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Extended Abstracts

CURRENT & EMERGING

EROSION PREDICTION TECHNOLOGY

A SYMPOSIUM

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OVERVIEW, SYMPOSIUM EXPECTATIONS and RESEARCH NEEDS

comments by

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When I was asked by SWCS to be chair of the organizing committee, little did I know the magnitude of the task I agreed to assume. As the symposium planning progressed and now as the papers are presented, I feel optimistic that the effort will be professionally rewarding to all the participants.

The symposium planning committee agreed that the discussions should concentrate on the following objectives:

- Examine current and emerging erosion prediction technologies identifying strengths, gaps, and limitations;
- Suggest the directions that future erosion prediction technologies should take;
- Determine how, under today's constraints, new technology can be implemented in the most efficient and timely manner;
- Assess the policy implications by implementation of existing, emerging, and future erosion prediction technologies.

We (organizing committee) feel that the papers being presented during this symposium will address many, if not all, of these issues and I look forward to hearing them. Models such as RUSLE, RUSLEFAC and RWEQ should provide some answers to current erosion prediction problems. Furthermore, WEPP and WEPS (as well as other models not included) offer promise for addressing problems in the first decades of the 21st Century. However, there will undoubtedly be a suite of questions and problems with regard to the last two symposium objectives requiring continuing thought and discussion following the symposium.

Considerable progress in new erosion prediction technology development has been made in the past decade. The ability to design effective erosion control programs (e.g. the Food Security Act), the policy implications resulting, and the practices suggested, in a large part depends on our ability to predict erosion rates, to determine the implications of resource management and land use, and to anticipate and mitigate the disruptive impacts of new technology implimentation.

Lest users of erosion prediction develop the false impression that new technologies will be a panacea to soil and water conservation planning, let me spend a few minutes discussing some questions that I envision as FUTURE PROBLEMS needing to be addressed.

Confidence Limits-Error Analysis: Most modern erosion estimation technology produces an answer (e.g. tons·unit area^{-1}) which the user intuitively knows has limits of $\pm$ an amount that may be specific or may be a percentage of the specific estimate. Those limits are usually difficult to ascertain with the result that the technology developers generally ignore this problem (myself included). As we worked on RUSLE, we discussed the problem but we

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have not yet been successful with identifying the limits. Obviously, the end result depends upon many factors including uncertainty of data base, model parameter values, the ability of the conceptual model to emulate *in situ* conditions, systematic errors in model structure, operator input errors, etc.

Model Conceptualization: Most natural resource models (including erosion-sedimentation as a part of this broad category) are one or two dimensional approximations of a process. We recognize that this approximation is a weak representation but one that is inevitable to avoid very complex and cumbersome computer models. How important is this assumption? Obviously in the case where the model is incapable of handling converging or diverging flow, the error may be most significant. In the case of RUSLE, the one dimensional model is a "poor-man's" approach to the real world. Yet errors resulting from this simplification may have limited significance when used to decide between alternative farming/ranching practices for erosion control. "The chaotic like behavior induced in process-based models of runoff and erosion processes by predictably deterministic, random, and unpredictably deterministic or chaotic spatial variations in topography, soil properties, vegetative cover, and ground cover" (Lane, personal communication) is a topic worthy of further investigation. The topic is also applicable for other models such as WEPP and WEPS.

Data Base Development: A considerable effort has been expended by ARS and SCS to develop CROP and OPERATION input files for RUSLE and WEPP. The files include numerous input variables. For example, in RUSLE, provision for above- and below- ground residue decomposition rates are in the program but the data are not available to quantify such differences. Furthermore it is recognized that the decomposition rate differs for leaves and stems/stalks. In the OPERATION file, the random roughness following a tillage operation undoubtedly varies as an interaction of tractor speed, soil moisture, soil particle size distribution, and organic matter. Again such information is elusive. It is also likely that roughness varies with uphill versus downhill plowing, etc. Can we collect such information in the immediate future to use in our models? Or is it even important (the answer should be obvious)!

Particle Size Distribution: To my knowledge, CREAMS was the first USDA erosion/sedimentation model to address sediment transport as a function of particle sizes. This important distinction is essential for water quality concerns where agricultural chemicals/pollutants move adsorbed to finer particles. Thus RUSLE and RWEQ have major limitations for water quality considerations that should be partly overcome by newer models such as WEPP and WEPS. But like in other instances, data bases are limited for model validation. Research designs along with *in situ* experiments to define the linkages between a comprehensive set of agricultural chemicals for soils of differing physical and chemical properties are needed to facilitate estimation of adsorbed chemical transport.

Sediment Transport in Rills and Ephemeral Channels: Most of the sediment transport equations used for rills and ephemeral channels (small concentrated flow areas that may be obliterated by land disturbing practices) are based on hydraulic flume studies or analyses of field data. In these efforts, flow depths are generally much larger than bed roughness elements. Yet in rills and ephemeral channels, the roughness may be comparable or larger than flow depth. In CREAMS, the Yalin (1963) transport relation was used. Although the relationship was shown to give the best agreement of those tested with actual data, one can only wonder if a transport relation developed where roughness is approximately equal to the flow depth would give different results.

Parameter Estimation and Model Validation: Parameter estimation often occurs based on limited data collection. If the estimation uses regression analysis, the validity of such parameters outside the data range is questionable. Model validation like parameter estimation, may be limited by the range of *in situ* conditions of the data used. To be globally applicable, a model mujst be compared over a wide range of conditions including conditions not experienced in the parameter estimation algorithms.

Rangeland Erosion Estimation: Most current erosion prediction technology is based on experiences in cropland, a situation that may or may not be adequate for rangelands. Thus, cropland conditions of soil disturbance and annual planting may provide inadequate technology for soil erodibility and the "clump type" plant communities encountered on rangeland.

Future Needs for Erosion Prediction Technology: Considerable information has been written recently (Nearing, et al. 1990; Lane, et al. 1992; and NRC-BA 1993) regarding research needs for soil erosion by water. Similar evalustions for wind erosion is not published. L.J. Hagen (1994, personal communication) stated:

> "Wind erosion research is needed to predict effects of: Combining various control practices; particle abrasion on plant damage; hills on both airflow and erosion; weather on soil temporal properties; production-size fields on the suspension component of soil loss, enrichment ratios and particles less than 10 microns production; rangeland spatial variability on erosion and productivity. Additional needs include improved instrumentation for field wind erosion measurement, interpretation of erosion impacts, and erosion control technology."

I look forward to the papers to be presented here. I expect that the summary at the end will conclude that much remains to be accomplished. As we progress into the 21st. century, we can do a much better job of managing our abiotic resources than heretofore. Finally, I expect that forthcoming questions and problems will result in future symposia similar to that which we have here.

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