Asia – Seasonal Changes, Water Utilisation – Aral Sea

The geographical situation of a continent on the globe, its topography, and the resulting climatic conditions with their seasonal variations of sunshine, temperatures and precipitation as well as the properties of the surrounding seas define the conditions for vegetation and human life.
This page provides information on Asia, comprising typical weather satellite images, precipitation maps and vegetation index maps in summer and winter. In the second part the focus is on the region between the Tjan San and the Caspian Sea, an arid area posing massive challenges for agriculture. The examples show the importance of the water household and the problems encountered as a result of man-made changes.
Purpose of the presented examples is

- to assess climatic peculiarities of the continent;
- to demonstrate seasonal differences and the reasons for them;
- to demonstrate the relationship between climate, water supply and vegetation;
- to show the potential and risks resulting from irrigation; and
- to assess the consequences for the distribution of the population.

Map Descriptions

Map 1a: Indian Ocean, Meteosat 5 image 31 December 2003
Satellite/Sensor: METEOSAT 5
Acquisition Date: 31.12.2003, 09.00 UTC
Band Combination: near natural colours
Map Information: -

Description: Northern and central Asia are covered by clouds. The high pressure cell over the Indian subcontinent results in low precipitation, while on the other hand the parts of southern Asia near the equator, which receive rain all the year, are cloud covered, like the regions with winter rain around Asia Minor and south-east China. An interesting detail of the Meteosat image is how clearly the Indus valley shows up.

Map 1b: Indian Ocean, Meteosat 5 image 30 June 2004
Satellite/Sensor: METEOSAT 5
Acquisition Date: 30.06.2004, 09.00 UTC
Band Combination: near natural colours
Map Information: -

Description: On the Indian subcontinent and in south-east Asia the rainy season is prevalent. Clouds cover most of India and the monsoon causes high precipitation. It is easy to see how the clouds of the monsoon are trapped by the mountain ridges surrounding Bangladesh in the east and north. They also define the ITC. The arid regions of the Arabian Peninsula and Iran also remain cloud-free in summer, and even at this scale reveal the major geological structures.

Map 2a: Average precipitation December to February
Satellite/Sensor: -
Acquisition Date: -
Band Combination: -
Map Information: quarterly precipitation, predominant wind directions, tropical storms, ITC.

Description: Due to the dimensions of the continent the climate of northern and central Asia is very varied. Polar zones are characteristic for the north, whereas an arid continental climate dominates central Asia. The south is under the influence of the monsoon.
In general, during winter the continent receives less precipitation. This is a consequence of the mainly westerly winds, which have already crossed Europe. An exception is made by Turkey along the coastline of the Mediterranean Sea, and parts of Syria and Iraq. Here the winter rainfall is a result of storm events in the Mediterranean Sea.
Higher precipitation occurs along the Himalayas and the Hindu Kush due to orography, and in the south-eastern part of India and in Sri Lanka because of tropical storms. Higher amounts of rainfall can also be found in the hilly regions north-east of Canton and in Japan. On the other side, the Qinghai-Tibet Plateau and Mongolia, the most continental parts of Asia, receive almost no precipitation.

Map 2b: Average precipitation June to August
Satellite/Sensor: -
Acquisition Date: -
Band Combination: -
Map Information: quarterly precipitation, predominant wind directions, tropical storms, ITC.

Description: During summer the southern part of the Asian continent is under the influence of the monsoon, which brings moist air from the Indian Ocean. This causes high precipitation, especially around the Bay of Bengal and along the southern slopes of the Himalayas, which are an insurmountable barrier to the monsoon. In the north-eastern parts of the continent easterly winds predominate, therefore almost the whole of Russia receives higher amounts of rainfall as well as large parts of China, which during this period (like the whole of south-east Asia) is also under the influence of tropical storms (typhoons).
Arid regions like the Taklamakan desert, the Gobi desert and the Gragum desert, can be recognised easily on the map. The deserts are surrounded by mountains and therefore are located in the area of the rain shadow. In addition, they are influenced by the continental climate. Air masses from the sea lose their moisture while travelling inland.

Map 3a: Vegetation – January 2004
Satellite/Sensor: SeaWIFS
Acquisition Date: January 2004
Band Combination: -
Map Information: NDVI (Normalised Difference Vegetation Index)

Description: Comparison of the vegetation cover, reflected by the NDVI, with the distribution of the precipitation and the temperature (Atlas page 36/37) shows the close correlation of these parameters. North of the polar circle no NDVI can be derived during the polar night in the winter season, as the NDVI uses the information in the red and the infrared reflection of sunlight. Large areas of the continent show no vegetation or low intensity of vegetation. Areas covered by snow are displayed in a brown colour, as are the desert regions. Vegetation can be found mainly in the tropical regions of India, south-east Asia and parts of China.

Map 3b: Vegetation – July
Satellite/Sensor: SeaWIFS
Acquisition Date: July 2004
Band Combination: -
Map Information: NDVI (Normalised Difference Vegetation Index)

Description: During the summer months the vegetation cover is relatively intense in northern Asia and in the coastal regions of China. The different tones of green enable one to distinguish between the tundra and the taiga regions in the north of the continent. Now parts of the central region, along the Tian San (Tien Shan) and Altai Mountains also show vegetation. The arid regions of the Qinghai-Tibet-Plateau, the Taklamakan and the Gobi desert have a low NDVI, as well as the Rub al Khali in Saudi Arabia and large parts of Iran.

Map 4a: Central Asia
Satellite/Sensor: SPOT Vegetation
Acquisition Date: summers 2000, 2001
Band Combination: near natural colour
Map Information: main geographical features.

Description: The map gives an overview of the topography of the region between the Caspian Sea and the Tian San in Central Asia. The region with the depressions around the Caspian and Aral seas is surrounded by high mountain ridges such as the Tian San, the Pamir and the Hindu Kush in the east and the Alborz and the Caucasus in the west.
Vegetated areas are restricted to the northern slopes of the Tian San, the Alborz Mountains and the Caucasus on one hand, and to the river valleys of the Amu Darya, Syr Darya and Volga (with their tributaries) on the other. The deserts, including Garagum and the areas south-east of the Aral Sea, cover a large part of the region. Along the Caucasus, south of the Caspian Sea and in parts of the Tian San mixed forests can be found. The green areas south and west of the Aral Sea and along the rivers are irrigated areas.
The endorheic Caspian Sea, at 371 000 km², is the world's largest fresh-water body. The Volga and the Ural rivers discharge into the lake. Where the Volga drains into the Caspian Sea a large inland delta has developed. A second endorheic lake, the Aral Sea, can be found in the east. The area of the Aral Sea is diminishing as water from its affluents is used for irrigation.

Map 4b: Land cover classification, Central Asia
Satellite/Sensor: based on SPOT Vegetation
Acquisition Date: summers 2000, 2001
Band Combination: pseudo colours
Map Information: main land use classes.

Description: The thematic map has been derived from the satellite image map and shows the major land use classes in Central Asia. Between the Caspian Sea and the Tian San mountains mainly deserts can be found, interrupted by smaller areas of flood irrigation. In the adjacent areas to the north and south of the desert area steppe can be seen. Forest occurs only in small patches across the Caucasus, south of the Caspian Sea and in the Tian San. Settlements are mostly restricted to irrigated areas and can be found e.g. in the Fergana valley at the foothills of the Tian San. It is interesting to note how the irrigated land follows the rivers (Amu Darya, Syr Darya). A third important line can be seen south of the Garagum, where the Garagum Canal has been built to irrigate the land. Around the Aral Sea and along the east coast of the Caspian Sea areas with high salinity are a visible sign of the problems of the region.

Maps 5a, 6a: Aral Sea 1964, 1973
Satellite/Sensor: ARGON, Landsat MSS
Acquisition Date: 21.08.1964, mosaic Summer 1973
Band Combination: 5a monochrome, 6a near natural colours
Map information: -

Description: The satellite image maps show the extension of the Aral Sea and the irrigated areas on its north-eastern coast in the years 1964 and 1973. The Aral Sea is a terminal lake in the Turanian Plain in Central Asia. It was the world's fourth largest lake until the 1960s, but had shrunk to less than half its original size by the year 2000. A large part of the water of the two affluents Amu Darya and Syr Darya was diverted for agriculture (irrigation of cotton fields and rice paddies) after 1960 in Afghanistan, Kazakhstan, Kyrgyzstan, Tajikistan, and Turkmenistan. As a consequence, the salinity of the Aral Sea more than tripled.
The environment of the area is also deteriorating due to the use of herbicides and pesticides. The drinking water in the area is contaminated with heavy metals, salts, organochlorine pesticides (DDT) and other toxic substances, which are causing considerable health problems.

Map 5b, 6b: Aral Sea 2000
Satellite/Sensor: SPOT Vegetation, Landsat ETM
Acquisition Date: summers 1999, 2000
Band Combination: near natural colours
Map Information:-

Description: The image shows the extent of the Aral Sea in the year 2000. The retreat of the waterline mainly happened at the flatter eastern shore. The northern part is now detached from the rest of the lake. The former island in the centre has now become a peninsula. At the same time the area of the irrigated land has increased slightly. Along the coast, saline sludge areas are visible.
As the lake shrinks the climate of the region has been changing. The area is now experiencing a more continental climate than before. The summers are shorter and hotter, and the winters are longer and colder, with less precipitation all over the year, thus leading to a shorter growing season. Dust storms are scattering more than 75 million tons of salt and dust per year, mainly towards the north-west. The ongoing desertification of the land is a huge problem for the population.

Map 6c: Change Detection of Aral Sea between 1973 and 2000
Satellite/Sensor: based on Landsat MSS and TM
Acquisition Date: summers 1973, 2000
Band Combination: pseudo colours
Map Information: land cover change classification.

Description: The change classification map, which has been derived from the satellite image maps of 1973 and 2000 respectively, highlights the massive changes following the water level reduction of about 20 metres within these 27 years. The area covered by the lake has diminished significantly, making way for the expansion of semi-deserts and salt flats. Irrigated areas have increased only slightly.