

GMES: TerraFirma

Pan-European ground motion information service in support of policies aimed at protecting the citizen

Over the last decade ground instability including subsidence and landslides has cost the UK insurance industry more than €500M a year. Although insuring against such damage is less common outside the UK, the geophysical causes and economic effects of ground instability are in fact widespread. Problems are exacerbated as the demand for land and resources is becoming more intense and by the centralisation of populations and development of the 'mega-city' with its associated demands for better transport infrastructure (much of which may need to be underground), more housing and improved opportunities for business.

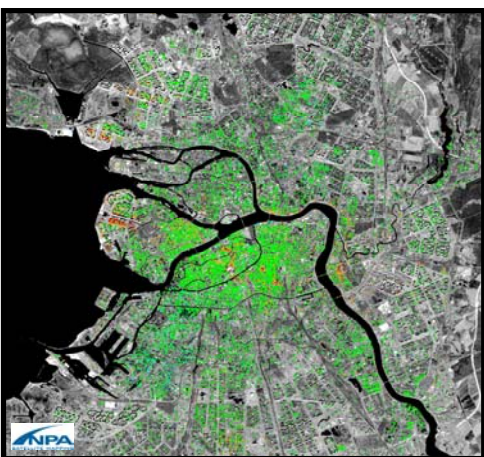
The need for awareness and control of ground instability is recognised through a variety of statutory instruments. Some, like EC Directives on Landfill or Impact Assessment, offer mandatory guidance at international level. Others laws, for example, governing extraction activities or civil protection operate at national level. However, most policy aimed at controlling ground instability is site-specific and administered by local authorities to correspond with a particular known local hazard, for example specific controls on foundation design because of known mining, or a landslide threat. This *reactive* approach has been largely due to the practical impossibility of monitoring anything other than pre-determined targets using the conventional means available (e.g. line levelling, electronic distance measuring, GPS).



Effects of mineral dissolution

The TerraFirma service

The ESA GMES project *TerraFirma* is based upon new hybrid radar satellite technology that can now for the first time measure subtle ground motions over whole cities or regions in one, non-invasive process. Furthermore, as the radar data has been regularly collected since 1991, measurements can be made back in time - a unique attribute to any surveying method! These features allow an unprecedented view of an area's overall stability, providing better understanding of ground conditions, and a more cost-effective and targeted approach to investigation and amelioration of ground motion effects.



A TerraFirma product for St Petersburg. Red areas represent subsidence due to settlement of old river systems

Suppliers

The acknowledged providers of these highly specialised services have been networked via a common *TerraFirma* protocol that ensures consistent quality and standards. An independent *reference* processing chain is to be implemented shortly to ensure the validation and qualification of new suppliers.

Users

Several user communities have been identified with an economic interest in ground motion information, though two stand out in particular who are also closely engaged with the project's validation activities: a) national geological surveys who usually have the remit to monitor geohazards country-wide and advise government and others accordingly, and b) civil engineering organisations who need information on ground stability for a variety of tasks, such as monitoring ground conditions as part of

a project feasibility study, monitoring the stability of structures such as highways or power stations that might

have been built on weak substrates, or monitoring the zone of surface influence of a metro tunnelling project. Over the last two years, *Terrafirma* has engaged with more than 50 geo-organisations and several of the largest engineering consultancies, culminating in two well-attended international practical user workshops.

Services

Terrafirma provides three types of product:

- **Historical** measurements of ground motion using the satellite data in archive. These are used to assess ground motion trends over the last decade or so, and are useful for prioritising a more expensive ground-based survey or *Terrafirma* monitoring product if necessary.
- **Monitoring** services using new satellite data acquisitions to update an historical product for latest measurements. Such products might be used to monitor the predicted zone of influence of a tunnelling project, or effects of water table change.
- Higher level **Interpreted** products that provide engineering geological context to assist in the understanding of ground motion causes. Higher level *Terrafirma* products are interpreted by geological experts using other pertinent data at their disposal to provide a first analysis of the causes of the motion observed and possible forecasts as to future behaviour.

User feedback

Since early 2003, the service providers have worked closely with a core group of national geological surveys and engineers to develop a portfolio of services that meet user's needs. A number of user-nominated products have been generated for analysis, validation and development of higher-level, interpreted products. These products - the first of their kind over these areas - have yielded new and exciting information never before realised, highlighting unforeseen areas of instability, validating known phenomena and providing an immediate over-view of an area's status. Overall, *Terrafirma* has been met with great enthusiasm for what is an entirely new and unique geological dataset. However, there are still some questions on reliability, and these are planned to be assuaged through an extensive validation campaign proposed for next 3-year stage.

Users involved

Terrafirma has a core group of users including:

- British Geological Survey (BGS - UK)
- Bureau de Recherches Géologiques at Minières (BRGM - F)
- Institute of Applied Geoscience (TNO - NL)
- Euro-Mediterranean Seismological Centre (EMSC)
- European Federation of Geologists (EFG)
- Ove Arup (civil engineering consultancy - UK)
- Centro Elettrotecnico Sperimentale Italiano (CESI - Italian utility provider)

Terrafirma has also entered into 'Associate Partner' agreements with more than 45 other geo-organisations in 25 countries. These organisations, who have received project information and attended user workshops, represent a widening user-base which will be encouraged and assisted to further exploit *Terrafirma* products over the next 3-year stage.

Complementary projects (EC and national)

- EURORISK / PREVIEW
- LESSLOSS
- LEWIS
- URAMIS
- SLAM
- CATMAP
- STAGE
- VOICE
- IGOS: Geohazards Theme



Devastation caused by landslides