determine gravity-based indicators of extreme hydrological events and demonstrate their value for flood and drought monitoring. Using a back-casting approach, the team will test the reliability and robustness of these indicators for predicting historical flooding events, with the goal of developing a system for predicting flooding and droughts into the future.

Like most EO data, interpreting satellite gravity data is still only possible by experts. One additional goal of the EGSIEM project is to expand the user community from purely scientific experts to the general public at large. The monitoring service, to be developed by the team, will provide products in user-friendly, easy-to-interpret formats. In this regard, significant effort will be devoted to developing adequate visualisation tools. All of these products will be tailored to the various needs of the respective communities. For most stakeholders a notable effort is needed to increase the temporal resolution and to reduce the time delay to make the gravity-derived products of value to decision makers. Nonetheless, the prospect of acquiring reliable early warning indicators from near real-time mass redistribution data demands prompt action in order to preserve European competitiveness within this particular space sector.

Consortium members

The EGSIEM consortium is made up of eight European university and government organisations with expertise in gravity field data processing and interpretation and hydrological modelling. The Universität Bern, Switzerland, co-ordinates the project and works alongside the following partners:

- University of Luxembourg;
- Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum;
- Technische Universität Graz;
- Gottfried Wilhelm Leibniz Universität Hannover;
- Centre National d'Études Spatiales;
- Deutsches Zentrum für Luft- und Raumfahrt EV; and
- Géode & Cie.

Professor Tonie van Dam and Dr Matthias Weigelt
University of Luxembourg

Professor Adrian Jäggi
Universität Bern
Project Leader
EGSIEM Project

tel: +43 31 631 8596

tonie.vandam@uni.lu
adrian.jaeggi@aiub.unibe.ch
http://www.aiub.unibe.ch