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Landscape Changes in the Middle East: A regional assessment using remote sensing

IDS project (NAG5-9316)

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Project Homepage: http://www.yale.edu/ceo/projects/swap.html

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Abstract: The Middle East landscape has a long history of human disturbance, yet the pace of this disturbance is accelerating today due population growth and international economic factors. Interannual climate fluctuation also plays a key role. These changes include expansion of both irrigated and rainfed agriculture, urban growth and increased grazing pressure in the steppe. In this study, we try to monitor these landscape changes and identify causal factors. Remote sensing plays a key role in our work as the spatial scales are large and access to conventional data is limited.

Keywords:

Research field: remote sensing, hydrology, climate, socio-economic factors, land use, land cover

Remote sensing: Landsat, IKONO, MODIS, MISR, AVHRR

Methods and Scales: Land cover change, BRDF, hydrologic and climate modeling, hyperspectral methods, crop yield, farming patterns

Scientific questions:

a) What are the changes in LCLU? (50% of current effort)

Our project is trying to evaluate the effectiveness of existing (Landsat, AVHRR) and new (MODIS, MISR, IKONOS, ASTER) satellite imagery for monitoring Middle East landscape change. We attempt to quantify:

- grazing pressure on desert shrub density
- crop yield
- soil degradation
- patterns of human migration, new plantations, settlements and roads
- sensitivity of grasses and crops to interannual climate fluctuation

b) Causes of LCLUC (30% of current effort)

- Interannual climate fluctuation using nested regional climate models
- Response to economic and regulatory changes: e.g. restrictions on barley farming in the Steppe and cotton farming with small wells
- Increased mobility of Bedouin sheep herds with trucks and water tanks

c) Consequences of LCLUC (20% of effort)

- Reduced river flow from upriver irrigation
- Wind erosion
- Salinization
- Reduced shrub density

Accomplishments of the first year:

1) Working with ICARDA, we have designed and run a six-month monitoring program in northern Syria measuring soil and ecosystems variables along with hyperspectral reflectances during the growing period. Six sites were monitored every two weeks. Multi-angle reflectance measurements are included. Landsat, IKONOS, MODIS and MISR images have been gather for this period.
2) We have extended our previous work relating inter-annual rainfall fluctuations to NDVI in the steppe. New data from a dense Syrian climate station network has been analyzed along with 20 years of NDVI data.
3) We have analyzed hyperspectral and crop yield data taken in 1999 at the ICARDA farms in Aleppo. These data allow us to develop regression curves for crop yield and investigate the information content of various narrow band vegetation indices. This work is being extended with IKONOS images.
4) We have extended our development of a 5-km gridded hydrology model of the Middle East with special attention to the Euphrates and Tigris watersheds. Climate sensitivity analyses have now been completed for each basin and sub-basin. The timing of spring run-off is quite sensitive to temperature change. Small tributaries at lower altitudes are especially sensitive to climate change.
5) A six month effort to evaluate new data from MODIS and MISR is still underway. Numerous problems have been encountered. Cloud removal and image compositing need improvement in these products. We have been exchanging ideas with others in the remote sensing community. We have also evaluated IKONOS products for use in multi-scale land cover analysis. R.Geerken presented this work at the NASA IKONOS Workshop in Virginia in March 2001.
6) From several ground truth expeditions, we have developed a georeferenced photographic database for Syria. This is being used to evaluate land cover analyses based on satellite imagery. New statistical clustering methods are being used to improve the land cover analysis.
7) Substantial progress on regional climate modeling has been made. Two 3-year mesoscale runs have been completed using RegCM2 at two different spatial resolutions (40 and 25km). The period for these runs is 1989 to 1991. The precipitation from these runs is being compared against five data sets: a 20-year climatology, satellite derived snow cover, satellite derived vegetation cover, 20-year 10-day precipitation maps, daily data from six special stations. Water budgets and sources for precipitation events have been analyzed. When verified, this model will be used for climate change analysis. A surprising result is the role that evaporated water from the Persian Gulf plays in the Tigris watershed precipitation and run-off.