Carbon Sequestration Potential in New Mexico Rangelands

Jay Angerer [1], Joel Brown[1], Robert Blaisdell [1], and Jerry Stuth[1]
[1] Dept. Rangeland Ecology and Management, Texas A&M University,
[2] USDA Natural Resources Conservation Service, Jornada Experimental Range

1.0 Introduction

The movement of carbon from the atmosphere and storage in the soil and vegetation (sequestration) is a contribution that agriculture and forestry can make to mitigate the greenhouse effect. Although the process of sequestration is relatively well understood by scientists and land managers, a systematic approach to prioritizing carbon sequestration activities is lacking, especially in the arid and semi-arid west. A regional characterization of carbon sequestration potential is needed so that government incentive programs can be targeted where impacts would be greatest. As part of the work conducted by the Southwest Regional Partnership on Carbon Sequestration, we conducted a study to assess land areas that could be viable for terrestrial carbon sequestration programs. Our objectives were to: (1) develop a GIS framework to identify areas where carbon sequestration programs would have the greatest potential to sequester carbon based on soil, climate, land tenure, and land cover information, and (2) estimate the amount of carbon that could be sequestered under various federal conservation programs on the areas identified in the GIS analysis.

2.0 Methods

The Southwest Regional Partnership encompasses the states of Arizona, Colorado, Oklahoma, New Mexico, Utah, and portions of Kansas, Nebraska, Texas, and Wyoming (Figure 1). We developed a framework for the regional assessment of sequestration potential that had two distinct phases (Figure 2). The first phase involved the use of climate, soil, land tenure, land cover, and major land resource area GIS coverages to define areas having greatest potential for implementing carbon sequestration programs. Once these areas were identified, the second phase involved the use of the COMET VR model to assess the amount of carbon that would be sequestered under programs available for the region (Figure 2). The analyses reported here focus on New Mexico.

2.1. GIS Phase

For this phase, the various data layers were acquired and the data were classified into categories of potential to allow for spatial indexing. To assess climate potential, the long term average precipitation (Spatial Climate Analysis Service, Oregon State University, http://www.ocs.oregonstate.edu/prism/) was used and was classified as follows: No Potential (0 to13 cm), Low Potential (13 to 23 cm), Moderate Potential (23 to 46 cm) and High Potential (>46 cm). For land tenure, the federal and Indian lands spatial coverage was acquired from the national atlas website (www.nationalatlas.gov). Land areas were classified as Federal, Indian reservations, and Private/Non-Federal lands. The analysis was limited to Private/Non-Federal land and Indian reservations, since incentive programs will not be implemented on Federal Lands.

Figure 1. Study area for the Southwest Regional Partnership assessment of terrestrial carbon sequestration potential.

Soils were classified based on three characteristics that influence soil carbon. These were Soil Organic Carbon (SOC), Calcium Carbonate (CaCO3), and Wind Erodibility Index (WEI). The data layers used were acquired from the NRCS SSURGO and STATSGO soil databases. The SSURGO data (higher resolution) were used where available. STATSGO was used to fill in areas not covered by SSURGO. SOC was classified for indexing as follows: Low (0 to 0.75%), Moderate (0.75 to 1.75%), High (1.76 to 10%) and Very High (>10%). CaCO3 content was classified as follows: Low (0 to 15%), Moderate (15 to 30%) and High (>30%). The WEI was indexed as follows: Low (0 to 100 t/ha/yr), Moderate (100 to 200 t/ha/yr) and High (> 200 t/ha/yr).

The climate, land tenure, and soil data layers were intersected in the GIS to create a coverage that would allow spatial queries based on these attributes. Boundaries of interest (Major Land Resource Areas [MLRA], and counties) were also included in the GIS to allow aggregation. After spatial queries were conducted to assess site potential, the Nation Land Cover Data (NLCD, http://landcover.usgs.gov) was used to determine land cover for these areas. NLCD is a 21-class land cover classification scheme applied consistently over the US. The data were reclassified into 4 major classes to reflect land cover types where government programs could be implemented: Grazinglands, Row Crops, Small Grains, and Forests. The acreage of each land cover type, along with pertinent soil information and MLRA, were exported from the GIS for use in the COMET VR model.

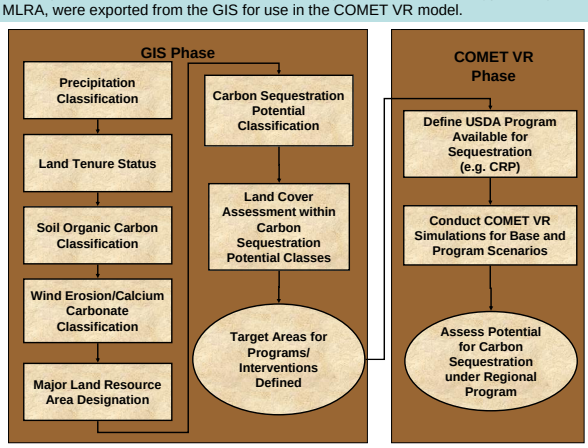

Figure 2. Framework for assessing carbon sequestration potential in the Southwest Partnership

2.2 COMET VR Phase

COMET-VR, an on-line interface to the Century model, was used to assess baseline carbon and management induced carbon changes in areas identified as having high to moderate potential for carbon sequestration. The COMET-VR interface allows a user to select a location (state and county), soil texture, landuse history, and a proposed 10 year future management alternative. Based on these choices, COMET-VR accesses information on climate and landuse from database sources and runs the Century model. The results are calculated and presented as ten year annual averages of soil carbon sequestration or emissions with associated statistical uncertainty values.

Areas identified during the GIS Phase that had sufficient acreage in either grazinglands, small grains, or row crops were modeled. For grazinglands, three practices were compared: continuous grazing (heavy or moderate), seasonal reduced grazing, and CRP (Conservation Reserve Program; a cropland retirement program)-grass-legume mixture (no grazing). For row crops and small grains five practices were compared: intensive tillage, reduced tillage, no-till tillage, CRP-100% grass, and CRP-grass-legume mixture. Weighted averages for carbon capture were calculated for each MLRA in order to identify MLRAs with higher sequestration potentials that could be targeted for government incentive programs.

3.0 Results

3.1 GIS Assessment

Land areas classified as having moderate to high climate potential, moderate to high SOC, low $CaCO_3$, and low WEI, were queried out of the GIS spatial database for New Mexico. These classifications were chosen because they were believed to have the highest probability for sequestering carbon over the long term. This analysis delineated potential target areas for carbon sequestration programs across (Figure 3A).The area delineated occupies approximately 8.3 million hectares (~20.5 million acres). Of this land area, approximately 82% of it is classified as rangeland vegetation, followed by 12% as forest lands, small grains at 2%, and row crops at 2%.

For the COMET VR analysis, a subset of these areas were selected to ascertain carbon sequestration amounts (Figure 3B) for the land management practices that could be implemented for the land cover types delineated by the GIS analysis. These areas were selected because current infrastructure would allow implementation through already existing incentive programs. Sites were examined by MLRA as many of the government programs administered by NRCS are implemented at the MLRA level. This analysis assumes that there would be 100% adoption of the practice for the areas delineated within each MLRA. Total land area for program viable regions was 3.1 million hectares (~7.7 million acres)

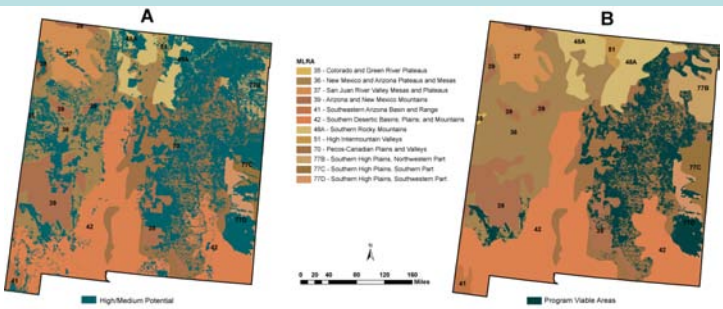

Figure 3. (A) Land areas within New Mexico that were classified as high/medium potential for sequestering carbon. (B) A subset of the high/medium potential areas that were chosen as program viable and were analyzed for the amount of carbon that could be sequestered under various changes in management. Numbers on maps indicate the Major Land Resource Area (MLRA).

3.2 COMET-VR Results

Broad, landscape scale analysis indicated that much of the region would accumulate soil carbon at < 0.1 ton ha-1 unless changes in land use occur, primarily converting cropland to perennial cover. Land use conversion to either 100% grass or a grass-legume mixture can result in accumulation rates of up to 1.0 ton ha-1 y-1 in a limited portion of the region.

The total tons of carbon that could potentially be sequestered (per year, assuming 100% adoption) within each MLRA for specific conservation practices are presented in Figure 4. In general, an incentive program like the Conservation Reserve Program (CRP) that converts land into a grass/legume plant community had the highest potential for carbon sequestration over reduced grazing/tillage and a grass only plant community. In MLRA 70, conversion of heavy/moderately grazed rangelands to a grass and legume plant community with no grazing had the greatest potential to sequester carbon on a regional basis. Although sequestration per hectare was low for this MLRA (CRP Grass/Legume = 0.13 t/ha/yr), the large number of rangeland acres in this MLRA increases total sequestration potential.

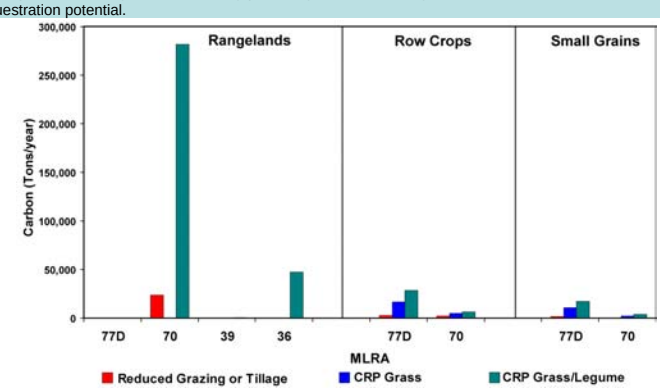

Figure 4. Net Carbon (tons/year) that could be sequestered under various land management changes for rangelands, row crops, and small grain crops by Major Land Resource Area (MLRA) for program viable areas in New Mexico. (CRP = Conservation Reserve Program).

4.0 Conclusions

- The GIS analysis was successful in delineating areas, on a spatially explicit basis, having characteristics desirable for implementation of carbon sequestration programs. The system also allows the extraction of pertinent data for simulation of carbon sequestration under land use practices that would be implemented under incentive programs.
- Land management changes using a grass/legume perennial cover has the highest potential for sequestering carbon, especially on croplands. Because of the large area of rangelands in New Mexico, sequestration potential for some areas is high, but would require large scale adoption of the conservation practice. The cost: benefit of conversion is likely to be more favorable for croplands than rangelands.
- Increasing soil carbon in the New Mexico will require policy and program decisions that motivate land managers to implement conservation practices on a broad scale.

Southwest Regional Partnership on Carbon Sequestration

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