Guidelines for Preparing Posters

Hydrology Days

Colorado State University

Guidelines for Preparing Posters

- Increasingly popular presentation form at conferences
- Advantages
  - Gives audience time to study details of interest
  - Permits informal or extended exchange between author and audience
  - Provides feedback to author

Poster Space

- Varies widely at different venues - check meeting guidelines well in advance
- For Hydrology Days
  - Single board, 4 feet high, 6 feet long; therefore your poster must not exceed 4’ x 6’
  - Tacks provided for mounting
  - Table space

Preparing the Poster

- Use eye-catching and attractive design
- Keep it simple
- Avoid clutter; make logical sequence obvious to audience
- Minimize amount of data and text presented
- Make everything bold and large
- Simplify concepts for those who do not hear your explanation

The Title

- Attractive, succinct, provocative
- Legible from 5 m -- bold, block letters at least 5 cm high

The Text

- Concise, legible, easily comprehended - minimum 16 point font
- Include:
  - Abstract
  - Brief introduction
    - problem statement
    - Aims of study
  - Results with minimal discussion
    - May present as figure captions
  - Conclusions

Figures and Photographs

- The larger the better
- Minimize the number: keep it simple
- High quality figures
  - Good color contrast
  - Bold, legible from 2 m
  - Clear labels, legible against background
- Clear sequencing

The Poster Session

- Stand by your posters during assigned time for discussion and questions
- In some cases, may be invited to give oral overview
  - use as invitation to audience
  - present as abstract
    - State problem, methods, principal conclusions

Type of Poster (Banner or Cards)

- Banner -
  - Simplest to mount
  - Harder to transport
  - See example on last slide
  - For a PowerPoint version, browse:
  - http://HydrologyDays.ColoState.edu/PosterExampleHDs.ppt
- "Cards" that fit in an oversized envelope
  - More time, materials required for mounting
  - Easy to transport in briefcase
  - Readily accommodates "guides", such as strings to connect related objects

Additional ideas

- Provide extra information
  - Hang envelopes from poster board for reprints, business cards, etc.
- Some venues permit electronics
  - Show videos or computer simulations
  - Make added information available on computer

The Evolution of Landscapes and Hillslopes

Jorge A. Ramirez and Rahul Rajagopal
DoD Center for Geosciences/Atmospheric Research, CIRA/Colorado State University, Fort Collins CO

We present the mathematical and numerical development of a new hillslope hydrology model as well as sample applications. The new model is a distributed, physically and mechanistically based hillslope evolutionary model. The model couples the fully two-dimensional hydrodynamic equations for overland flow, Richards equation for infiltration, and a set of sediment detachment and transport equations. This model, based on the fundamental physics of the governing processes of hillslope hydrology is used to test our ability to fully explain the fine scale processes and mechanisms leading to the development of erosion drainage networks. Sample applications are presented to show how the model is capable of capturing the interaction between overland flow, erosion and infiltration at very small scales and of modeling the evolution of hillslope caused by spatially variable erosion caused by small scale variability of the hydraulic and soil properties. We also present analyses with respect to energy expenditure during hillslope evolution. Finally, we show applications of the scaled-up model to describe watershed response at basin scales.

The Evolution of Landscape and Hillslopes

❖ Specific Objectives

- Develop detailed, physically based model of hydrologic response that includes coupling of:
  - surface and subsurface flow dynamics,
  - interactive infiltration,
  - and erosion and sediment transport
- Develop properly up-scaled model
- Implement model to simulate:
  - Effects of flooding
  - Effects of anthropogenic disturbances of the landscape

The Evolution of Landscape and Hillslopes
Hillslope Hydrology Model

❖ Overland Flow

- The overland flow component of the new model is a 2-D, fully hydrodynamic, mathematical description of the small-scale processes associated with overland flow on an infiltrating surface. This model allows for explicit representation of micro-topographic features and spatially variable infiltration characteristics. (Fiedler and Ramirez, 2000; Raff and Ramirez, 2005).

- Mass Conservation equation

$$\frac{\partial h}{\partial t}+\frac{\partial (uh)}{\partial x}+\frac{\partial (vh)}{\partial y}-q_l=0$$

- Momentum equations

$$\underbrace{\overbrace{\frac{\partial (uh)}{\partial t}+\frac{\partial (u^2h)}{\partial x}+\frac{\partial (uvh)}{\partial y}+\overbrace{g\frac{\partial\left(\frac{h^2}{2}\right)}{\partial x}-\overbrace{gh(S_{ox}-S_{fx})}^{\text{kinematic wave}}}^{\text{diffusive wave}}}^{\text{quasi-steady dynamic wave}}}_{\text{dynamic wave}}-\overbrace{u\,q_l}^{\text{lateral}}=0$$

$$\frac{\partial (vh)}{\partial t}+\frac{\partial (v^2h)}{\partial y}+\frac{\partial (uvh)}{\partial x}+g\frac{\partial\left(\frac{h^2}{2}\right)}{\partial y}-gh(S_{oy}-S_{fy})-\overbrace{v\,q_l}^{\text{lateral}}=0$$

❖ Infiltration (Richards Equation)

(Raff and Ramirez, 2004; Raff and Ramirez, 2005)

$$\frac{\partial}{\partial z_g}\left(K(\psi)\frac{\partial\psi}{\partial z_g}\right)+\frac{\partial K(\psi)}{\partial z_g}=\frac{\partial\theta(\psi)}{\partial t}$$

❖ Sediment Detachment and Transport

(Raff and Ramirez, 2004; Raff and Ramirez, 2005)

- The unit sediment transport capacity in the x direction (and analogously for the other directions) is defined by:

$$q_{s_x}=\eta\left[pS_{0x}-(pS_0)_{crit}\right]^{\epsilon}$$

- The governing equation for bed elevation change as a function of changes in sediment load is:

$$\frac{\partial z}{\partial t}=-\frac{T_g}{(1-p_o)}\left(\frac{\partial q_{sx}}{\partial x}+\frac{\partial q_{sy}}{\partial y}\right)$$

The Evolution of Landscape and Hillslopes
Basic Numerical Solution

❖ Structured Grid
❖ Finite Difference Method
❖ Overland Flow

- Explicit with Implicit term (Fiedler and Ramirez 2000)
- MacCormack Predictor-Corrector method

❖ Infiltration (Raff and Ramirez, 2004; Raff and Ramirez, 2005)

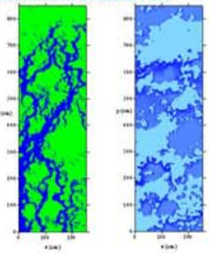
- Implicit (Celia et al. 1990)
- Picard Iterative Scheme

❖ Sediment Detachment and Transport (Raff and Ramirez, 2004; Raff and Ramirez, 2005)

- Explicit
- Centered in space forward in time

The Evolution of Landscape and Hillslopes
Small Scale Simulations

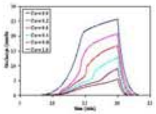
❖ **Surface Interactions in Overland FLow**



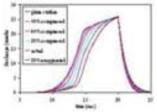
❖ Figures show

- model-predicted flow-channels (blue on green) for an experimental plot (far left)
- Model-predicted cumulative infiltration illustrating the interactions that occur as a result of realistic vegetation patchiness. The darker blue represents greater infiltration (left).

❖ In addition to the patchy nature of the surface where infiltration is greater in vegetated soil, areas of greater infiltration due to surface interactions appear at the interfaces of bare soil and vegetated soil.



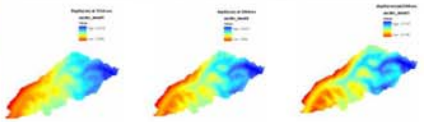
❖ Effects of spatially variable Ks. Runoff is shown to decrease significantly as the variation increases, clearly showing the importance of sub-grid scale interactions.



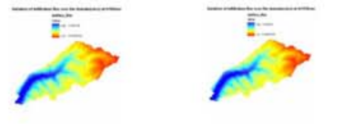
❖ Effects of micro-topographic amplitude variation. Increasing amplitude of topographic relief delays the rising limbs and extends the recession limbs of the hydrographs.

The Evolution of Landscape and Hillslopes
Large Scale Simulations

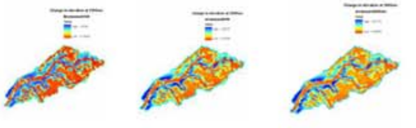
❖ Rainfall – Runoff Simulation Goodwyn Creek, MS



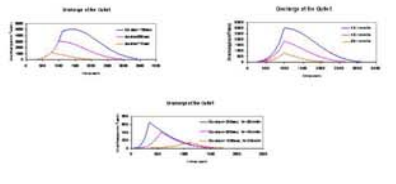
Flow depths in *cm* as a function of time



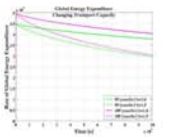
Infiltration flux in *cm/s* as a function of time



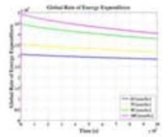
Variation in surface elevation as a function of time



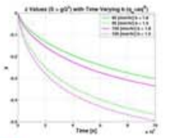
Varying transport capacity ($q_s\ \alpha\ q^b$)



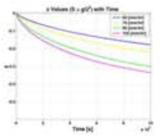
Varying rainfall rate ($q_s\ \alpha\ q^{1.8}$)



Varying transport capacity ($q_s\ \alpha\ q^b$)



Varying rainfall rate ($q_s\ \alpha\ q^{1.8}$)



❖DoD Relevance

- **Countermine detection efforts** - the identification of natural versus disturbed soil surfaces (i.e., mine areas)
  - Natural surface erosion patterns are needed for more realistic and accurate countermine remote sensing simulations
  - Improved countermine simulations can better identify and test new remote sensing techniques for battlefield use
- High resolution HYDROR model also enables large scale parameterization improvements resulting in **better large scale hydrological estimates**
- More accurate estimates are used to create **improved DoD chemical transport estimates**

❖Conclusions

- A two-dimensional overland flow model, with detachment and transport-limited erosion, predicts landforms resembling observed natural hillslopes.
- As observed in nature, simulated landscapes evolve towards minimization of:
  - the global rate of energy expenditure,
  - the coefficient of variation of the local rate of energy expenditure per unit area,
  - the total unit stream power and
  - the total stream power.
- The longitudinal profiles developed have slope-area relationships that approach optimality.
- The rates at which the energy characteristics are minimized are exponentially related to the rainfall input to the system because the work that can be done by a flow is exponentially related to that flow.
- In two-dimensional cases the model shows that the total global rate of energy expenditure and the total stream power approach a minimum throughout hillslope evolution but optimality in unit stream power and the distribution of local energy expenditure per unit area are highly variable and depend critically upon the threshold at which the concentrated flow paths are delineated.
- Hillslope development occurs at different rates spatially and temporally and therefore does not always approach optimality as a whole but should tend towards optimality.

❖**Publications**

- Fiedler, F. R., and J. A. Ramirez, A numerical method for simulating discontinuous shallow flow over an infiltrating surface, Int. J. for Numerical Methods in Fluids, 32, 219-240, 2000.
- Fiedler, F. R., G. W. Fraser, J. A. Ramirez, and L. R. Ahuja, Hydrologic response of grasslands: effects of grazing, interactions, and scale, submitted to J. of Hydrologic Engineering, October 2000.
- Raff, D.A. and J. A. Ramirez, 2005. A Physical, Mechanistic and Fully Coupled Hillslope Hydrology Model. *International Journal of Numerical Methods in Fluids.* (in press)
- Raff, D., J. A. Ramirez, and J. Smith, 2004: Hillslope Drainage Development with Time, A Physical Experiment. *Geomorphology*, Vol. 62, pp 169-180.
- Raff, D. A. and J. A. Ramirez, 2002: Physical, Mechanistic Hillslope Hydrology Model: Development and Applications, Proc. AGU Hydrology Days 2002, J.A. Ramirez (ed), Hydrology Days Publications, Fort Collins, CO., pp. 224 - 232.

❖**Papers Presented at Scientific Meetings**

- Raff, D. A. and J. A. Ramirez, 2001: Channel Initiation, Drainage Density, and Channel Network Structure at the Hillslope Scale. Paper presented at the *AGU Chapman Conference on State-of-the-Art Hillslope Hydrology*, Sunriver Resort, Sunriver, Oregon, October 8-12, 2001
- Raff, D. A. and J. A. Ramirez, 2002: Physical, Mechanistic Hillslope Hydrology Model: Development and Applications, paper presented at the *AGU Hydrology Days 2002*, Fort Collins, CO, April 1- 4, 2002.
- Raff, D. A. and J.A. Ramirez: A Physical, Mechanistic and Fully Coupled HillslopeHydrology Model. *AGU Fall Meeting*, December 8 – 12, 2003, San Francisco, CA.