Assessing future stability of US High Plains land-cover: integration of process modeling with Landsat, *in situ* modern and paleoclimatic data

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Year One Progress Report

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The first year of work on the NASA LCLUC project "Assessing future stability of US High Plains land-cover: integration of process modeling with Landsat, *in situ* modern and paleoclimatic data," has gone well on multiple fronts. Progress is summarized below by focus.

1. Arc/Info GIS database developed for US High Plains LCLUC research. This GIS work will form a central tool of our research, providing basic data for site selection, characterization and modeling. Data ingested in YR1 include AVHRR 1km land cover data, instrumental climate data (temperature, precipitation and drought related), soil data, river data, lake data, topography and agricultural land-use data. Landsat scene boundaries were also ingested. Efforts have begun to incorporate information on paleoclimatic, paleovegetational, and paleoeolian change, as well as to investigate other data that can be used to improve land-cover/biogeochemical modeling.

2. Selection of primary Landsat-based study sites. The US High Plains LCLUC GIS first application was to explore the High Plains region for the best areas for intensive Landsat remote sensing and modeling. Criteria for site selection included: (1) presence of sand dunes that were active in the present interglacial (e.g., in the last 1200 years), (2) presence of a clear climatic gradient, from moist to dry, (3) a diversity of land-cover, (4) a record of at least two anomalously dry and two anomalously wet years (summers) since the launch of Landsat 5, (5) availability of low-cloud Landsat scenes from the EROS Data Center, and (6) proximity to existing paleoenvironmental records and/or promising sites for paleoenvironmental reconstruction. Our survey of potential sites meeting all these criteria revealed that Landsat scene availability was the most limiting factor. However, we were able to find two sites that fit our criteria : (1) a two-scene, predominantly grassland, east-west transect across the Nebraska Sand Hills and (2) a two-scene east-west transect in SW Texas that includes both grassland and woody-plant landcover types.

Our strategy is to develop a linked/verified Landsat-model-data land cover change assessment capability for each of the two study areas. We then should be able to extend our assessement strategy to the rest of the High Plains using the Landsat scene library being compiled by Dr. A. Goetz for his MTPE effort "Land and Land-Use Change in the Climate Sensitive High Plains: An automated Approach with Landsat."

3. Ordering of Landsat imagery. The purchase of thirty-nine Landsat scenes was approved by C. Justice as part of the NASA LCLUC data buy, and have been ordered from the EROS Data Center. These will be combined with scenes already in hand for our LCLUC investigation.

4. Paleoenvironmental linkages. An important component of our work is to define and understand the full range of climate variability on the High Plains, particularly with

respect to drought and eolian land-cover change. We will then work to ensure that our Landsat and model-based land-cover change assessment methods are able to handle this full range of environmental variability. The first step to defining the full range of High Plains environmental variability was to carry out a comprehensive literature review of all existing paleoenvironmental records for in and around the High Plains. Despite a sparsity of existing data, our review revealed a surprisingly coherent picture of past change. Our results, now submitted for publication in the Bulletin of the American Meteorlogical Society (Woodhouse and Overpeck, 1998), make it clear that the droughts of the 20th century, including those of the 1930s and 1950s, were eclipsed several times by droughts earlier in the last 2000 years, and as recently as the late 16th century. In general, some droughts prior to 1600 appear to have been characterized by multidecadal duration and greater spatial extent of the 20th century. Clearly, this range of variability must be accounted for in any climate-induced land-cover change assessment program.

In addition to our comprehensive review, we (R. Webb) have also organized a paleoenvironmental session at the upcoming June GEWEX Continental-scale International Project (GCIP) Mississippi River Climate Conference. We plan to follow up this small gathering of paleo-scientists with a larger workshop in Boulder, CO designed to define and answer the most critical land-cover related palenvironmental questions on the High Plains. This workshop will be coupled with our funded paleoenvironmental data acquisition program to have the best possible paleoenvironmental framework possible for building and testing our land-cover assessment methods.

5. Land-cover/ecosystem modeling. The CENTURY Ecosystem model has been run for the two selected study sites (see #2 above). The first non-control experiments utilized instrumental climate data for the period 1920-1989, and provide time series perspectives of ecosystem change for that period through both major dry and wet periods. Sensitivity experiments have also been made to investigate the roles of grazing and early-season plant die-off. All experiments to date are for one type of edaphic (e.g., soil) characteristics. These runs are being analyzed and will set the stage for realistic transect experiments once the Landsat data are converted to land-cover data.

The stage has also been set for paleoclimate land-cover model validation experiments. Climate model diagnostics for a 6000 years B.P. (before present) experiment, and are being used to drive CENTURY simulations of the much drier mid-Holocene landscape.

Although our primary focus is on using CENTURY, we have also made plans with Drs. John Foley and Colin Prentice to perform model comparisons with the IBIS and BIOME3 models.

6. Project Coordination and Outreach. Linkages with the land-use stake-holders (i.e., decision- and policy-makers) has be pursued primarily via the building of linkages with other integrated assessment efforts in the High Plains and Rocky Mountain Front Range regions. We participated in the Southwest Regional Climate Change Symposium, September 3, 1997, in Tucson, Arizona. Focused on an assessment of the regional impact and vulnerabilities of climate and global change, this meeting provided contacts while serving as forum for the exchange of information between science programs and representatives from government, ranching & agriculture, water management, fish & wildlife management, forestry, mining, energy production, and non-governmental organizations. Starting with initial planning meetings, we have also been involved in the development of a joint University of Colorado-NOAA 'Water in the West' research and regional assessment initiative that will directly complement our research in the High Plains. We have also begun preliminary discussions with Dr. Dennis Ojima (Colorado State University) on how our research can be integrated with other efforts as part of future assessments of the regional impact and vulnerabilities of climate and global change in the High Plains.

7. Publications/presentations.

Webb, R.S , R. Healy, J.T Overpeck and D.H Rind (1998). Simulations of the Central North American Climate 6000 YR B.P. Using NASA/GISS Climate Model Version 2 and 2'. GEWEX Continental-scale International Project (GCIP) Mississippi River Climate Conference, June 8-12, 1998, St. Louis, Missouri

Woodhouse, C.A. and J.T. Overpeck, (1998). 2000 years of drought variability in the Central United States. ***Bulletin of the American Meteorological Society*** (submitted).

Woodhouse, C. and J. Overpeck (1998). A 2000-year multiproxy record of drought in the Central United States. GEWEX Continental-scale International Project (GCIP) Mississippi River Climate Conference, June 8-12, 1998, St. Louis, Missouri