Tools to better predict floods and droughts

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The fact that water accounts for about 71% of the Earth's surface is common knowledge. What is less known, however, is that this water mass is constantly redistributing and that such changes can be responsible for floods and droughts. The EGSIEM project set out to integrate the redistribution of this mass into Earth Observation data products, in order to help predict these events.

Launched in 2002, the NASA's Gravity Recovery and Climate Experiment (GRACE) was first to deliver insights into the Earth's global water cycle. Now, a consortium of eight organisations has started using this data to demonstrate that mass redistribution products could open the door to innovative approaches for flood and drought monitoring and forecast.

"GRACE made the temporal variations of environmental mass observable and we have seen related data products grow mature over the last 16 years. Now that this process is complete, other GRACE-type missions can be initiated. However, there was still a great demand for consolidated products and for improving accessibility to the data for non-specialists," explains Prof Adrian Jäggi, coordinator of EGSIEM on behalf of the University of Bern.

Besides, the project aimed to increase the temporal resolution from one month, typical for GRACE products, to one day and to provide gravity field information within five days for time-critical applications. The point was to allow for timelier awareness of potentially evolving hydrological extremes.

"For us the equation is simple: better knowledge yields better decision making and preparing for a potential threat is often less expensive than cleaning up after a hazard strikes," Prof Jäggi explains. "Gravity and water mass changes provide essential quantitative information on changes in sea level, river discharge, ground water, snow mass, glacier mass, and polar ice sheet mass. With our products, we could establish an early warning service for flood forecast and drought monitoring as well as generate advanced flood alerts."

To better understand the potential of their products, the project team looked into historical flood and drought events and developed relevant indicators. The flood that affected Namibia in 2009, for instance, killed

131 people and strongly affected another 445 000. Studies showed that if people had been warned 10 days earlier, this alone would have brought down the number of victims by about 57 %, and damages in the social, production and infrastructure sectors by 58 %, 41 % and 35 % respectively. EGSIEM's products and tools can enable this for mass induced floods.

Three main types of products were developed: combined global gravity field solutions, near real-time gravity field products and wetness indices. Combined global gravity field solutions solved the problem of users previously having to choose a data product from one of the five to six existing processing centres. EGSIEM unified these solutions and, by doing so, outperformed any existing product due to better signal to noise ratios.

The near real-time product, on the other hand, can deliver data with a latency of not more than 24 hours in most cases, thereby enabling a new range of near-real time applications for the likes of flood and drought monitoring. Finally, the wetness index – which consists of either monthly or daily global maps with a one-degree by one-degree resolution – can identify mass-induced flood and droughts that occurred in the past and, by doing so, deepen the understanding of the conditions leading to such extreme events. It also allows for easy access and interpretation of the gravity data.

"This kind of product/information has not been used before, but its potential is tremendous. Besides scientific interest, it has a direct impact for public safety, as in the near real-time mode, the data directly indicates the hazard risk," says Prof Jäggi.

With the project now completed, an event to watch for is certainly the launch of the GRACE mission successor. "GRACE ceased operation in June 2017, which means that the user community is currently blind to all

kind of mass-induced changes. With the launch of GRACE Follow-On, currently scheduled for May 21th, 2018, we can provide this unique data to the communities and the public. We are just beginning to explore the potential of our data products but we are confident that in five to ten years from now they will be indispensable in the monitoring and forecasting of the Earth system," Prof Jäggi concludes.

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