The Earth – Traffic and Information Networks, Satellite Navigation Systems

The transport of goods and people always has been a key element of cultural exchange as well as the economic development of cultures or nations. The dense network of traffic connections has left its traces, be it in the manifestation of the road and railway systems spanning the globe, or in the form of the transient contrails of aircraft and ships. With the increasing density of traffic, the development of new navigation tools was inevitable. Global positioning systems such as GPS or Galileo allow us to use the available time and space more efficiently, thus also reducing the impact of traffic on the concerned population and the environment. A second trend, which is also related with the enormous development in the field of information technology, is that the transport of goods and people is partly replaced by the transport of information. The world-wide web and related technologies have started to spread since the 1980s, with an exponential growth of the transferred data volume. The atlas page helps

- to link the issues of transport of goods, people and information;
- to introduce the role of satellite navigation systems; and
- to start an assessment of the relationship between transport, information and wealth.

Map Descriptions

Map 1: Air traffic and sea traffic
Satellite/Sensor: -
Acquisition Date: -
Band Combination: -
Map Information: air and sea traffic routes

Description: Aviation and shipping provide a vital connection to the wider world for both passengers and freight. The substantial growth in air travel has increased accessibility and opportunities for many people and is important for global economic growth as well as for national and regional development. Shipping's strengths are in freight rather than in passenger travel. The map shows the densities in terms of air movements and the main ship routes. Furthermore, the important airports are mapped. It is obvious that North America, Europe, East and South-East Asia especially have dense networks of airports and flight routes, whereas, despite their sizes, Africa and Australia have less dense air traffic.
The main ship routes show important centres with a dense network of routes. Interesting features are the canals (see Atlas p. 248/249) like the Panama Canal or Suez Canal, which provide shortcuts and help to avoid long detours.
In a situation of increasing traffic density, satellite navigation is becoming more and more an essential tool for the safe conveyance of both ships and aircraft.

Map 2: Flight densities above the United States, 10.09.2001
Satellite/Sensor: -
Acquisition Date: 10.09.2001
Band Combination: pseudo colours
Map Information: flight densities

Description: The two maps, which have been derived from Air Traffic Control data, show the flight densities at cruise altitudes across the North American continent. It becomes obvious that the density is highest in the morning at the East coast. Urban conurbations like BosWash (see Atlas p. 121), New York, Toronto and Chicago can be easily recognised by the increased flight densities. During the night the flights are much less dense and almost evenly distributed.

Map 4: Ship contrails over the Atlantic Ocean

Satellite/Sensor: Terra MODIS
Acquisition Date: 27.01.2003
Band Combination: near natural colours
Map Information: -

Description: The satellite image shows tracks of large ships that are rendered visible by a trail of shallow stratus clouds. These clouds form in the wake of ships and are remarkably long-lived. They typically are between 0.5-5 km wide and are due to cloud condensation nuclei in the ship's exhaust. The ship tracks on the satellite image give an impression of the ship traffic density in the Atlantic Ocean and the Gulf of Biscay. As they increase the albedo, ship tracks tend to cool the regional climate.

Map 3: Air contrails above the USA
Satellite/Sensor: Terra MODIS
Acquisition Date: 29.01.2004
Band Combination: near natural colours
Map Information: -

Description: The satellite image map shows a part of the south-east of the United States with a striking pattern of contrails caused by the dense air traffic in the region. Contrails are a product of the combustion of hydrocarbons (kerosene) in the aircraft's engines, which forms water and increases the amount of water in the air. When the water vapour is oversaturated, condensation forms a contrail. Depending on the weather conditions, contrails are more or less stable. The overall effects of contrails on climate are still being discussed – the question is, whether the cooling effect by the reflection of solar irradiation (negative radiative forcing) or the heating effect by trapping the outgoing thermal radiation (positive radiative forcing) is stronger. Traces of the first effect can be seen in the satellite image map – the bright contrails are accompanied by the dark stripes of their shadows on the ground, where the temperature tends to be lower than in the sun-lit areas. The image also shows that the local atmospheric conditions determine the occurrence of contrails. Regions with dryer and/or warmer air (e.g. a strip across Georgia) are not covered with contrails, whereas they form dense grids over other regions.

Figure 5: The European Satellite Navigation System Galileo

Description: Galileo is the satellite navigation system built by the European Union as alternative to the Global Positioning System (GPS) and the Russian GLONASS. With the introduction of this new civilian satellite navigation system, a greater precision than currently available is aimed at. Furthermore, the coverage by the satellite signal in higher latitudes (e.g. Scandinavia) should be improved.
Galileo is based on a constellation of 30 satellites, positioned in three inclined, circular Medium Earth Orbit (MEO) planes in 23.616 km altitude above the Earth. The signals of at least three satellites must be visible by a Galileo receiver to be able to determine the position. This is done by using the known satellite positions and the times the signals require to travel from the satellites to the receivers. As the total travel time of the signal is only in the range of 0.1 seconds, highly accurate atomic clocks are installed on board the satellites.
In addition to the satellites there will be ground stations providing information to improve the positioning for users in many sectors such as transport (compare Map 1), search and rescue systems, and GIS-applications. The first satellite of the system (GIOVE-A) was launched in 2006, the system is planned to be in operation by 2010.

Map 6: Visualisaton of internet traffic flows between countries 1996

Satellite/Sensor: -
Acquisition Date: -
Band Combination: -
Map Information: network traffic intensity between nations.

Description: During the two last decades of the 20th century, parallel to the fast development of computer systems, the transfer of information between remote information systems increased massively. This was possible as a consequence of the development of the infrastructure (glass fibre networks, telecommunication satellites) and of the software (data transfer protocols, applications). The map shows the uneven distribution of internet traffic, which reflects the wealth of the nations. Interesting comparisons are possible with the global traffic map (Map 1), with the NO_2-distribution (Atlas p. 44/45) and with the population density map (Atlas p. 42/43).

Figure 7: Galileo satellites sending data

Figure 8: Precision farming with Galileo

Description: The applications of global positioning systems such as Galileo go far beyond determining the position of the receiver – sophisticated navigation systems that are integrated into more comprehensive systems e.g. for an exact control of fertilizer input and its effect (precision farming) or the possibility to transmit emergency calls from a Galileo receiver to an emergency response centre are among the manifold existing and upcoming applications.