TERRAFIRMA

TERRAIN MOTION INFORMATION SERVICE FOR EUROPE

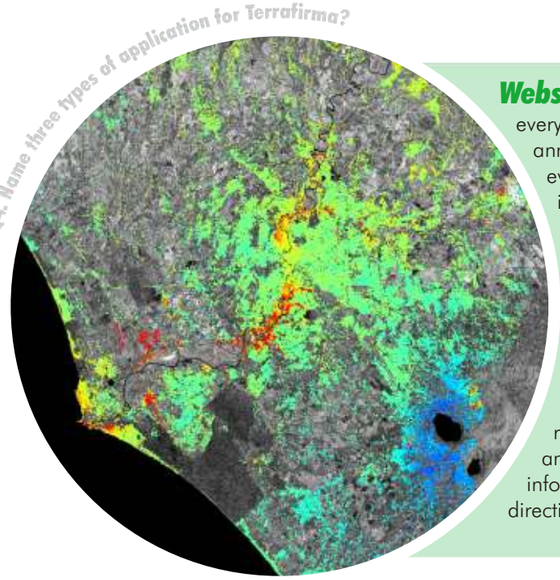
NEWSLETTER 2 NOVEMBER 2007

To all those interested in the ways in which the earth moves, welcome to the second Terrafirma Newsletter! We are now half way through the three-year Stage 2 of this, literally, groundbreaking project, the first two-year Stage 1 having been completed in 2004. In this latest edition of Terrafirma news we bring you a host of information-snippets on the project and where it's going. Included is news on production around Europe, the injection of new funds into the project, information on Terrafirma's own validation campaign, and of course news of the 4th Terrafirma User Workshop (November 5th) which happily coincides with the European Space Agency's own 2007 International Geohazards Week (5th-9th November). So to all those geophysics, engineers and agencies concerned with the insidious effects of terrain-motion, welcome to Terrafirma Newsletter 2 and read on!

The future? So, where is Terrafirma going, especially in the knowledge that ESA's funding for the project will end early in 2009? First we need to consider the wider picture. The intention behind all ESA GMES projects is that they would eventually be absorbed into the EC as part of Europe's autonomous monitoring of the environment. Terrafirma, however, is in a weak position - although we all realise that the detection and monitoring of terrain motions can be of high socio-economic value, and PSI continues to prove its worth in this regard, there is no clear EC policy-driver on the subject, and the EC's operations are based solely upon the support of policy. This is one reason why only the landslide component of Terrafirma has so far been taken up by the EC as part of their Emergency Response Fast Track Service in FP7 - it is simply mandatory to monitor various landslide-prone regions of Europe and Terrafirma can offer these services. However, there is no general policy to monitor-for-motion towns, coastal floodplains, mining areas, specific geological conditions, inter-seismic deformation, communication networks, tectonic tilt vs sea-level rise, reclaimed areas, gas-, oil-, water-abstraction, the list goes on. As said earlier, maybe there is no policy because it has simply not been possible to pro-actively monitor large-scale terrain-motions using existing techniques - it was therefore not considered. After all, we did not have a policy to monitor ozone and do something about its depletion until the technology came along to alert us and measure the hole!

Terrafirma has produced its own cost-benefit analysis and shown the positive benefits for routinely monitoring vulnerable areas. It is common sense, however, that at around €40,000 per survey, needed, say, every three years, it must be cost-effective to PSI-monitor all significant towns and areas where populations are at risk from geohazards. The savings can be huge in terms of remediation and better planning.

For the future of Terrafirma (and the satellites that continue to provide the raw material) it is imperative that we continue to communicate the benefits of a Terrafirma-type service to decision makers in Brussels, and this must begin nationally, mainly through the geo-science and civil protection organisations who are in a position to realise the benefits of Terrafirma and have the remit to monitor geohazards in their own countries.



Website: The Terrafirma website continues to be the main source for everything to do with the project. All results are posted up as colour average annual velocity maps, all SLAs, exploitation and utility reports, all dossiers, everything to do with the Terrafirma validation project, and perhaps most importantly, training materials as used at the last Terrafirma training day. The website continues to be updated as well as improved, so please remember to visit regularly.

Thanks: I would like to thank all the many people who are, or have been, involved with Terrafirma. We have come a long way in the last three and a half years and without your help nothing would have happened. However, we have many challenges to overcome before we reach a point where earth-surface motion monitoring is widely accepted and routinely provided as a public good. This, however, is our aim and the information disseminated in this Newsletter is one very small step in that direction. Thanks for your support!

Ren Capes, Terrafirma Project Co-ordinator.

Q5. What colour is Philippe Bally's new Triumph motorcycle?

PS. If you've read to here, you will know most of the answers to the 5 questions. If you would like to win a fantastic prize, then put your answers on the back of your business card and give it to Morris Dean before 17:00 on the day of the Terrafirma workshop. A single random winner will be chosen during the cocktails from the cards with all five correct answers.

For more information about any aspect of Terrafirma please visit the Terrafirma website at www.terrafirma.eu.com or contact Ren Capes directly on ren@npagroup.com.

Terrafirma is one of a number of Service Element projects being run by the European Space Agency under the Global Monitoring for Environment and Security (GMES) initiative. Terrafirma is establishing a pan-European ground motion hazard information service in support of policies aimed at saving lives, improving safety and reducing economic loss. For more information on ESA initiatives on GMES, see http://earth.esa.int/gmes/ or email: info@terrafirma.eu.com. For further information www.terrafirma.eu.com.

Some numbers... Terrafirma is primarily driven by Service Level Agreements (SLAs), and of the 59 SLAs planned (17 of which are for landslide products), only 11 involving PSI processing are left to agree and these should be wrapped up within the next six months. The 59 SLAs represent 46 individual PSI processes (some sites have more than one user and hence SLA), over half of which have now been completed. This success demonstrates not only the ubiquity of terrain-motion geohazards in Europe, but also the prevailing need and enthusiasm for more information concerning the dynamics of the phenomena involved.

Feedback from users: Most SLAs ask for reports back from Recipients on product quality, the product's utility and details of exploitation activity. Though this might seem like unnecessary bureaucracy, please be assured your hard work is highly valued and that all these documents are being rigorously scrutinised by way of a formal 'service review'. Early results reveal some common experiences, such as a need for more training and educational materials, better information on product quality and the need for a guaranteed background mission that will ensure adequate data archives into the future. These issues will be taken on board. For example, the next workshop will involve a training program to ensure that Terrafirma services can become more accessible to more people.

Training and education: Education in the understanding, application and analysis of PSI is essential for a wider acceptance of what many practitioners see as a 'black-box' technology. Not only is PSI complex in itself, but there is also an assumption that all users are familiar with GIS, geo-referencing and map projections, for example. The need for further training is substantiated by the initial review of comments made in utility and exploitation reports. In response to this, we will be conducting a third Terrafirma Training Workshop next year and revamping the education materials that are already available from the Terrafirma website (www.terrafirma.eu.com). We also encourage dedicated national training days in individual countries where interested parties, such as geologists, engineers and planners can congregate to learn more about PSI and its practical application.

Product Validation Workgroup: Terrafirma includes a Product Validation Workgroup (PVW) made up of key partners in geophysics, engineering and geodesy. The main aims of the PVW are to:

- Develop their own higher-level H-2 (Causal) products from H-1 processing.
- Guide product development by way of their own experience in H-2 production, as well as reviewing all project output, e.g. all processing, product-acceptance, utility and exploitation reports
- Oversee the Terrafirma Alkmaar/Amsterdam Validation Project.
- Compile a Product Validation Manual. This document is a major output and will represent the 'Terrafirma Bible' in terms of explaining PSI, its accuracy and limitations, the range of Terrafirma products, practical application to real-life problems, exemplar case study examples and results of key product validation exercises, such as Terrafirma's own validation campaign.

The range of Terrafirma Products:

Although Terrafirma provides services that relate to a wide range of terrain-motion phenomena, all products are made in accordance with six basic specifications:

- **H-1 Products:** These are the products with which most Recipients will be familiar. They represent the 'raw' output measurements from the Suppliers, and take the form of geo-referenced average-annual-velocity maps with accompanying time-series data.
- **H-2 Products:** Although many Recipients are making 'initial interpretations' of H-1 output, the H-2 specification is a more formal analysis of the H-1 against other geophysical data to provide a 'cause' as to the motions observed, hence H-2 is a 'Causal Product'. Eight H-2 Products are being made in total, four of which are being made by Terrafirma's Product Validation Workgroup.
- **H-3 Products:** These are 'modelled' products, representing the highest form of analysis where some form of forecast as to the development of observed motions might be derived. These are not seen as 'standard' products, being conducted more on a project basis. The PVW will be making four H-3 products from the H-2 products they are already producing.
- **M-1/2 Products:** These are 'monitoring' products made by updating an existing H-1. Two M-1/2 products will be made during this stage of Terrafirma to demonstrate the capability to not only map terrain-motions but to monitor them.
- **LSI Products:** Landslide Inventory products are derived from the expert interpretation of PSI results covering whole watershed basins to discern, characterise and database unstable slopes. Within Terrafirma, the University of Florence, the Spanish Institute of Geomatics and the Swiss Federal Office for the Environment specialise in the particular geophysical work needed.
- **LSM Products:** Landslide Monitoring products are usually derived from LSI products, whereby a specific landslide event detected in the LSI is subjected to further, higher-level multi-look PSI processing and expert interpretation.

Q2. When was ERS-2 launched (year only required)?

But is it true?

Terrafirma products offer a new and unique way to monitor and detect terrain motions. However, the process itself is complex and subject to several variables that can impact the quality of results. A number of activities have therefore ensued (some outside Terrafirma) to 'validate' the reliability and accuracy of PSI. The main and most authoritative of these exercises is Terrafirma's own validation campaign known as the **'Terrafirma Alkmaar/Amsterdam Validation Project'**. This is a major 12-month activity that is using two contiguous areas in the Netherlands, one of gas production, the other of new metro tunnelling, the project is not only making detailed comparisons of the PSI processing output from the Terrafirma service providers, but also making comparisons of the PSI output against groundtruth - thus validating both the 'process' and 'product' stages of Terrafirma output. All documented output from this campaign is available from the Terrafirma website.

Other PSI validation activities of relevance:

- **Jubilee Line Extension inter-comparison:** As part of Terrafirma, this limited project focused around the relatively small area of the Treasury Building in London. It compared the processing from NPA, TRE, Altamira and Gamma against high quality groundtruth collected during tunnelling for a new extension to the London metro system.
- **PSI Codes Cross Comparison and Certification (PSIC4):** This ESA-funded project compared the output from eight InSAR providers, four of which were Terrafirma service providers. Processing over a difficult mining site in France was conducted in a completely 'blind' fashion with the processing teams having no knowledge of the site, its extents or the terrain motion phenomena to be mapped.
- **Provence inter-comparison:** As part of Terrafirma, this small project analysed the 'slant-range' data output from the Terrafirma service providers involved in the PSIC4 project.

Detailed information on these PSI validation activities, as well as access to all corresponding documentation is available from the Terrafirma website at: http://www.terrafirma.eu.com/product_validation.htm.

Terrafirma's Quality Control Protocol:

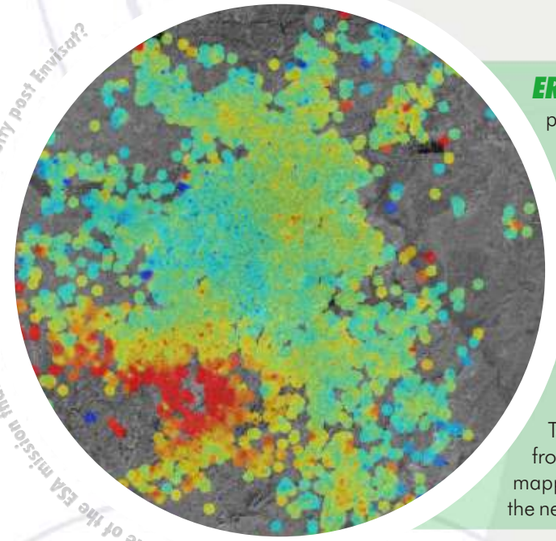
Besides validation, assurance of quality is critical to users and the wider uptake of Terrafirma services. To this end, considerable work has been put into the compilation of a specific Terrafirma 'Quality Control Protocol'. This is based around the individual Supplier's existing quality control procedures with further Terrafirma-specific requirements. The QCP being applied is currently at version 1.4 and will be updated using the output from the Terrafirma validation campaign. Meanwhile, a sign-off certificate is in operation that should be completed by the Supplier's departmental head and sent with the process results and processing report, assuring that the product complies with the latest version QCP. The Terrafirma QCP can be accessed by visiting: http://www.terrafirma.eu.com/Documents/QCP/QCP_Level1_Products.pdf

New funds sink into Terrafirma:

The benefits of Terrafirma are being realised around Europe as more sites are completed. Some countries have considered it worthwhile to formally provide additional funds into the project to allow for more substantial undertakings. Spain, Switzerland, Italy, Germany, Denmark and Greece have all made additional contributions. The cases for Demark and Greece are outlined below:

Floodplains in Denmark: Many countries of Europe have coastlines which in many places are susceptible to sea-level rise. Any simultaneous land subsidence will only accelerate the flood-risk to property and the local environment, and this is where Terrafirma can play a useful role. The area of Esbjberg in Denmark is a case in point, and the country has secured new funds for Terrafirma specifically to enable the monitoring of this sensitive area, using an integration of PSI and GPS.

Rion-Antirio Bridge, Greece: Since the beginning of Stage 2, many countries have realised the benefits of being involved with Terrafirma, and have sourced additional funds to allow some broader activity. For example, our partners in Greece have begun an exciting project using an integration of PSI with conventional levelling and GPS to monitor the land motions either side of the new Rion-Antirio bridge, which spans the Gulf of Corinth. On the southern side, the Pelopennese landmass is known to be tectonically drifting to the southwest a few millimetres a year, and so this unique bridge is built on rollers to accommodate! Monitoring motions around the bridge is obviously of safety-critical importance and PSI offers a cost-effective complement to the challenge.



ERS2 Showcase booklet:

The raw material for Terrafirma products is radar data, and Terrafirma suppliers routinely use three satellite sources ERS-1 (1991-2000), ERS-2 (1995-extant) and Envisat (2002-extant). Although most focus is on Envisat as the latest mission, the significance of ERS-2 as a continuing source of high quality SAR data should not be forgotten. This situation is emphasised by new efforts made by ESA to provide the meta-data necessary that allows easier integration of ERS-2 data into Terrafirma products. To help promote the continuing success of ERS-2, ESA decided to add extra funds to Terrafirma to produce an "ERS-2 Showcase" booklet which will provide a number of 'classic' differential InSAR case studies. The examples, made by the Terrafirma Operational Service Providers, include applications from mining through volcanic inflation to glacier velocity mapping. The ERS-2 Showcase booklet will be available early in the new-year.

Workshop:

Terrafirma is conducting its fourth User Workshop at the ESRIN ESA facility in Frascati on the 5th November 2007. The event combines with other geohazard-related workshops which all go to make up ESA's '2007 International Geohazards Week' (5-9th November). The other workshops include that for the 'Global Geodetic Observing System' and for the '3rd International Geohazards Workshop' organised by the Group on Earth Observations and the IGOS Geohazards initiative. The Terrafirma workshop represents an exciting opportunity for SLA Recipients to present many new results and discuss issues with like-minded practitioners. We have 18 presentations ranging from applications in tectonics, groundwater rise, mining and landslides, to latest information on Terrafirma's seminal validation campaign. The event should prove to be both informative and convivial. Meanwhile a fifth Terrafirma workshop is being planned for 2008 that will include a training day in the integration and practical use of Terrafirma products.

Promotional material:

Terrafirma now has a new range of promotional material that will be available at the workshop. These include a new and generic Terrafirma brochure, a dedicated landslide brochure, the first two of a number of individual 'case-study' sheets and this newsletter. If you have not seen some of this material, please check them out at the workshop and take some home with you for further dissemination to your own contacts. If you need more of any of this publicity please let NPA know. Meanwhile, the Terrafirma website (www.terafirma.eu.com) continues to be updated. All project documents, including all processing results and SLA deliverables are available from the site. We have also added a new set of pages under 'Product validation' where important information relating to the validation of PSI can be found. This is updated as the Terrafirma validation campaign is completed.

Finally, some of you will remember the 'Terrafirma Atlas 1' a glossy booklet that show-cased all the Terrafirma Stage 1 results, accompanied by user comment. The Atlas proved to be of immense popularity and so, by popular demand, we will be producing a Terrafirma Atlas 2 that will be of similar format and include all Stage 2 results and user comment from exploitation reports. Atlas 2 should be produced during the latter half of next year.