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IMPLEMENTATION UPDATE

Assessing the benefits of grazing land conservation practices

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The Conservation Effects Assessment Project (CEAP) component aimed at assessing conservation on grazing lands was initiated in 2006.

"Grazing land" is a collective term used by the USDA Natural Resources Conservation Service (NRCS) for rangeland, pastureland, grazed forestland, native and naturalized pasture, hayland, and grazed cropland (figure 1). Although grazing is generally a predominant use on grazing lands, the term is applied independently of any actual use for grazing. Grazing land is also described as land used primarily for production of forage plants maintained or manipulated primarily through grazing management. It includes all lands having plants harvestable by grazing without reference to land tenure, other land uses, management, or treatment practices.

Rangelands comprise approximately 40% of the landmass of the United States, including nearly 80% of the lands of the western states. Much of the rangelands in the west are sparsely populated, and conditions on that land are not well documented over extensive areas. Rangelands provide valuable grazing lands for livestock and wildlife and serve as a source of high quality water, clean air, and open spaces for the benefit of both society and nature. While rangelands occur in every region of the North American continent, they are the dominant land type in arid and semiarid regions. Some of the primary conservation practices implemented on rangelands include prescribed grazing, invasive species control, fire management, brush management, upland habitat management, fencing, water distribution, range seeding, and riparian management. These conservation practices are designed to reduce losses of soil, nutrients, pesticides, pathogens, and other biological and chemical materials from rangelands, conserve natural resources, and enhance the quality of ecosystems and wildlife habitat.

The environmental benefits of grazing lands conservation practices have not previously been quantified at a national scale. Moreover, while a limited body of literature exists on the effects of conservation practices at the field level, there are few research studies designed to measure the cumulative effects at watershed scales.

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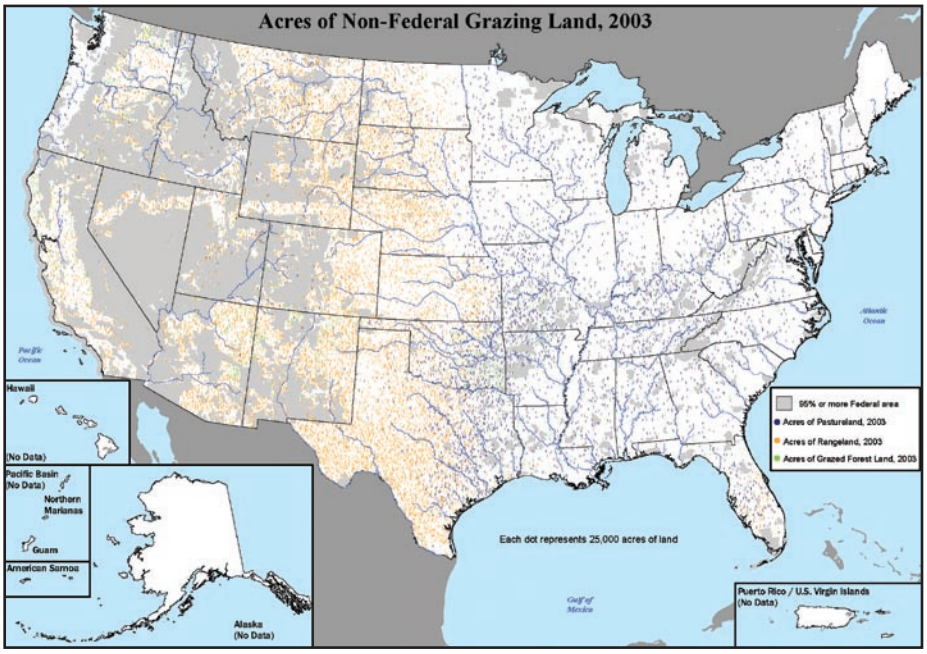
Figure 1

Areas of nonfederal grazing land in the United States.



Source: 2003 National Resources Inventory.

CEAP GRAZING LAND STRATEGY

The USDA strategy for the CEAP Grazing Land national assessment encompasses a five-part process:

1. ***National Assessment.*** The CEAP Grazing Land national assessment will include national summary estimates of conservation practice benefits and an assessment of the potential for USDA conservation programs and technical assistance to meet the nation's environmental and conservation goals.
2. ***Watershed Assessment Studies.*** Basic research on conservation practices in selected watersheds nationwide will provide a framework for evaluating and improving performance of national assessment models.
3. ***Bibliographies.*** Current literature on what is known and not known about the environmental benefits of conservation practices and programs has been assembled and is electronically available in a publication from the USDA National Agricultural

Library. In addition, dynamic bibliographies using real-time searches in the National Agricultural Library catalog (AGRICOLA) on publications relating to environmental effects of conservation practices on grazing lands are available to the public (USDA National Agricultural Library 2007).

4. ***Literature Review/Synthesis.*** A current literature synthesis is underway by the Society of Range Management in partnership with USDA to describe what is known about the environmental effects of NRCS grazing lands conservation practices at the field, hillslope, and watershed scale and is scheduled for publication in 2010.
5. ***Technology Transfer and Outreach.*** Special symposia and conferences will be organized and conducted in association with professional societies to gather technical material and results from recent research that can be used to improve the scientific knowledge base for making decisions on which conservation practices are most efficient at achieving specific environmental benefits.

The principal grazing lands resource concerns that CEAP plans to evaluate are (1) plant community status, condition, and dynamics; (2) water quality (nutrients, pathogens, and sediment delivery to lakes, rivers, and streams); (3) soil quality (including soil erosion and carbon storage); (4) water conservation (flood and drought protection); and (5) wildlife habitat.

The initial USDA Agricultural Research Service (ARS) focus will be on Intermountain shrub- and grass-dominated rangelands, followed by efforts on Eastern pastures and the Central Plains over the next five years. This article focuses on the Intermountain aspects of the ARS CEAP Grazing Lands Assessment.

NRCS and the USDA Cooperative State Research, Education, and Extension Service (CSREES) are collaborating under the assumption that funds will be available over the next several years to support competitive funding for CEAP Grazing Land watershed projects. CSREES seeks to fund projects that evaluate the effects of grazing land conservation practices, especially with respect to understanding how the suite of conservation practices, the timing of these activities, and the spatial distribution of these practices throughout a watershed influence their effectiveness for achieving locally defined watershed health goals. Through the CEAP Grazing Land projects, CSREES intends to (1) address what we know about the impact on the hydrologic cycle from the application of conservation practices on grazing lands and (2) fill knowledge gaps about the impact of grazing practices on watershed health that may include soil quality, plant communities and dynamics, and impacts on ecosystem services at the landscape scale. The CSREES research program will sponsor a collection of watershed case studies that will explicitly investigate the linkages among a variety of conservation and land management practices as implemented over space and time on grazing lands and their resultant effects on watershed health. Developing these linkages will allow for a synthesis of common principles and lessons learned across the United States.

RANGELAND HYDROLOGY AND EROSION MODEL (RHEM) FOR SOIL EROSION ON RANGELANDS

A new process-based model is under development by ARS for assessing soil erosion rates on rangelands. The Rangeland Hydrology and Erosion Model (RHEM) is being developed based exclusively on data collected from rangeland erosion experiments and is designed to use data that are routinely collected by range managers. RHEM will be used to calculate runoff and erosion at the site scale. Efforts are currently underway to apply RHEM to NRCS National Resource Inventory sampling sites. NRCS collects site-scale inventory data on a routine basis, and there are approximately 17,000 rangeland sites in the United States for which data have been collected and may be applicable for CEAP efforts. Once the protocol for using the National Resource Inventory data is established and current erosion rates are estimated on as many sites as possible, the intention is to use remotely sensed information to spatially expand the site-scale information to produce regional and national estimates of the condition of private rangelands. Current methods are in place to estimate vegetation cover using remotely sensed data, and methods are being jointly developed by USDA and the National Aeronautics and Space Administration to use that information to inform the soil erosion models for these regional and national assessments.

Source terms for RHEM are based on rangeland data, which models splash and sheet flow effects as the dominant process on undisturbed natural grasslands. The unit scale for splash and sheet erosion is the rainfall simulator plot, which is larger than the unit scale of interrill areas in cropland environments. This was done to incorporate the scale of rangeland heterogeneity and complexity associated with the larger complex vegetation patterns on most rangeland sites. RHEM models concentrated flow erosion, which is active on degraded shrublands and disturbed lands (e.g., those sites having been exposed to overgrazing, wildfire, and drought). An important aspect of the model relative to rangeland application by rangeland managers is that RHEM is parameterized based on plant growth form classification using the data that are typically collected for rangeland management purposes (e.g., National Resource Inventory and rangeland health assessments). RHEM will be implemented and available in an interactive, Web-based form by December 2009.

Rainfall simulation experiments are planned for selected US Geologic Survey eight-digit hydrologic unit code scale drainage basins in Arizona, Nevada, and Idaho for the purpose of collecting data to evaluate models and methods relative to achieving CEAP goals. Experiments will focus on the evaluation of hydrologic and sediment response of states

within designated ecological sites, which are defined as "a distinctive kind of land with specific characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation." Ecological sites are the planning units through which NRCS recommends management decisions. For example, recommended levels of grazing will be dependent upon ecological sites, varying as a function of site resistance (stability relative to stressors such as drought, invasive weeds, and time since last wildfire) and resiliency (ability to recover). Each ecological site may have multiple states depending upon how the site has been changed by various stressors or management practices, which include such things as grazing, drought, rangeland renovation and seeding, brush encroachment or control, and invasive species.

Important characteristics on an ecological site include soil, slope, aspect, and annual precipitation regime. Preliminary results in Arizona (major land resource area 41-3 for a loamy upland 12-16 inch precipitation zone) show that the difference in saturated hydrologic conductivity and soil erosion rates can be documented between alternative stable states within ecological sites. These differences can be described by the variation in plant life form and corresponding changes in canopy and ground cover, which in turn can be used to parameterize the RHEM model. Using this approach, it is possible to quantify the impact of conservation practices that directly impact vegetation and the corresponding impact/benefit it would have on surface hydrologic process and soil erosion rates of the site.

WATER INDUCED SOIL EROSION, MANAGEMENT, AND NATURAL SYSTEMS (WISEMANS) MODEL FOR PLANT GROWTH AND HILLSLOPES

A team of ARS, National Aeronautics and Space Administration, and NRCS scientists has begun the task of modifying and adapting an existing plant growth model (ALMANAC) for use in estimating the impact/benefit of conservation practices for plant community associations.

The primary function of the revised ALMANAC model is to provide the required biophysical output (i.e., canopy cover, plant height, standing biomass, root distribution and mass, ground cover, and percentages of functional plant groups) to estimate soil and water quality and wildlife habitat with other component models being developed as part of CEAP.

The modified ALMANAC model will be used to estimate plant community response to climate and management (with and without deployment of conservation practices) (Kiniry et al. 1992). The model is being adapted to simulate inter- and intra-species competition on rangelands. This model will focus on developing a functional plant group approach where classes such as short grass, mixed grass, tall grass, annual grass, shrubs, trees, and forbs can be simulated on a single ecological site.

The modeling team will also develop the technology to simulate the temporal and spatial impact of the following conservation practices: prescribed grazing, prescribed fire, brush management, range seeding, invasive species control practices, riparian management and the associated affiliated practices such as fencing, water development, and placement of supplements as defined in the NRCS *Electronic Field Office Technology Guide*.

This new tool will be called the Water Induced Soil Erosion, Management, and Natural Systems (WISEMANS) decision support system. Full model documentation, relevant peer reviewed publications, and the software are available (USDA ARS 2008).

The WISEMANS model will be incorporated into both the Kinematic Runoff and Erosion (KINEROS) watershed-scale model and the Soil and Water Assessment Tool (SWAT) basin-scale model in order to conduct eight-digit hydrologic unit code level analyses across the West, similar to the assessments that have been done on croplands.

This will provide three scales of evaluation of conservation practices: hillslope with WISEMANS; small watershed scale with the KINEROS model (Smith et al. 1995), and river basin scale with SWAT.

KINEMATIC RUNOFF AND EROSION (KINEROS) MODEL FOR SMALL WATERSHED SCALE

KINEROS is a physically based model describing the processes of interception, infiltration, surface runoff, and soil erosion from small agricultural and urban watersheds. KINEROS may be used to determine the effects of various artificial features such as buffer strips, urban developments, small detention reservoirs, or lined channels on flood hydrographs and sediment yield.

In KINEROS, the watershed is represented by a cascade of overland flow planes and channels; the partial differential equations describing overland flow, channel flow, and sediment transport are solved by finite difference techniques. The spatial variation of rainfall, runoff, and erosion parameters can be accommodated.

SOIL AND WATER ASSESSMENT TOOL (SWAT) FOR RIVER BASIN SCALE

The SWAT model (Gassman et al. 2007) will be used to evaluate the impact of conservation practices at the river basin scale. SWAT is a river basin scale model that operates on a daily time step and is designed to predict the impact of management on water, sediment, and agricultural chemical yields in ungauged watersheds.

In SWAT, the watershed is divided into multiple subwatersheds, which are then further subdivided into hydrologic response units that consist of homogeneous land use, management, and soil characteristics. The hydrologic response units represent percentages of the subwatershed area and are not geospatially referenced within a SWAT simulation. Alternatively, a watershed can be subdivided into only subwatersheds that are characterized by dominant land use, soil type, and management.

PROJECTED BENEFITS

CEAP will develop approaches, methodologies, and databases to produce scientifically credible estimates of environmental benefits/impacts of conservation on grazing lands. Project findings and results will be used to report progress on the environmental effects of these programs, aid discussions on conservation policy development, guide conservation program implementation, and ultimately help farmers and ranchers make informed conservation choices based on sound science.

Anticipated products and impact of the of the CEAP Grazing Lands work include (1) the development of new site-specific risk assessment tools specifically designed and validated for use on rangelands (e.g., RHEM and ALMANAC/WISEMAN models); (2) a comprehensive literature review and synthesis document for use by rangeland managers; (3) determination of the status and extent of private Western rangelands; (4) development of a database for national, regional, and local assessments; (5) documentation of management practices currently in place; and (6) a better understanding of the on-site and off-site benefits and impacts of Grazing Land practices in place.

Additional benefits may include (1) better invasive species management based on the ability to use remote sensing to detect new outbreaks; (2) a better understanding of the impact of natural hazards such as wildfire and drought on range condition, and ability to use precipitation, soil moisture, and temperature to predict fire and drought risk; (3) a better understanding of ecological sites through a scientific assessment and documentation of hydrologic and soil erosion differences as a function of states within ecological sites, improved linkages among hydrologic outcomes, vegetative states, and wildlife habitat implications in response to disturbance; and (4) an advanced scientific understanding of basic processes and rates of soil erosion across scales.

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