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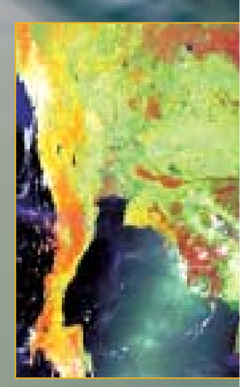
LAND USE & MONITORING

Technology Transfer Programme



Technology Transfer Programme

What do land use, agriculture and satellites have in common? This brochure will help you find out, and tell you just how the European space industry is having an increasing impact on monitoring and preserving the Earth.

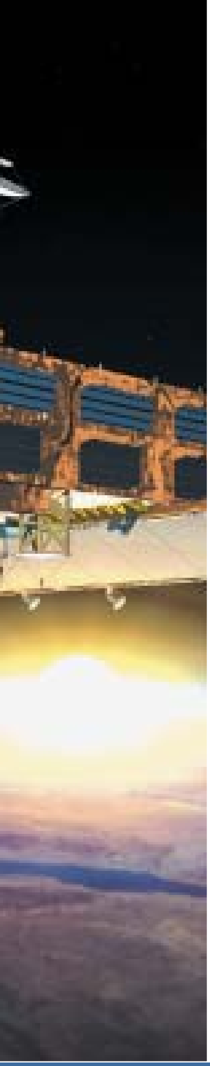
Several of the technologies used in Earth management come from systems that were developed for applications in space. I hope this brochure will give you an insight into how advanced European space technologies are being applied to our precious planet in order to keep it safe and hospitable for humans.

Many innovative non-space products and services that will benefit society are now being introduced as a result of technological spin-offs from the space industry, and it is worth remembering that Earth management is not the only sector to take advantage of the new technologies developed by European space companies.

I hope this brochure will enable you to discover the new and unexpected ways in which space activities are improving our daily lives.

Pierre Brisson
Head of the Technology Transfer and Promotion Office

We are becoming ever more aware of the need to preserve the Earth's sensitive ecosystem, to minimise the harmful effects of our own activities on the environment, and to husband and conserve natural resources. Increasingly space technology is helping to supply the tools that enable us to do this. Satellite observations have provided us with effective methods to monitor climate change and the impact of land use and development. Some of the underpinning space technologies have been adapted to improve the ways in which we exploit and manage the Earth's natural resources.



TERRESTRIAL APPLICATIONS OF EARTH IMAGING

Recognising that Diapason is user-friendly (it does not require a specialised knowledge of radar), CNES began to think about selling the package outside the space industry. In particular, it targetted large laboratories and geophysicists as potential customers. These users typically buy radar data from governments with radar satellites, and then must find a way to generate useful results.

CNES developed a training programme which encouraged scientists to learn how to use Diapason, focusing on the fact that the software automatically does the work of translating the radar data into information the scientist can easily understand and use. These efforts resulted in the adoption of the software in laboratories across Europe and in the USA, primarily for non-commercial application in the early detection of earthquakes and other tectonic movements. CNES has also been approached by two French companies who wish to license Diapason for commercial use.

MONITORING PIPELINES

The pipeline industry is becoming increasingly interested in exploiting Earth observation satellites to improve the integrity of its pipelines. As part of the ESA Technology Transfer Programme's Harsh Environment Initiative (HEI), C-Core, a specialist R&D company based in Canada, has developed a Pipeline Integrity Monitoring project which uses Earth observation satellites for the early detection of encroachment activities near remote pipelines, as well as the monitoring of slope stability and subsidence in remote locations which may affect pipelines in the vicinity. The system is currently under trial and early test results have proved very successful.

Benefits for our daily lives: the ESA Technology Transfer Programme

Over the past 35 years, the European space industry has gained considerable expertise in building, launching, controlling and communicating with satellites. From this long experience of how to overcome the hazards and problems created by such a hostile environment, many valuable new technologies, products and procedures have been developed. Today, this expertise is improving our daily lives by providing many innovative solutions for products and services on Earth.

Groundbreaking European space technologies are becoming increasingly more available for development and licensing to the non-space industry through the process of technology transfer. The ESA Technology Transfer Programme has already achieved over 120 successful transfers or spin-offs from space to non-space sectors.

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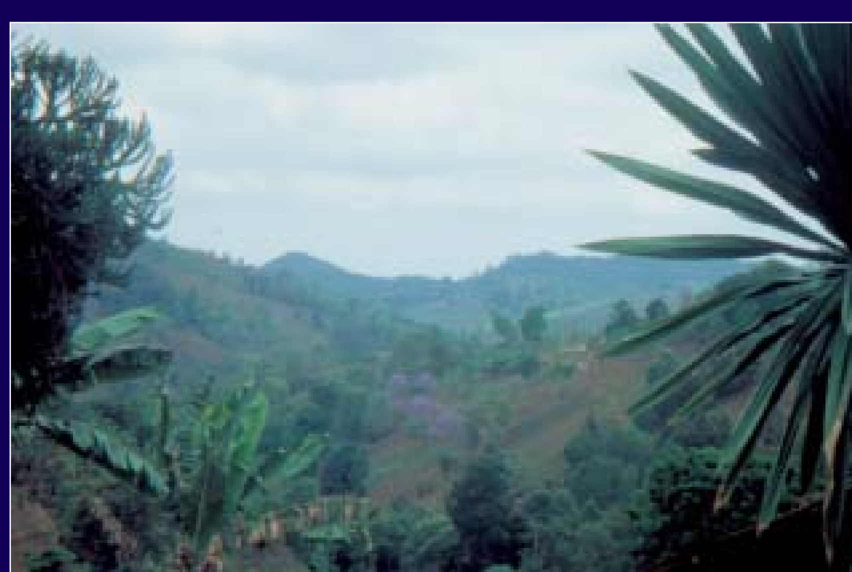
This success is reflected by the fact that since 1991 technology transfer has generated more than 20 million euros in turnover for European space companies and 120 million euros for the non-space industries involved. Already 2,500 jobs and 12 new companies have been created, with 25 expected by 2003.

The ESA Technology Transfer Programme is carried out by a network of technology brokers across Europe and Canada. Their job is to identify technologies with potential for non-space applications on one side, and on the other side to detect the non-space technology needs. Subsequently, they market the technology and provide assistance in the transfer process.



KEEPING AN EYE ON THE PLANET

Of the many satellites now orbiting high above the Earth, a large proportion of them are there to simply observe the land below. Governments increasingly employ remote observation and sensing technology to assess how land is used - an activity which when traditionally done on the ground is both time-consuming and expensive. Satellites have the advantage of being able to cover large areas quickly, and of being able to fly over a particular location frequently (this is important when following changes in land use over time).

One application of satellite observation, increasingly used by government agencies, is to monitor crops. This is particularly important in regions where there are statutory restrictions on how farmers use their land, or where farmers can apply for subsidies for certain crops. In Europe, for example, satellite images may provide intelligence on whether farmers are ‘setting aside’ the correct proportion of their land; or in southern Europe they may help ensure that farmers receive the correct subsidies for their olive crops.

Farmers themselves also benefit. Satellites can remotely monitor how fast their crops are growing and whether they have any diseases. This enables them to decide when to harvest, or apply fertiliser or pesticides. Aid agencies are increasingly exploiting this kind of information to educate and inform farmers in developing countries, so that any local shortfalls in agricultural production and food supply can be predicted.

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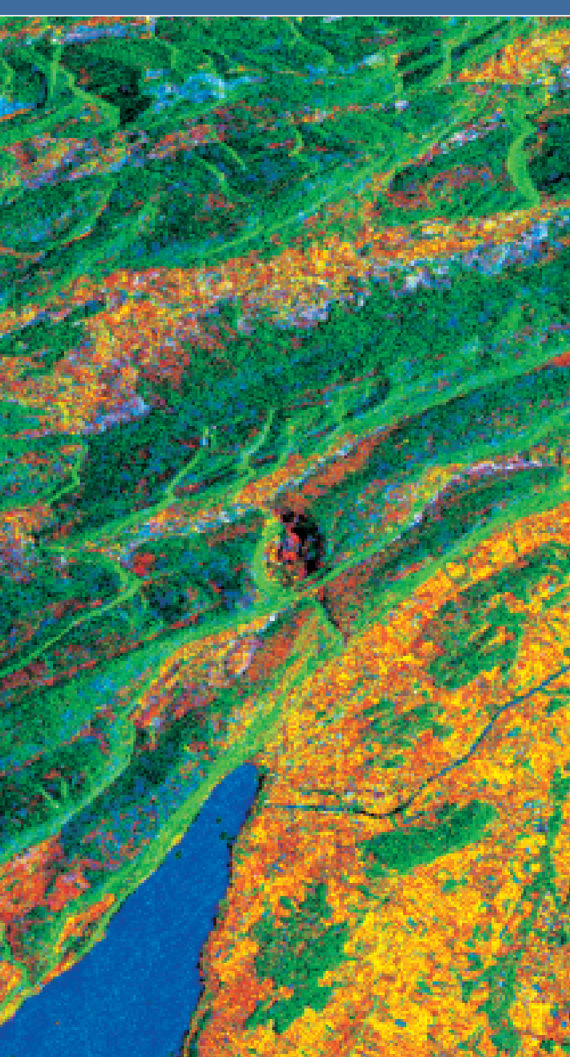


The expansion of deserts, or desertification, is another major problem in some parts of the world, and related to this is the impact on our use of water resources. Again, remote sensing is an important tool in monitoring such changes, as well as global climate change and the impact of human activities on the planet's biodiversity.

Many organisations are involved in interpreting photographs from Earth-observation satellites. One Italian company, ACS SpA, is leading the way in the development of software to aid their analysis. ACS's software has an innovative image-overlay function, which enables pictures from different satellites (or those taken from aircraft) to be combined. This software is already being applied in monitoring land use - for example, in a recent investigation into the populations of olive trees in several Mediterranean countries.

VEGETATION ACTIVITY ASSESSED FROM SPACE

Although global warming is frequently headline news, the part played by vegetation in absorbing or emitting carbon dioxide (a well-known ‘greenhouse’ gas), is notoriously difficult to estimate. The take-up of atmospheric carbon dioxide by plants is driven by photosynthesis. However, some of this is re-emitted via respiration and so - depending on the equilibrium state of the vegetation - it may act as either a carbon sink or source.

Although the effect is well known, until recently detailed measurements were available only at selected test sites. To obtain information on a continental scale, researchers have developed simulation models; but with many kinds of plants, terrain, climatic variations and seasons, these models rapidly become highly complex and they end up requiring many inputs in the attempt to mirror reality. Inevitably, as the area represented by each model was enlarged, the availability of the data needed to support it became more problematic and hence the validation of the model also.

The gap between local measurements and regional modelling can partly be bridged by using imagery from Earth-observation satellites. Through a series of research projects, Vito (the Flemish Institute for Technological Research) in Belgium has worked to unravel the complexity and develop a reliable method of estimating carbon-exchange in vegetation using satellite data.

COMBINING MODELS AND SATELLITE DATA

The system, C-Fix, attempts to quantify carbon flows on a regional basis by combining a simplified carbon-exchange model with satellite observations. Its aim is to obtain an accurate and repeatable estimate of the behaviour of terrestrial vegetation across the globe. Each day, for set locations, the model estimates three kinds of carbon mass fluxes. The first represents the uptake of carbon by photosynthesis, the second concerns respiratory losses which are partly due to plant growth, and the third covers losses caused by decomposition of soil litter. Data taken from satellite images provide information on the amount of sunlight available to drive photosynthesis. This is combined with meteorological input from weather stations across the study area.

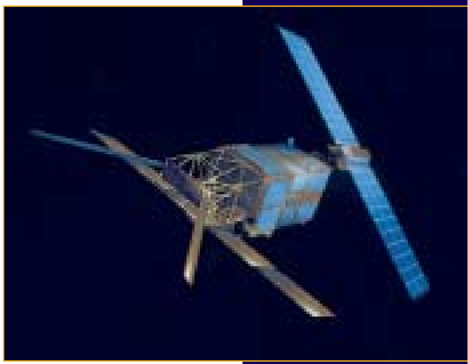
Using NOAA-AVHRR satellite imagery between 1990 and 1997, the researchers applied C-Fix over Belgium with reasonable success. With EU funding, the C-Fix model has now been adapted to cover continental Europe, and the next step will be a demonstration using data from the SPOT 4 satellite to generate images relating to carbon synthesis across Europe and Africa over a full year.

BIG BROTHER IS WATCHING OVER YOU

Today, the Earth's surface can be mapped using satellite radar imaging and even small changes on the Earth's surface can be monitored over a long period of time. This is done via a technique called 'interferometry', whereby two radar signals acquired from approximately the same geographic position but at different times are combined and compared. If the signals are identical, the waveform of the combined signal will remain the same. If there has been any change at ground level then the waveforms will be slightly different and will 'interfere' when combined (in the same way that some ocean waves are partially cancelled and some are reinforced when they interact). By analysing this interference pattern on a computer, it is possible to identify any changes in topography and to map small displacements.

Interferometric studies have traditionally been carried out using simultaneous measurements from two or more instruments situated in different locations. However, a single satellite can 'interfere with itself' if its measurements are taken and properly recorded at consecutive passes over the same place. This technique was developed in the 1980s when software became available that could compute the radar data digitally in a reproducible fashion.

Using its expertise in this area, the French national space agency, Centre National d'Etudes Spatiales (CNES), developed a software package, called Diapason, for radar satellites such as ESA's ERS-1 and ERS-2 which orbit the Earth to monitor environmental changes. Not only does the software provide efficient and almost automatic computing capabilities, but it is also simple to use. Diapason can detect changes in sections of the Earth's surface from one kilometre across to within a few millimetres in some cases. In particular, very small surfaces displacements can be identified, which is useful in mapping changes that precede volcanic eruptions or, possibly, earthquakes.



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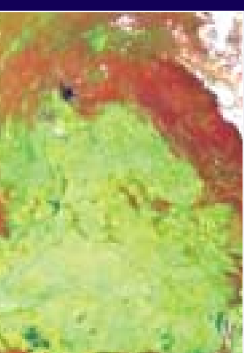

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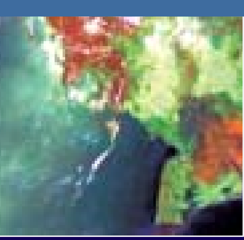

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or visit the ESA Technology Transfer Website: **http://www.esa.int/ttp**

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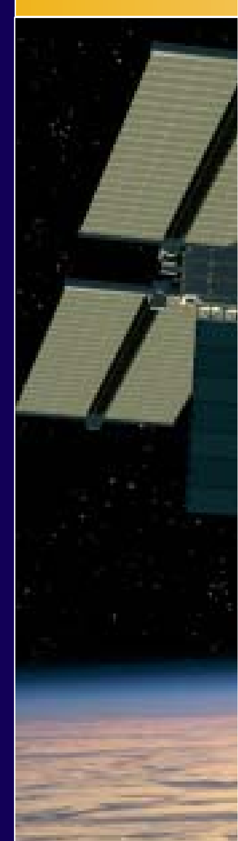

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