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Climate Change Impacts on Soil and Water Conservation

Planning for Extremes: Addressing Climate Change Impacts on Soil and Water Conservation, Milwaukee, Wisconsin, 1-3 November 2006.

Climate change and particularly precipitation changes will affect water runoff and soil erosion from agricultural cropland, but will the change be large enough to warrant modifications in U.S. conservation policy or practice? In a 2003 report by the Soil and Water Conservation Society (SWCS), this question was answered with an emphatic yes [*SWSC,* 2003]. This article reports on a follow-up workshop that builds on the findings of the 2003 report.

The 2003 report reviewed existing literature on general circulation model projected climate change over the United States, which suggested a likely increase in mean precipitation and a very likely increase in heavy precipitation. Observed precipitation records pointed to similar results, an increasing trend in annual precipitation in most regions of the United States and an increase in intensity and frequency of heavy precipitation [e.g., *Groisman et al.,* 1999; *Kunkel et al.,* 1999]. Other studies used simulation models to estimate impacts of projected changes in precipitation amount, intensity, and frequency on surface runoff and soil erosion, and results confirmed potentially substantial climate change impacts on soil erosion and runoff [e.g., *Phillips at al.,* 1993; *Pruski and Nearing,* 2002].

Impacts of projected precipitation changes on soil erosion and runoff are complex, display high regional and temporal variability, and depend on a number of nonclimatic factors, such as agronomic practices that create greater vulnerability to soil erosion during certain seasons, and antecedent soil moisture conditions that govern surface runoff potential of a storm. Altogether, observed and projected changes in precipitation are believed to substantially heighten the risk of runoff, soil erosion, and related environmental consequences. These findings of the 2003 SWCS report call for a review of current approaches to estimating soil erosion and runoff on agricultural lands, enhancements to soil and water planning tools, and strengthening of conservation practices and standards.

A Call for Action

The SWCS organized and hosted the joint U.S.-Canada workshop, 'Planning for Extremes: Addressing Climate Change Impacts on Soil and Water Conservation.' The workshop was held on 1–3 November 2006, in Milwaukee, Wisc., and was sponsored by the Joyce Foundation in the United States and Canada, the Walter and Duncan Gordon Foundation, Natural Resources Canada, and the U.S. Department of Agriculture Natural Resources Conservation Service. The

workshop consisted of commissioned white papers and discussion sessions. Invited participants represented U.S. and Canadian academic institutions, federal and state agencies, environmental organizations, Canadian conservation authorities, and private landowners and farmers.

The objectives of the workshop were to review current soil and water conservation planning tools, approaches, and practices, and to make recommendations to enhance our ability to manage natural resources in agricultural watersheds under anticipated climate changes. The focal point for discussions was the Great Lakes Region because observed and projected changes in precipitation patterns are significant in the region, and conservation planning and water quality improvement efforts are currently being investigated.

The major objectives of the workshop were as follows:
1. Clarify the risks to soil and water resources posed by increased precipitation frequency and intensity, along with identify additional information needed to support soil and water conservation planning.
2. Investigate opportunities for adapting current planning tools and approaches to environmental risk management of cropland under anticipated climate change.
3. Develop recommendations to improve conservation planning policy, enhance conservation planning and risk assessment tools, and stimulate research to fill knowledge gaps.

Workshop Discussions

The majority of workshop discussions addressed the enhancement of conservation planning methodologies and tools to better account for effects of projected and observed climate changes. Main discussion subjects were enhancement of upland erosion prediction, gully erosion estimation, use of a design storm, and watershed-scale conservation assessment. SWCS is developing specific recommendations to address each of these subjects and will produce a report by March 2007. A brief description of the workshop discussions is presented below.

With regard to enhancement of hillslope erosion prediction, conservation agencies rely predominantly on the Revised Universal Soil Erosion Equation (RUSLE2) to estimate average annual hillslope soil erosion rates. The equation contains a rainfall-erosivity factor and a soil erodibility factor that reflect average-year precipitation conditions. However, currently available values for the rainfall-erosivity and soil erodibility factors may inadequately represent low-probability return-period storms and the more frequent and intense storms under projected climate change. This shortcoming can lead to an underestimation of annual soil erosion rates. Remedial actions that were debated included periodic updating the rainfall-erosivity and soil erodibility factors for low-probability return-period storms and projected climatic conditions, and switching to a storm-based approach that explicitly accounts for individual storms, such as the Water Erosion Prediction Project (WEPP) model.

On the topic of gully erosion estimation, ephemeral and classic gully formation and erosion potential are expected to increase with projected climate intensification and resulting runoff rates and volumes. Gully erosion can be a major contributor of upland soil erosion and sediment delivery, but the state of current methodology for estimating gully erosion lags far behind that of hillslope soil erosion. Participants identified the need for better methodologies to predict land

vulnerability to concentrated flow erosion on uplands, conservation guidelines to reduce gully formation, land rehabilitation options to remove permanent gullies, and remediation actions to inhibit gully growth under projected climate change.

Recognition that large storm events are responsible for much upland soil erosion raised the possibility of using a design-storm approach to assess the effectiveness of conservation practices. A design storm of predetermined return period can be adjusted to reflect changes in storm frequency and intensity due to climate change. Discussions centered mainly around an appropriate storm return-period for upland soil erosion and/or for other environmental end points. Strengths and weaknesses of using a design-storm approach, as well as the economic and policy implications of implementation, were also discussed. Participants also pointed out that while the design storm appears well suited to define an index for effectiveness of alternative upland conservation practices, it does not quantify long-term soil erosion losses and sediment delivery values that are generally needed to estimate sediment loading to downstream water bodies.

With respect to watershed-scale conservation assessment, soil and water conservation policies have traditionally emphasized and focused on farm, upland, and edge-of-field conservation efforts. However, over the past decades it has become increasingly clear that other sources of sediment can affect loading and sedimentation of downstream water bodies. The stream system is a source of sediment that can equal or surpass upland erosion contributions. Under an intensified climate, unstable channels may develop, stream bank failure may occur more frequently, and instream sediment transport capacity may increase. Current conservation tools are designed primarily to estimate hillslope erosion and are limited in their capabilities to quantify sediment contributions from destabilized channels and stream banks, to track the downstream movement and timing of sediment, and to provide reliable cause-effect estimates of sediment delivery at a downstream point of interest.

While the above subjects emphasized enhancement of conservation planning tools to better account for climate change effects, it was also recognized that increasing our knowledge base and developing better soil erosion and sedimentation tools may not lead by itself to an increase in voluntary adoption of conservation practices. Many nonclimatic considerations govern policy and adoption of conservation practices. Items discussed at the workshop included the following:

1. Great conservation effects can be achieved by targeting conservation practices to areas that are most vulnerable to soil erosion and are the primary sources of sediment delivery. However, current policies and incentive programs do not promote targeting of high-priority areas, and, as a result, the effectiveness of conservation programs is impaired.

2. Conservation planning at the watershed scale tends to focus on upstream or upland areas of the watershed, whereas intended benefits are often downstream lakes and reservoir. Participants discussed ideas for financing mechanisms that would encourage downstream beneficiaries to share the financial burden of upstream conservation practices.

3. At a watershed scale, communication and coordination among multiple water agencies, water managers, landowners, and water users are often inadequate and uncoordinated conservation

efforts have limited effectiveness. Watershed simulation models and spatial display tools were discussed as a means of identifying sediment sources, illustrating conservation effects and downstream impacts, and enhancing communication between agencies and individuals in a coordinated watershed conservation program.

4. Effective implementation of conservation practices in the field requires technical support traditionally provided by conservation offices and agricultural extension services. Recently, cost-cutting and other factors have reduced the on-site person-to-person support services available to landowners. Participants stressed that well-trained professionals in the field will be essential to adapting conservation planning and practice to a more intense precipitation regime.

Recommendations regarding the above issues are currently being developed by workshop organizers and participants. These recommendations, along with workshop presentations and summaries of discussions, will be made available by March 2007 at the Soil and Water Conservation Society Web site: http://www.swcs.org

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