Mining, Energy, Industry – Fossil Fuels

Oil and gas play a crucial role for industry and energy supply. Today's world completely depends on these non-renewable resources. Mineral oil is mostly used to produce fuel. It also serves as a raw material for chemical products such as plastics and fertilizers.
Crude oil is a product of pressure and heating of organic material which has been buried by sediments. The liquid and gaseous hydrocarbons which form during a metamorphosis process migrate through the adjacent rock layers until they become trapped in porous rocks. Large oil and gas fields are mainly found on the continental shelf where the liquids are been extracted by off-shore drilling. Saudi Arabia, Russia and the United States are the world's top three crude oil producing countries. On the basis of the oil drilling process a large industry with an enormous infrastructure (pipelines, oil rigs, refineries, roads, harbours) has developed.
The map provides an overview of oil production and its infrastructure in Europe (North Sea), Siberia and the Persian Gulf countries, in order to

- show similarities and differences in the off-shore and land-based production of oil;
- show the huge impact of oil production processes on the environment, in respect of both production and transport of the product;
- provide an insight into the high potential for political and environmental conflicts in this context.

Map Descriptions

Map 1: Oil and gas production in the North Sea
Satellite/Sensor: Envisat MERIS
Acquisition Date: mosaic, 2002
Band Combination: near natural colours
Map Information: oil and gas production, boundaries, vegetation

Description: The satellite image map shows the North Sea with its oil and gas fields and the pipeline connection to the riparian states. Tanker terminals and oil and gas processing sites give an impression of the spread of the oil industry sites. From the map it is clear that a majority of the oil and gas fields lie within the boundaries of the United Kingdom and Norway, the main oil producing countries in the North Sea. Some smaller fields belong to Denmark and the Netherlands. Oil fields are found in the western part, gas fields rather in the eastern part of the North Sea.
The oil exploitation in the North Sea started in the 1970s. Due to rough conditions at sea, such as severe wind gusts and waves up to 30 metres high, offshore exploitation is considered a challenge, requiring expensive exploration and production methods.

Map 2: Oil rigs, North Sea, radar image
Satellite/Sensor: Envisat ASAR
Acquisition Date: 08.05.2004
Band Combination: SAR amplitude
Map Information: -

Description: The radar satellite image map shows a section of the southern Norwegian Sea with some of the oil rigs of the Brent oilfield, which is located on the territories of both the United Kingdom and Norway. The oil rigs show up as bright dots, in part accompanied by oil slicks appearing black. Radar satellites enable the detection of oil pollution on the sea in medium to low wind conditions. The presence of oil slicks and the surface waves of the sea modify the reflection of the radar waves. Other structures in a darker tone are a result of calm zones between air streams, again leading to lower waves. In very low wind conditions, as in this image, pollution of oilrigs may be caused simply by waste water or even much diluted drilling liquid. However, the black eroded areas in the central

eastern part of the image are likely to be oil films deformed by the changing wind direction and the sea current.

Map 3: Oil rigs in the North Sea
Satellite/Sensor: IKONOS
Acquisition Date: 16.10.2001
Band Combination: near natural colours
Map Information: -

Description: The satellite image shows a part of the Statfjord oil field, one of the most productive offshore oil wells. Three platforms can be distinguished, as well as some ships.

Map 4: Oil tanker in the North Sea
Satellite/Sensor: IKONOS
Acquisition Date: 16.10.2001
Band Combination: near natural colours
Map Information: -

Description: The image shows two oil tankers in the North Sea.

Map 5: Oil rig, Statfjord Oil field
Satellite/Sensor: IKONOS
Acquisition Date: 16.10.2001
Band Combination: near natural colours
Map Information: -

Description: The detail of the satellite image shows one of the three platforms at the Statfjord oil field. Oil platforms are used to drill into the oil field and extract the oil. Gas is a by-product of the oil drilling, which is partly burned. The flames and smoke are clearly visible in the satellite image.

Map 6: Oil storage and processing infrastructure in the harbour of Rotterdam, The Netherlands
Satellite/Sensor: QuickBird
Acquisition Date: 05.09.2004
Band Combination: near natural colours
Map Information: -

Description: The satellite image shows the oil port of the port of Rotterdam in the Netherlands (cf. Atlas page 250/251). With an area of 10.500 ha and a total length of 40 km it is the largest port in Europe and one of the largest in the world. It is also one of the world's major centres for oil. The five largest petrochemical companies (Shell, BP, Esso, Kuwait Petroleum and Texaco) have refineries in Rotterdam. The map shows several oil terminals across the port. Large circular tanks which are used to store crude oil can be seen. A network of roads and railways in the area provide excellent connection with the hinterland.

Map 7: Detail of petrochemical industry, port of Rotterdam
Satellite/Sensor: QuickBird
Acquisition Date: 06.09.2004
Band Combination: near natural colours
Map Information: -

Description: The map displays a detail of Map 4. Numerous circular tanks and a refinery are shown. The refineries process the crude oil into furnace oil, motor spirit and kerosene. The harbour installations allowing efficient loading and unloading are visible as well as the dense network of pipelines across the area.

Map 8: Oil and gas production in the Persian Gulf
Satellite/Sensor: SPOT Vegetation
Acquisition Date: June-Sept. 2000/2001
Band Combination: near natural colours
Map Information: political situation, oil fields, pipelines.

Description: The satellite image map shows the Persian Gulf with its oil and gas fields as well as the pipeline connections to the surrounding states, tanker terminals and oil and gas processing sites. Due to the anticlinal structures in the sedimentary sequence of the north-eastern Arabian Platform and its offshore extension, the region is rich in oil and gas. Therefore, in contrast to Europe and the North Sea, large oil reservoirs are found onshore.
Large oilfields are found especially in Saudi Arabia, Iraq and Iran. Saudi Arabia is the world's most important oil producer. About 24% of the global proven reserves are located here (status 2004). East of Ar Riyad the world largest oil field is located. The Ghawar oil field, on a deep sandstone reservoir, stretches from the north-east to the south-west. Approximately 4.5 million barrels of oil are produced every day. There are also several gas fields.
In Iran, the world's second largest oil producer, oil is found along the plains of the northern Gulf coast. Offshore oil production also plays an important role in the Persian Gulf – Safaniyah (Saudi Arabia) is the world's largest offshore oilfield. Most of the gas reserves in the Gulf are located in the North Dome field north of Qatar.

Map 9a: Kuwaiti oil fires, Februar 1991
Satellite/Sensor: Landsat TM
Acquisition Date: 23.02.1991
Band Combination: near natural colours
Map Information: -

Description: The satellite image map of Kuwait shows the burning oilfields in the south of Kuwait during the Gulf War in the year 1991. As the Iraqi troops retreated from Kuwait they set fire to more than 700 oil wells in different oil fields. Several burning oil wells are shown on the image as red spots. A dense dark plume of soot and smoke covers almost the whole area of Kuwait. Kuwait city is located in the north of the image along the coast. The sky was blackened for weeks by smoke, and people suffered from serious respiratory problems. In addition to that, spilled oil had a severe environmental impact on the flora of the Persian Gulf.

Map 9b: After oil fires
Satellite/Sensor: Landsat TM
Acquisition Date: 05.03.1992
Band Combination: near natural colours
Map Information: -

Description: The image displays the oil fields after most of the fires had been extinguished. In the centre of the map some oil wells are still burning. The destruction of the oil production installations has led to the formation of oil lakes, a potential hazard for groundwater resources.

Map10: Oil terminal Kharg (Hark), Iran, ISS oblique view
Satellite/Sensor: ISS Astronaut Photograph
Acquisition Date: 31.08.2002
Band Combination: -
Map Information: -

Description: The very high resolution oblique photograph shows the island of Kharg in the Persian Gulf. The island contains oil production sites and is one of the largest offshore crude terminals in the world. Several round oil tanks and infrastructure installations are visible, with slightly polluted water following the wind currents towards the north. However, the change in colour is due to the reflecting sunlight on smooth water surfaces. Kharg is linked via a pipeline to the mainland of Iran.

Map11: Oil and gas production, Saudi Arabia
Satellite/Sensor: IKONOS
Acquisition Date: 11.11.2002
Band Combination: near natural colours
Map Information: -

Description: The image shows an oil production site in the desert of Saudi Arabia, south of Ra's Tannūra. In the refinery the crude oil is processed and refined. During the process any contaminants and impurities are removed. Asphalt, fuel oil, kerosene and paraffin wax are some examples of refined oil. The image map presents a typical example of the complexity of oil production sites, with its dense pattern of pipelines and roads.

Map 12: Pipelines in Saudi Arabia
Satellite/Sensor: IKONOS
Acquisition Date: 11.11.2002
Band Combination: near natural colours
Map Information: -

Description: The detail view of an oil production site in the Saudi Arabian desert gives an impression of the difficulties to be encountered. In the south-east part of the satellite image map four pipelines are shown. They are partly covered by sand. In the northern part some masts of a power line supplying the oil production site are visible. The scene is dominated by sickle-shaped sand dunes.

Map 13: oil and gas production in Siberia, Russia
Satellite/Sensor: Envisat MERIS
Acquisition Date: mosaic, 2004
Band Combination: near natural colours
Map Information: oil production infrastructure, oil fields.

Description: The satellite image map shows an overview of the central Ob region in Siberia, an important oil production area. Apart from oil fields and gas fields, the network of the main pipelines and the locations of the production sites are shown.

Map 14: Oil and gas infrastructure around Surgut, Russia
Satellite/Sensor: Landsat TM
Acquisition Date: 06.07.1987
Band Combination: near natural colours

Map Information: -

Description: The satellite image map shows the city of Surgut and its surroundings. Due to the oil and gas exploitation the natural vegetation has been significantly reduced. Only small forested areas remain. Along the rivers swampy areas are found. The meanderings of the river Ob are clear. North of the city round lakes can be detected. They have been formed by thermokarst processes.
Since the 1960s, when the oil and gas reserves were discovered, Surgut has experienced development and urbanisation. West of the city, the oil and gas production sites with infrastructure can be recognised, and it is easy to follow the pipelines. Surgut has its own port and is also connected via pipelines to the Urgensy gas fields.