**Cover–MODIS image of the Middle East**

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The Moderate Resolution Imaging Spectroradiometer (MODIS) instrument was launched on the Terra platform on 18 December 1999. It was designed to observe and monitor the surface of the Earth, ocean color, and the atmosphere. The spatial resolution of MODIS products varies with respect to the application between 250, 500, and 1000 m, with a near daily global coverage. MODIS provides a new and improved capability for terrestrial satellite remote sensing aimed at meeting the needs of global change research. In particular, analysis of land-cover and land-use changes will benefit from MODIS data available.

The cover image (figure 1) shows a true colour composite made from the MODIS data acquired on 10 September 2000. The image was produced by combining data from the red (250 m, 620–670 nm), green (500 m, 545–565 nm), and blue (500 m, 459–479 nm) MODIS wavebands. The image covers a large portion of the Middle East, including Egypt (Western and Eastern Deserts and the Sinai Peninsula), Israel, Jordan, Lebanon, as well as parts of Saudi Arabia, Iraq, and Syria. The most remarkable features of this image are the verdant vegetation of the Nile Valley, the Al Fayyum depression, and the Nile Delta, all in stark contrast with the surrounding arid lands and the precursor of the Nile.

The precursor of the present day Nile evolved during late Miocene times as one of the events of the Miocene Messinian episode along the south-eastern margin of the

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Figure 1. A true colour composite made from the MODIS data acquired on 10 September 2000. The image was produced by combining data from the red (250 m, 620–670 nm), green (250 m, 459–479 nm), and blue (500 m, 459–479 nm) MODIS wavebands.

Mediterranean Sea. This pre-Nile flowed out over a broad alluvial plain of braided streams depositing mainly carbonate rich sediments, sand and sabkha mud west of the present day Nile. Tectonic events during the late Pleistocene led to a north-east tilting of the area and a migration of the Nile channel to its present day location. Progradation continued into the Holocene with the lowering of sea level and rapid influx of sediment to give the present morphology of the delta, the triangular dark area on the image. The precursor Nile delta is seen as the large brown triangular area, with NW–SE longitudinal dunes, west of the Nile and an apex meeting a Nile bend some 275 km south of Cairo.

The current Nile River is the longest river in the world. It is 6500 km long and drains an area of 287 million km$^2$. It rises in central Africa and flows northwards to the Mediterranean discharging 84 billion m$^3$ per year. Prior to the construction of the Aswan High Dam in 1964, in Upper Egypt, the Nile carried 120 to 140 million tons of sediments per year. The delta front progressed seawards at an average rate of 15 m yr$^{-1}$. This was the main source of sediment in the circulation cell of the south-eastern Mediterranean. Following completion of the dam, most of the sediment is trapped in the reservoir. Consequently, sediment transportation has decreased significantly to about 2 million tons per year. Since then the delta front has undergone major erosion of about 200 m yr$^{-1}$.

The dominant wind direction in this region is north-west. These winds force water and sediment to move from the delta region eastwards. Additionally, the geostrophic circum-Mediterranean anti-clockwise gyre is an effective mechanism in
the eastward transport of Nile sediments. The estimated longshore sediment transport ranges from 2 million tons per year east of the delta to less than 80,000 tons per year along the northern coast of Israel. Thus, sediment deposition east of the Nile delta has led to the development of the relatively wide continental shelf of Sinai (42–50 km) and the narrower Israeli shelf (10–26 km) (Karnieli et al. 1993, Mayo et al. 1993). The MODIS true colour composite shows these offshore sediments in green hues north of the Nile delta and along the Sinai and Israeli coasts.

The Nile sediments are the source material of the sand fields in northern Sinai and the north-western Negev. Although the sand field of the Negev represents the eastern extension of the Sinai fields from the geomorphological and lithological points of view, the area is artificially divided by the political borderline. The borderline is characterized by a sharp contrast, higher reflectance values (brighter) on the Egyptian side and lower reflectance (darker) on the Israeli side. The traditional and popular explanation asserts that the contrast is mainly due to severe anthropogenic impact of the Sinai Bedouin—especially overgrazing by their black goat and sheep herds, as well as gathering of plants for firewood. On the other hand, a new theory that was recently proposed by Karnieli and Tsoar (1995) and Tsoar and Karnieli (1996) suggests that the contrast is not a direct result of severe overgrazing of higher vegetation but is caused by an almost complete cover of soil biological crust, consisting of cyanobacteria, algae, lichens, and mosses, in the Israeli side while human and animal activities prevent accumulation of these crusts, or trample any existing crusts, in the Egyptian side.

The image demonstrates the potential contribution of MODIS to studying land-cover and land-use change on a regional scale to complement more refined local-scale analyses with Landsat. One of the largest human dimension questions involves around allocation of water among the interested and competing elements: ecosystems, agriculture, urban, range lands. Understanding how decisions on water allocation and use translate to measurable impacts at the landscape level and ultimately to the regional and global scale is an important question for the next 50 years. Remote sensing tools, such as MODIS, will help in studying these impacts.

For additional MODIS images see http://ltpwww.gsfc.nasa.gov/MODIS/MODIS.html

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References

