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6- *Europe:* *a developed continent*

Watching over the Earth

the
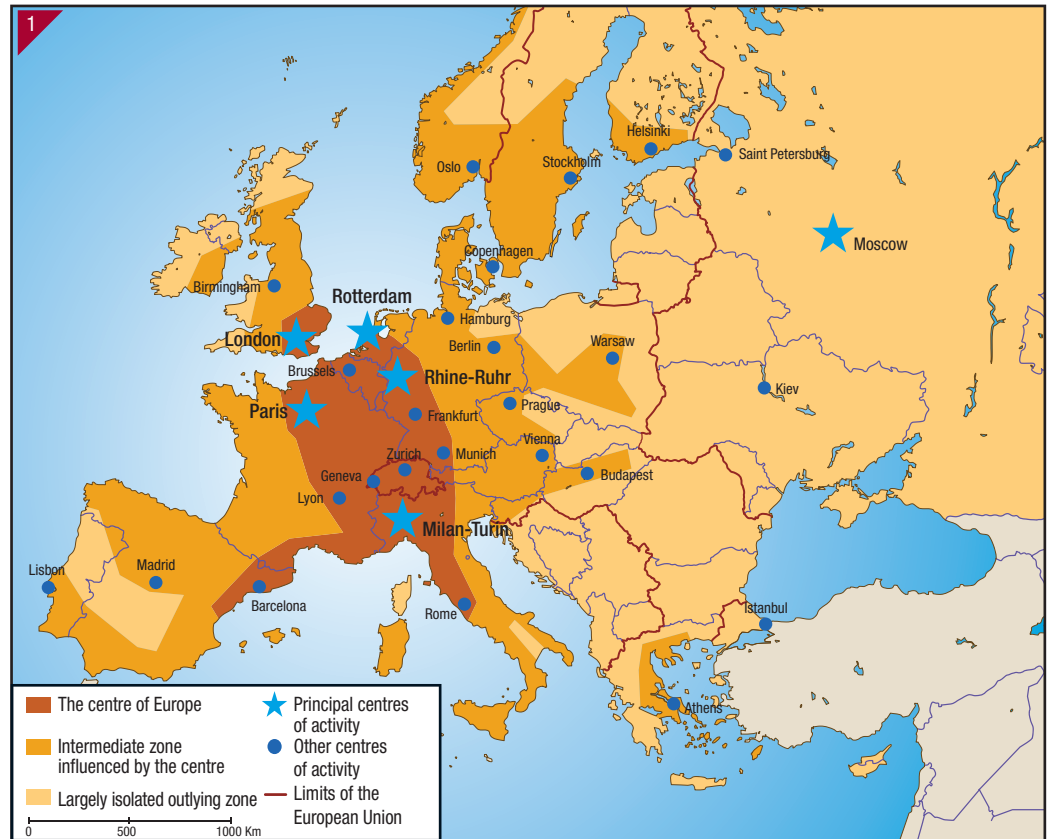*Living Planet*

THE MAIN AREAS OF ECONOMIC ACTIVITY IN EUROPE

Europe can be divided into three main regions, classified according to their levels of activity and economic importance. There is the heart of Europe, which comprises the key cities and is home to much of the industrial and commercial activity. This region stretches from southern England to northern Italy. An intermediate zone just beyond is also dynamic and active, with modern agriculture and industrial activity. The expansive outlying area is poorer and more thinly populated.

Legend:
- The centre of Europe
- Intermediate zone influenced by the centre
- Largely isolated outlying zone
- ★ Principal centres of activity
- ● Other centres of activity
- — Limits of the European Union

Levels of development across the European Union vary considerably. The heart of Europe, its richest part, contains the greatest concentrations of population and economic activity and forms a dense network of cities and axes of communication. The other two zones, on the other hand, are less industrialised and less densely populated.

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London is one of Europe's biggest cities. It is also a major financial centre and a city of major international significance (image by SPOT 5).

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Greater London extends over an area of 1,580 km^2 and has 7,4 million inhabitants (2004 figure). The entire urban conurbation of London has over 12 million inhabitants.
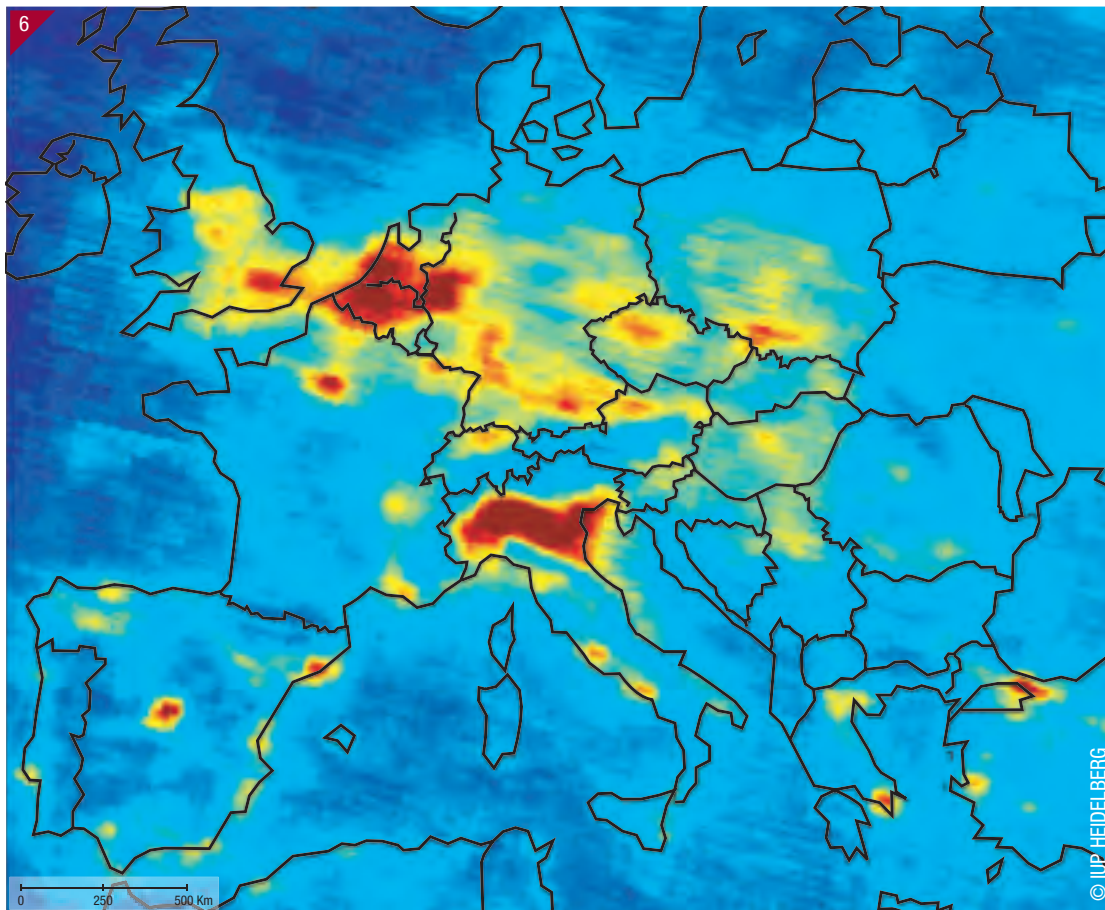
Satellite images, since they are able to observe an entire territory, reveal disparities between Europe's regions. These images, which cover very wide areas, do not show industrial activity directly but instead measure its indirect consequences (for example through luminous flux and atmospheric pollution). Other satellite images, focussing on a more limited part of a given territory, make it possible to monitor changes to urban and industrial areas and can thus be used in town planning.

This satellite image, reconstituted from night-time views, shows Europe's major urban conurbations. The combined effect of street lighting, industrial activity and lighting along communication routes is to emit a luminous flux that is clearly visible from space. This provides one way of comparing and assessing the intensity of economic activity in a region, although of course it only shows activities using a great deal of electricity.

The major cities are linked by large axes of communication. Transport activity is a sign of intense economic activity but at the same time is one of the main sources of pollution.

Economic activity has its downsides, notably that it generally causes high levels of pollution. By regularly measuring emissions of pollutant gases across the globe, satellites help to build up a map of atmospheric pollution. Note, however, that not all regions are affected to the same degree.

In 2004, more than 15 billion tonnes of carbon dioxide (CO_2) were released into the atmosphere.

Map of NO_2 (nitrogen dioxide) emissions based on measurements from the SCIAMACHY instrument on board the Envisat satellite.

ROTTERDAM: EUROPE'S LARGEST PORT
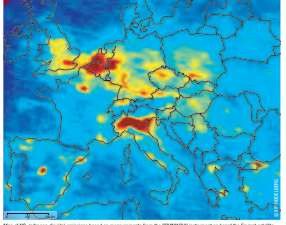
Rotterdam at the mouth of the Rhine, whose port handles almost 350 million tonnes of goods every year is the biggest port in Europe and the 3rd biggest in the world. Some of its port facilities, which are continuously expanding in response to the growth in international maritime traffic, are built on platforms in the sea. The port authorities often use satellite images to assist them in their development.

Aerial view of the port of Rotterdam.

In the picture to the left, areas of vegetation are shown in red. Plants reflect most of the energy they receive from the sun's rays in the infrared channel, an area in which satellite sensors are extremely sensitive. This image follows the convention of colouring them in red.

Satellite view of the port of Rotterdam. In this image, vegetation is shown in red and built-up areas in blue (image by SPOT 5).

The great diversity of Europe's soil and climate means that conditions for agriculture are good. Consequently, Europe has a rich variety of rural and agricultural areas covering most of its landmass.

Farming has become a minority activity but is nonetheless essential to the economic balance of the continent.

Andalusia in Spain has a climate which provides high yields and allows precocious crop development (crops can be grown early). It is one of Europe's most important agricultural areas, and much of its production goes to the north of the continent.

Aerial view of Andalusia.

When accurate observation of vegetation cover is required, images are often captured by satellites in the near infrared. It is this wavelength which is used to detect vegetation since it reflects more energy in the infrared than in the green channel. Such images thus show traces of vegetation and variations in the type of vegetation in more detail and with greater accuracy.
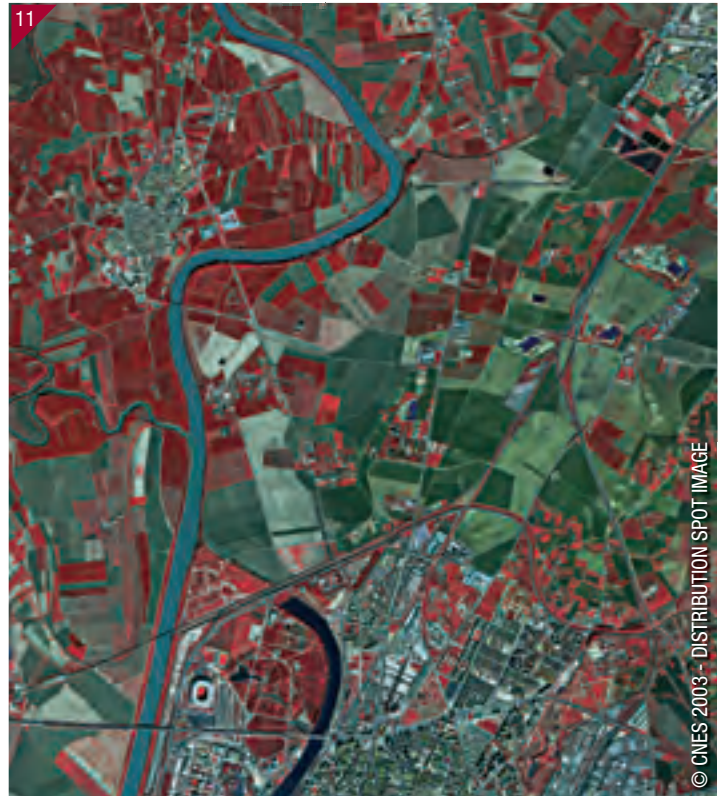
Agricultural area north of Seville in "true" colour, left, and "false" colour, right (images by SPOT 5).

How do satellites work?
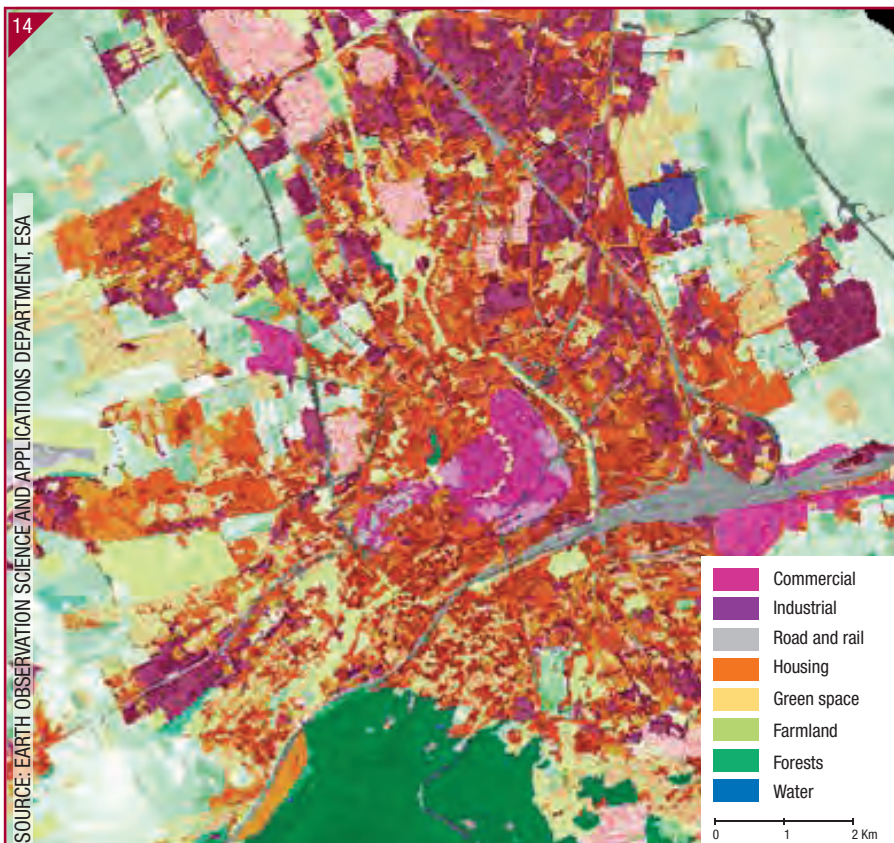
Urban expansion in Europe

Aerial view of Erfurt city centre.
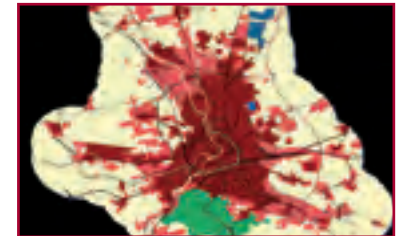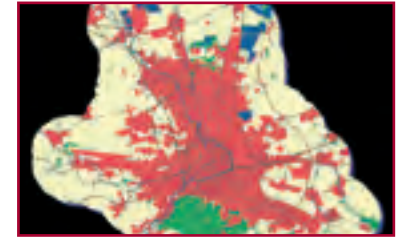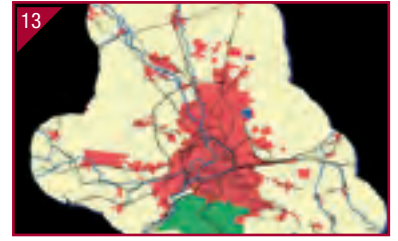
Expansion of the city over a 30-year period.

Using satellites to analyse the characteristics of urban areas

A satellite image laboratory-processed to highlight different types of urban areas.

Legend:
- Commercial
- Industrial
- Road and rail
- Housing
- Green space
- Farmland
- Forests
- Water

0   1   2 Km

Light and the signals reflected by the Earth's surface display different characteristics depending on their nature. In built-up areas, a zone containing detached houses will not send back the same signal as one containing apartment buildings. Likewise, forests do not send back the same signals as meadows or fields.

Armed with a good knowledge of land use (acquired from ground-based observation), specialists correlate this knowledge with measurements from satellite images. They observe how the satellite reacts to certain land characteristics in a small area designated as a test zone. Then, knowing that when they obtain the same results these correspond to the same land types, they can draw up precise land use maps of other regions.

Satellites are used in the production of accurate and regularly updated maps. They can be of assistance in all types of development projects, notably in urban areas.

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SOURCE: EARTH OBSERVATION SCIENCE AND APPLICATIONS DEPARTMENT, ESA

Information for teachers

The "Information for teachers" sheets are designed to offer assistance with the preparation of classes and complement the worksheets handed out to pupils. They contain useful information for the presentation of the subject, additional information relating to the satellite images, and a list of websites dealing with the subjects concerned.

Worksheet 6: Europe, a developed continent

Worksheet 6 is centred on the study of Europe. Its aim is to focus on the major urban concentrations which make this part of the world the prosperous and dynamic continent it is. In terms of scale, the main focus is on western Europe, although some large urban areas such as London and Rotterdam are also examined in more detail.

This worksheet can be used to:
• locate and identify the continent's major urban centres and economic hubs;
• analyse urban landscapes;
• apply concepts such as city, landscape, pollution, etc.
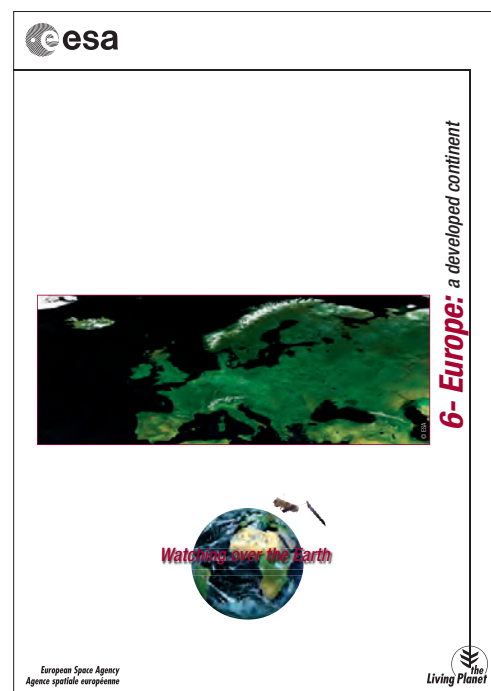
The major areas of economic activity in Europe

Europe is home to 12% of the planet's inhabitants concentrated on 7% of the Earth's landmass. It has the third largest population concentration after East Asia and South Asia. The smallest of the Earth's continents (which is actually a part of the Eurasian continent), it is also the one whose urban and trade legacy reaches furthest into the past. It is one of the most densely populated regions in the world with estimated average density of 100 inhabitants per square km (not taking into account that part of Russia which is in Europe, which, along with Russia, has a density of 80 inhabitants per square km) which is double that of the global average density. Nonetheless, population distribution is uneven. This can be explained by both geographical factors (mountainous regions and large parts of Scandinavia's interior are less populated than the plains, river valleys, and coastal regions) and by historical factors (large valleys have always formed the communication axes which are key to major trade flows and which determined the siting of market towns).

The core of this population centre is made up of the major cities in the centre of Europe which links the system of vast agglomerations between London in the North and Genoa in Italy in the South. This core area constitutes the essence of the economic, financial, and demographic power of Western Europe and the European Union. Its cities, commercial activity, democracy, and now economic liberalism make up the essential pillars of a strong European identity. Europe (including Russia) produces a third of the planet's wealth and is one of the three major centres of the world economy (along with the United States and East Asia). It is a wealthy and developed continent. In addition, of the 20 countries with the highest HDI (Human Development Index) rating, 15 are in Europe. Of the 20 best health care systems (according to the WHO), 17 are to be found in European countries.

It is the product of a long social history, and despite persistent differences in development between West and East European countries, the region still serves as a model for development for the rest of the world. The European project and its successes—enlargement, establishment of a single currency, thriving intra-community trade—contribute to the idea of a continent where, despite certain internal difficulties, economic prosperity, social progress, and peace between neighbouring nations has succeeded in flourishing.

The satellite images

Cover image : The European continent (Envisat/MERIS image)
This image, taken at the end of spring, shows northern and mountainous areas still covered in snow.

Core content

Image 1: Map of economic activity in Europe
This map of the European continent is shown at approximately the same scale as the two neighbouring images showing Europe by night and the zones severely polluted by nitrogen dioxide. This layout is designed to permit instant correlation of the information in the different images.

Images 2 and 3: London (Spot 5 images, 2003)
Greater London has a population of 7.4 million and is one of the most densely populated areas in Europe. One in eight inhabitants of the United Kingdom lives in Greater London.
The images here show only central London.

Image 4: Europe by night (NASA/DLR)
This optical image shows the use of electric light in major cities and other urban areas. It was created using partial views acquired during cloudless and moonless periods. The contrast has been adjusted through digital processing, thus highlighting the extent of urban areas. The contrast with the Sahara Desert is particularly pronounced. It can be interesting to view this image alongside the map showing the major areas of economic activity in Europe and the image showing the distribution of NO_2 pollution in Europe.
The image, from NASA (MODIS), was processed by the German Remote Sensing Data Center, operated by the German space agency, the DLR.
In 2004, electricity production in the European Union stood at 2950 TWh (terawatt hours). By comparison, the worldwide figure is 17450 TWh (NB: TWh = a thousand billion watts/hour or 1 billion KWh).

In Europe, in 2004, consumption per habitant per year stood at 6565 KWh, as opposed to 546 KWh in Africa. According to UN estimates, close to two billion humans had no access to electricity in 2004 (source: AIE).

Image 6: NO_2 emissions in Europe (Envisat/SCIAMACHY)
This image is produced from readings taken over 18 months by the SCIAMACHY instrument. (Image by IUP, Heidelberg). This instrument records the spectrum of sunlight shining through the atmosphere. Different gases present in the atmosphere influence the visible spectrum in various ways, thus allowing some of them to be identified.

This map reveals the impact of human activity on air quality. Nitrogen dioxide (NO_2) mainly produced by human activity and excessive exposure to this gas causes serious health problems. Over highly polluted large cities such as London, the ratio of NO_2 particles can reach levels of one hundred parts per billion air particles. There is little data on this pollution taken from sensors on the ground; only space-based sensors are able to carry out effective global monitoring. (Additional information on this map is to be found in Worksheet N° 3, ''Humans on Earth'').

Image 7: The port of Rotterdam (SPOT 5 image, 1999)
The vegetation surrounding inhabited areas and industrial facilities is shown in red. Satellite observation tools do not see in colour. They record in various spectral bands the amount of light reflected by the ground. Through processing the data in laboratories a different colour can be allocated to each spectral band in order to produce an image.

Satellite instruments such as SPOT are sensitive to the near infrared. (It is an important wavelength for observation from space, especially because vegetation reflects very strongly in this spectral band). However, SPOT does not record blue.
When producing an image, laboratories processing the data allocate - by convention - the colour red to that which is seen in infrared. However, this means they have to ''shift'' the other colours. Thus, the colour green is allocated to red-shaded areas and the colour blue to green-shaded ones. A coloured composition is thus created with false colours, in which vegetation is shown in red and water is black or dark blue. All these colours combine with each other, depending on the amount of light recorded, to reproduce the full range of shades.
This is the convention, and various choices can be made: the colours the general public is accustomed to are restored in the images produced, with green vegetation and blue water. These choices and representations are equally valid: landscapes as seen by the human eye are not actually any more true or real than when they are represented in infrared or by radar. (See Worksheet N° 11, ''Colours in satellite imagery'')

Page 5 - Europe contains vast tracts of agricultural land

Images 10 and 11: Agricultural area north of Seville (two SPOT 5 images, 2003)
These two images of an agricultural region near Seville show the various possible processing methods. The first image reproduces the colours according to standard human vision (the colours match those in aerial photography) whereas in the second, the colour red has been allocated to the infrared channel.

Page 6 – "How do satellites work?"

Images 13 and 14: Urbanisation in Erfurt (ESA)
Satellites provide precise data for land classification and land use. The example provided here is that of an ESA study carried out on behalf of the town of Erfurt in Germany.

This type of sensing requires observations on the ground and by satellite to work in conjunction with one another. Satellites do not themselves "see" the characteristics of different land use types. However, the measurements and data they provide can be used to highlight with a very high degree of reliability any variation in terrain: scattered settlements do not send back the same signal as more densely inhabited areas, while pasture land does not send back the same signal as forest or cultivated fields. This makes it possible to create precise maps showing the land in all its variety and where the different land types are to be found. It is by conducting parallel studies on the ground that it is possible to determine the land use and characteristics of each area. This data is then correlated with data returned by the satellite. Armed with this information, which requires numerous studies and checks, it is then possible to interpret maps produced by satellite without having to carry out exhaustive investigations on the ground.

Regular satellite observations also provide the opportunity to study variations in land use over time. Thus, with space-based resources one can obtain up-to-date information on all the changes in a given region.

Online resources

www.esa.int — ESA (European Space Agency) website
www.esa.int/SPECIALS/ESRIN_SITE/index.html — ESRIN (European Space Research Institute) website
ESRIN is ESA's centre for Earth observation

www.esa.int/eo — ESA Earth observation website
earth.esa.int/earthimages — Gallery of ESA satellite imagery
www.esa.int/education — ESA educational website
www.eduspace.esa.int — Earth observation educational website (EDUSPACE)
www.cnes.fr — CNES (Centre National d'Etudes Spatiales) website
Presentation of the French national space agency's missions and activities

www.cnes-edu.fr — CNES educational website
www.spotimage.fr — SPOT IMAGE gallery

EUROPE
europa.eu/index_en.htm — European Union portal
www.fco.gov.uk/servlet/Front? — Information on the European Union and Britain's place in it
pagename=OpenMarket/Xcelerate/
ShowPage&c=Page&cid=1007029391674

URBAN SPRAWL IN EUROPE
reports.eea.europa.eu/eea_report_2006_10/en — The challenge of urban sprawl in Europe. Includes link to downloadable PDF

ATMOSPHERIC POLLUTION
www.esa.int/esaEO/SEM340NKPZD_index_0.html — Global air pollution map
www.esrin.esa.it/export/esaCP/ — Air pollution in London
SEM2AS1DU8E_index_2.html

Satellite images

esa   SPOT IMAGE   DLR   NASA

Worksheet N° 6 – Europe: a developed continent

Once you have read and carefully examined the worksheet, please answer the following questions :

1 – What is the difference between the centre of Europe and its outlying regions?
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2 – Compare the map of Europe and the satellite image of Europe by night. What observations can you make?
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3 – Based on the satellite image of Europe by night, what conclusions can you make regarding urbanisation levels on the Iberian Peninsula?
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4 – How is nitrogen dioxide pollution distributed across Europe? Why?
What are the main reasons behind this pollution?
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5 – Compare the satellite image of Rotterdam and the aerial photograph of the port of Rotterdam. What industrial structures can you identify on both images?
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6 – Andalusia is an important agricultural region. Which regions of Europe import its agricultural production?
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7 – What do you think is the purpose of having detailed maps of urban areas and of their different features?
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