GENIUS

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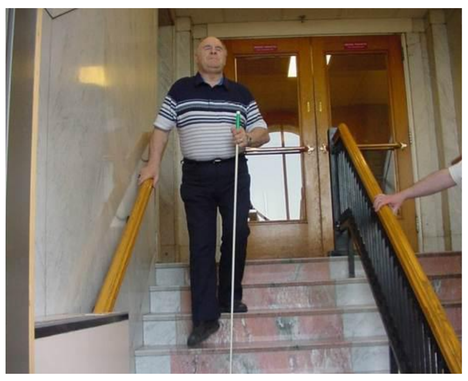
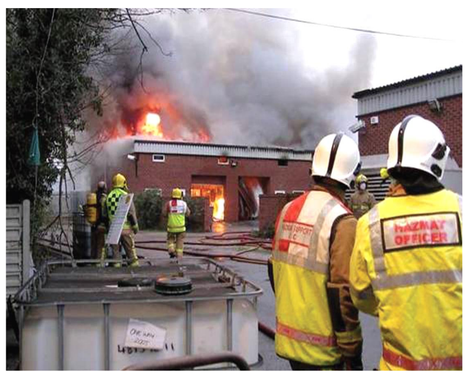
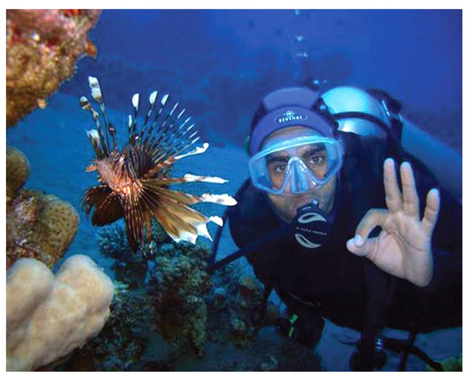
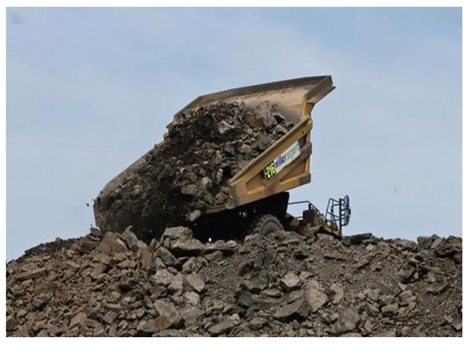
GNSS Education Network for Industry and UniversitieS









The benefits of GNSS for Earth Observation

Global Navigation Satellite Systems (GNSS) are now an integral part of all aspects of our lives. GNSS positioning, navigation and timing services are central to a range of applications including:

Road: in-vehicle navigation systems for route planning.

Aviation: GNSS devices for navigation and precision landing, working alongside other navigation systems.

Maritime: both stand alone and integrated navigation systems.

Location Based Services: GNSS-enabled mobile phones and services.

Agriculture: vehicle guidance and variable rate technology

Surveying: land and hydrographic surveys,

Recent cross-disciplinary scientific research is now opening up the value of the navigation signals to a wider market, especially the Earth Observation (EO) community, who are using them to solve problems in new and novel ways.

This booklet is aimed at introducing the GNSS and Earth Observation communities to some of the new possibilities that are opening up for them through new techniques like:

GNSS Reflectometry: analysing the quality of reflected GNSS signals to gain information about the surface characteristics of reflective surfaces e.g. water, ice, vegetation.

GNSS Radio-Occultation: based on comparing the expected and actual phase measurements of GNSS signals to a receiver mounted on a Low Earth Orbit (LEO) satellite, to calculate the refractive index of the atmosphere.

The **Group on Earth Observations**, and **Copernicus** are two organisations whose aims and activities are creating datasets and networks that need consistent, accurate, reliable and globally available monitoring systems for Earth Observation. The following pages give a flavour of some of the ways in which GNSS can support their work.

GENIUS is funded through the European Union FP7 fund and the European GNSS Agency (GSA)

SEVENTH FRAMEWORK PROGRAMME

European GNSS Agency

Group on Earth Observations

An intergovernmental organisation that is responsible for coordinating and improving Earth observations through the creation of:

The Global Earth Observation System of Systems (GEOSS)

GEOSS is building links between content providers for global observing systems and providing support for the development of new systems where gaps currently exist. It simultaneously addresses nine areas of critical importance to people and society.

The products will supply decision and policy makers with a range of information that complies with common technical standards enabling the creation of coherent, user-friendly datasets through the combination of different instruments.

The benefits of GNSS for GEOSS

- It is a global system, allowing the comparison of position within a consistent time-frame
- It provides 24 hour coverage
- It provides information about the nature of the atmosphere between transmitting satellites and receivers
- It provides information about the characteristics of any surface a from which signal has been reflected
- It is free to access

Some of the ways in which GNSS is being used to support each Societal Benefit Area are explained below.

Disasters:

A new understanding of volcanic and seismic events and precursors has been brought about by precise (millimetre scale) monitoring of the earth's crust in vulnerable areas. GNSS buoys are becoming an important part of tsunami early warning systems. GNSS navigation allows emergency relief to be delivered –especially in areas with little or no mapping.

GNSS Reflectometry is able to provide information on the extent and depth of flooding.

Health:

GNSS positioning enables individual patients, staff or equipment to be monitored, and response teams directed more efficiently. The Galileo Search and Rescue Service will provide a two-way link between victims and rescuers.

The conditions that enable communicable diseases to propagate can be monitored using GNSS techniques: e.g. water levels and humidity, biomass, animal movement.

Energy:

The logistics of delivering the raw materials, and safely disposing of waste are now governed by GNSS.
Smart-Grids need sub millisecond coordinated timing to work efficiently, this can only be provided by GNSS.
GNSS Reflectometry techniques can produce scatterometry models to assist in the optimum positioning of off-shore wind farms.

Climate and Weather:

The two areas are very similar, weather is a short to medium-term commentary, whereas climate is the analysis of long-term (at least 30 years) statistics.

GNSS Radio Occultation - measuring the refraction of GNSS signals to either a monitoring satellite in a lower orbit, or ground receiver, provides information about the temperature and the water vapour content of the atmosphere. As the geometry of the transmitting satellite and the receiver change, it is possible to scan different layers of the atmosphere in almost real time.

GNSS positioning can be used to monitor the height, speed and extent of glaciers.
Reflectometry can give information about the depth and type of snow or ice.

WATER:

Precise measurement of vertical movements of the Earth's surface by GNSS, enables the precise calibration of tide gauges for monitoring sea-level variation in coastal waters. GNSS buoys provide tidal and sea-level variations beyond these areas. Ocean surface height and roughness / sea-state, can also be calculated from the reflected signals picked up by adapted GNSS receivers.

ECOSYSTEMS:

GNSS Reflectometry offers the potential for monitoring vegetation and biomass. It also has an important role in providing information for global monitors such as: carbon modelling, greenhouse gas emission inventories and deforestation control.

AGRICULTURE:

GNSS contributes to drought early warning systems through improved climate data, soil moisture monitoring, monitoring of lake and reservoir levels, vegetation growth and stress monitoring of vegetation.

GNSS assists Precision Agriculture – enabling precise application of seed, fertiliser, water and pest control even in low visibility and night-time working.

BIODIVERSITY:

The use of GNSS Telemetry for tracking migratory species, gives important information about the feeding and resting patterns, and even the health of individual animals.

GNSS Reflectometry can monitor vegetation and even provide the data for modelling biomass, an important factor in calculating greenhouse gas emissions and deforestation.

Copernicus – formerly known as **GMES** (Global Monitoring for Environment and Security), is the European programme for the establishment of a European capacity for Earth Observation. Many of the services it is building up use similar techniques to those mentioned for GEO.

The six services provided by Copernicus are listed below. Under these general headings, it provides support for applications in a wide variety of domains. These include: urban area management, sustainable development and nature protection, regional and local planning, agriculture, forestry and fisheries, health, emergency management, infrastructure, transport and mobility, and tourism.

GNSS Radio Occultation is an effective tool for monitoring atmospheric water vapour content, more research needs to be done to discover if it can also identify individual gases and pollutants.

GNSS positioning can provide long-term deformation monitoring of the earth's crust, for subsidence, volcanic and seismic activity. It can also be used for navigation, especially in areas where the usual landmarks are no longer available, for the efficient delivery of relief or location of victims

GNSS Reflectometry can provide land use maps based on the characteristics of the reflected GNSS radio signal from different types of surface and vegetation type

GNSS positioning and navigation are important tools for border security and maritime safety.
European security forces use GNSS for navigation and tracking of vehicles and personnel, and it plays an important part in modern ballistic guidance systems.

GNSS Reflectometry can provide information about sea-state, including the thickness and extent of sea-ice and the height of the oceans. GNSS tracking of larger marine creatures provides information about their migration and feeding patterns.

GNSS positioning is used to monitor the thickness and extent of ice sheets and glaciers, ocean height and deformation of the Earth's surface.
Reflectometry can monitor soil moisture levels more economically and efficiently than in-situ monitoring.

The GENIUS partners working to foster links between universities and industry are:

For more information about the work of the GENIUS project visit: www.gnss-education.eu