What is Terrafirma?

- Terrafirma is one of a number of services being run by the European Space Agency under the GMES Service Element Program as part of the Global Monitoring for Environment and Security initiative of the European Union. Terrafirma started in 2003 and will end in 2008 when it is planned that services will be adopted by the European Commission as part of their GMES strategy.
- Terrafirma harnesses the unique power of satellite radar interferometry to detect and measure Earth-surface terrain motion. These data, in combination with geophysical expertise, are used to save lives, improve safety and reduce economic loss.
- Terrain motion can be related to subsidence, landslides, earthquake activity, flooding, coastal erosion, volcanoes, unstable buildings and infrastructure, and even poor engineering standards. Many of these phenomena and their associated hazards are made worse by the effects of rapid climate change.
- The socio-economic cost of terrain motion across Europe runs into tens of billions of euros a year, and is becoming higher as populations increase, cities become larger, resources become scarcer and the climate becomes more unstable.

Products

The technology underpinning Terrafirma uses data collected by European radar satellites in a process called Persistent Scattered Interferometry, or PSI for short. The synoptic view of the satellite covers whole cities and regions, and because an archive exists of repeat satellite coverage dating back to 1991, PSI is unique in being able to look back at past terrain motion with millimetric precision. Products are being used by national civil protection agencies and the civil engineering community, as well as being offered by national geological surveys who are integrating pre-existing and in-situ data to provide “interpreted”, “causal” and “modelled” information services.

Suppliers and Users

- Terrafirma has consolidated and standardised the supply of interferometry products from the European companies specialising in this type of processing. In combination with this, the project has federated most of Europe’s national geological surveys, provided services to Europe’s Civil Protection Agencies and enrolled high profile engineering companies. This federation not only forms a primary user-base, but also provides the best source of the interpretation and value-adding skills necessary to maximise the products’ utility. Terrafirma, therefore, represents a single point of contact for information on terrain motion hazards in Europe.
- Terrafirma is delivering products for at least one major site in each country of Europe, plus 17 landslide products for Italy, Greece, Spain and Switzerland. By 2008, nearly 60 Terrafirma products will have been made, interpreted and utilised.

Recent statistics show that 50% of the world’s population already live in cities, and ‘mega-cities’ of over 10 million people are now commonplace. As the trend toward urbanisation continues and pressure on space grows in both vertical and horizontal domains, ground stability becomes an increasingly critical concern. Issues such as metro tunnelling, historical and contemporaneous mining, compressible substrates, oil and gas production and water-table change can all have adverse effects to property and people. Furthermore, many mega-cities already lie on vulnerable flood plains, in coastal lowlands or in earthquake-prone zones. In the past, these kinds of hazards have been monitored in a purely reactive manner. For the first time, Terrafirma offers a wide-area synoptic overview of terrain motions, allowing for proactive remediation and planning.

14% of the EU27 population live in coastal regions and the majority of tomorrow’s mega-cities will be built on or near a shoreline. There are major geodetic issues in de-correlating small variations in land level from climate-induced sea-level rise. Recent work for DEFRA [UK] comparing PSI results with GPS, tide gauge and absolute gravity measurements have shown that PSI data can be valuable, not only in correcting the inherent uncertainty of past and present GPS measurements and filling in the gaps between stations, but also in optimising GPS station placement for ongoing monitoring. Equally, natural subsidence within floodplains may be affecting flood defences or increasing vulnerability locally.

Landslides account for a significant number of deaths and damage to economies in many mountainous parts of Europe. Terrafirma products have been successfully used to both identify unstable slopes and monitor known slides. One village in Italy was even relocated based upon the direct evidence provided by Terrafirma partners using this technology. For landslides, Terrafirma also provides a ‘rapid mapping service’ where results can be provided to civil protection authorities within hours of request. The result for Lumnez, Switzerland, shown here, identified two unstable sectors which are currently home to several villages. This information is being used by the Federal Office for the Environment who have responsibility for landslide risk in Switzerland.
Understanding fault mechanisms is critical to earthquake forecasting, and large amounts are spent in the US and Japan in monitoring crustal deformation using satellite positioning. GPS, however, can only be deployed in relatively sparse networks and is typically less accurate in the horizontal plane, whereas PSI provides high vertical accuracy and integrations between the two techniques can help de-correlate motion vectors as well as highlight localised motions which might be biasing GPS results. In Turkey, PSI results have been useful in detecting zones of old sediment which have the potential to liquefy and amplify the effects of earthquakes. This product led to a re-evaluation of risk zonation within the city. In other cities, for example Lisbon, PSI has revealed deep basement geology and improved tectonic modelling. Terrafirma know-how and products have the capability to create ‘virtual GPS networks’ with a historical time-series reaching back 15 years for all earthquake-prone cities of Europe.

Subsidence caused by mining is a major concern across many parts of Europe. The effects of active mining are perhaps better controlled, though the many private companies responsible are sometimes reticent to proactively monitor and publicise results for liability reasons. This is one good reason for an independent synoptic overview of the type that Terrafirma can provide. On the other hand, Europe is honeycombed with old, historical mines, some of which are mapped, but many of which are unknown until some collapse occurs. This represents a real power of Terrafirma products - being able to provide a synoptic view over whole regions that can reveal these kind of deformation trends, allowing a more proactive approach to remediation.
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 protecting the citizen.

For more information on ESA initiatives on GMES, see http://earth.esa.int/gmes/

For further information www.terrafirma.eu.com

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TerraMentor, Greece.

"Terrafirma provided subsidence data with a detail that would have been nearly impossible to detect in most circumstances."
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"The project outputs have the potential to significantly enhance the BGS’s national digital geohazard information system (GeoSure)."
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"Over the last year, our approach to the study of the active tectonics of the Lower Tagus Valley was re-defined following the advent of PSI."
Dr. Joao Fonseca, Institute of Engineering and Structures, Portugal.

If your organisation is interested in participating in Terrafirma or procuring Terrafirma services for a particular area, please contact:

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