Multi-temporal land cover analysis of the south-central Anatolian landscape: Remote sensing as a support tool for studying carbon, water, biogeochemical cycling and landscape changes

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Project Overview and Goals

- Study the impacts of recent agricultural intensification in southern Turkey on soil organic carbon (SOC), nitrogen (N), hydrology at the landscape scale
- Characterize landscape as a combination of human land management—physical environmental condition (HLMPC) "sets"
- Link regional-scale, remote-sensing-based analysis of agricultural and steppe regions with field-scale data on soil organic carbon, irrigation, drainage structures
- Share insights on relationships between biogeochemistry, hydrology and land use with farmers, land managers, regional and global biogeochemical and hydrological modelers

Research questions

- How do SOC and nitrogen vary across agricultural and steppe landscapes and soil types in south-central Anatolia?
- Is SOC and N significantly different between agricultural (irrigated, non-irrigated) and steppe lands?
- Is soil type or land use more strongly associated with observed SOC and N?
- Variability of SOC, N among HPLMC sets: from a biogeochemical standpoint, what places/practices are best suited for sustainable agricultural intensification?

Agricultural intensification in Turkey 1970-present

- Irrigated farmland, fertilizer use and population have more than doubled over the last 40 years while the overall area of arable land has increased only 11% (Evrendilek and Ertekin 2002)
- Land degradation due to soil erosion, salinity and mismanagement affects over 50% of the country’s farmland every year (Cangir et al. 2000)
- Managing agricultural lands for SOC, N conservation may reduce fertilizer costs for farmers, maintain aggregate stability and infiltrability in soils (Brady 2002)
- Possible benefits for carbon sequestration—though this is debated in the literature (e.g. Lal 2002, Post and Kwon 2000)

Framework for a multi-temporal land cover analysis

1. Collect LANDSAT TM, ETM+ imagery
2. Training site selection from multi-date image stacks
3. Classification: Experimentation with Machine-Learning and SVM algorithms
4. GIS-based analysis of land cover/use, physical and social variables for optimum selection of soil sampling sites

Assessing preliminary results

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Multi-temporal land cover analysis challenges

- Choosing vegetation indices, data reduction methods improve classifications
- Maximizing user accuracy for land cover maps
- Differentiating irrigated versus non-irrigated crops reliably: do trends in phenology correspond with irrigation status?
- Differentiating areas of forest and forest re-growth from orchards along riverbanks
- Bright steppe: sand dunes, salt flats, or highly eroding regions? Significance for our analysis?
- Factoring changes in fertilizer use and cultivation practice into our analysis: asking good questions while doing fieldwork

Impacts of agricultural intensification on soils, ecosystems

- Cultivation and human land use affects all five soil formation factors (the CLORPTs):
- Climate: larger/altered soil seasonal temperature cycles, altered moisture regimes
- Organisms: changes in ecological conditions, species introductions/pests
- Relief: expansion of agriculture over steep topography can involve leveling, changing impacts on erosion
- Parent material: differential effects by location based on native soil textures, structures, underlying geology
- Time: "natural" rates of weathering, other processes greatly altered (often accelerated)

Ongoing and future work

- Complete independent accuracy assessment of current maps
- Translation of Turkish soil GIS information, further research on local soils, underlying geology
- Change-detection analysis for expansion of agricultural regions since late 1980s to inform soil sampling, study of relationships between expansion, irrigation and fallow land coverage
- Field work, Summer 2010
- Ground-truth accuracy assessments of SVM, decision-tree land cover maps
- Soil sampling
- Talking with local farmers and managers about history, current practices, and challenges to sustainable land use
- Integrate results with studies of grain-scale soil physics and regional-global scale hydrological and biogeochemical models.