Rock salt shows all aspects of brittle-ductile deformation and is, therefore, an ideal analogue material for petrophysical studies. In addition, salt structures are used as host rocks for the storage of oil and hydrocarbons and, probably, for the long-term storage of radioactive waste due to their very low in-situ permeability (less than 10-20 m2). The low permeability is basically attributed to the ductility of the halite minerals ensuring healing processes. Nevertheless, there is experimental evidence that rock salt tends to become permeable at two specific conditions: (1) at large deviatoric stresses (e.g. Peach, 1991; Popp et al., 2001), and (2) at fluid pressures higher than the minimum principal stresses. At conditions where fluids can permeate into the polycrystalline microstructure and generate a pore fluid pressure the physical properties of rock salt will be significantly changed.

The poster presents results of deformation experiments focusing on the transport properties of rock salt subjected to a pore fluid pressure. Combined measurements of ultrasonic wave velocities (Vp, Vs) and permeability were used to determine the state of stresses at the dilatancy boundary. The crack-sensitivity of ultrasonic wave velocities is found to provide a powerful means to monitor the in-situ state of the microstructure and to identify onset of dilatancy. Loading in the dilatant stress domain gives rise to the generation and propagation of cracks and to the increase of damage with strain. Effects of pore fluid pressure leading to reduction of effective pressure are only of importance in the dilatant domain, due to strain-induced increase of permeability. The coupling between stress and fluid flow is particularly dependent on the geometry of the fracture network.

From the experimental results we infer that the mechanical stability and the hydraulic integrity of a rock salt barrier are not a concern as long as the stress conditions are within the compaction domain, that is, below the dilatancy boundary and as long as the pore fluid pressure remains below the minimum stress.

H51E MC: 125 Friday 0830h

Communicating Scientific Consensus in Hydrology *(joint with PA)*

Presiding: **H C Hartmann,** University of Arizona**; B D Adams,**

H51E-01 0830h INVITED

Are Scientific Assessments Really "Scientific", and How Are they Perceived by Non-Scientists?

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Scientists take for granted that our conclusions are forever tentative, and that "accepted science" really means enough empirical and theoretical verification that a very high probability can be assigned to the process or event being "true". Non-scientists often think being "scientific" means being precise and certain. Concepts like standard errors, when we are lucky enough to work on a problem with good data and some theoretical underpinning, are not often part of the public's thinking about what is "scientific", let alone the situation when "deep uncertainty" exists-i.e., no empirical basis for direct testing, like a forecast of the changes in flow regimes in 2100 from anthropogenic climate changes. In the latter case, our scientific assessments search out as much empirical and theoretical understanding as possible on the elements of a complex systems analysis, but the probability of a specific event happening is not a traditional data-driven "frequentist" likelihood, but rather a Bayesian prior based on our degrees of belief an event will occur–hopefully informed by a large amount of good systems theory and data underlying the prior. Even honest scientists can strongly disagree about such subjective probabilities, and some even think attempting to assess them at all is "unscientific." But when policymakers need the assessments to fashion policies on the best information available, we in the scientific community lose the luxury of "normal science"-performing experiments that can directly lead to frequency diagrams. Of course, good scientific assessments are built on as much good theory and empiricism as possible in the elements of our systems theory, but that is lost on most Members of Congress, the press and many in the public. It is a situation ripe for out of context assertions, misrepresentation and confusion. I will recount the IPCC history in this regard as an empirical example of the opportunities and obstacles for scientists trying to communicate what is known about their field that is relevant to policymakers, particularly when the problem is still mired in "deep uncertainty."

URL: http://www.stanford.edu

H51E-02 0845h INVITED

Media Perceptions of Hydrologic Research

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Scientists often lament that journalists are ignorant of how scientists work and of scientific "facts," and that this ignorance leads to misleading coverage. Examination of coverage of such issues as climate prediction, Hudson River PCBs and the Yucca Mountain high-level nuclear waste storage facility suggests that this view is simplistic, however. Journalists ARE respectful of facts, but have trouble putting them into exact context. Journalists who are the most quoted and most widely circulated on such issues tend to understand how scientists work, and understand the strengths and the limitations of scientific information and even raw technical data.

But even the best journalists are swayed with relentless public relations campaigns by environmental groups and by industry (GE and Hudson River PCBs). They tend to over-cover "first instances" of new lines of inquiry (potential for water leaking into the Yucca Mountain facility). They tend to trust "recent experience" more than long-term (especially geologic-scale) events (El Nino and climate). Most say they have been lied to by civil engineers or hydrologists working for developers, when covering local stories early in their careers. Most tend to color their stories with issues such as equity and fairness ("Why should WE accept nuclear waste? Why should anybody?") because their readers, editors, and democracy itself demands that they do so. But they often complain they are not given the resources and time to investigate such issues thoroughly.

H51E-03 0900h INVITED

Consensus and Uncertainty: The National Assessment Climate and Water Report

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The recently completed Water Sector report of the National Assessment of the Potential Consequences of Climate Variability and Change evaluated the implications of climate change for U.S. water resources. This report was the product of more than two years of work reviewing more than 900 peer-reviewed papers on climate and water. The report also included new research prepared as part of the assessment. The final assessment was prepared by a large, multi-disciplinary assessment team of scientists, economists, engineers, and water managers, and went through two separate peer-reviews and a 60-day public comment period.

One of the greatest challenges of the Water Assessment was determining how best to address the questions of uncertainties and consensus. Different methods of evaluating and presenting uncertainties were reviewed, including those in use by other scientific assessments such as the Intergovernmental Panel on Climate Change. Substantial debate among assessment team members led to modifications of these methods, and ultimately, the adoption of different approaches for different aspects of the report - scientific uncertainties and policy uncertainties were treated separately and explicitly.

Based on the feedback received in the year since the report was released, the report successfully and clearly identifies what we know as well as what we don't know, and may provide useful guidance for policymakers considering how to move forward.

URL: http://www.pacinst.org/naw.html

H51E-04 0915h INVITED

The Consensus Process at the Water Science and Technology Board, National Research Council

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Whereas the very birth of the U.S. Geological Survey arose from the recommendations of a National Academy of Sciences report, water science has not always had a prominent place at that institution. Prior to the 1980s, water issues were dealt with on an ad hoc basis by various boards related to science, engineering, and policy. With the birth of the Water Science and Technology Board (WSTB) in 1982, a diversity of water-related issues are now handled under one roof. The business of the WSTB is to produce consensus reports on a spectrum of topics in water science. Some of the projects that the WSTB works on are self-generated. The majority are generated either by Congress, or by government agencies.

The WSTB takes on several different kinds of studies. Some of these are designed to advance the science of hydrology itself. This category would include the report Opportunities in the Hydrologic Sciences, which helped to establish hydrologic science as something separate from applied hydrology in Congress, the White House, and agencies such as NSF.

However, the majority of the boards consensus studies involve hydrology in the interests of improving the natural and human environment. For example, Water for the Future: The West Bank and Gaza Strip, Israel, and Jordan outlined consensus principles backed by scientists from all of these entities for sustaining freshwater resources of the region. Closer to home, but no less controversial, a WSTB committee recently reached consensus on improving the process by which states determine which water bodies are polluted enough to require clean-up, and develop Total Maximum Daily Loads for these pollutants. Another committee recently sorted through the scientific bases for using natural attenuation for various contaminants in ground water and soil. And an ongoing committee is trying to help the South Florida scientific community to determine the best strategies for restoring the Everglades to some semblance of its former self, while continuing to provide drinking and irrigation water and flood control.

The committees and panels that we assemble meet over a period of months to years, and struggle to reach consensus on topics that by their very nature are problematical or controversial. Generally they succeed, by virtue of good will, strong leadership, and a well-defined statement of task.

H51E-05 0930h INVITED

Arriving at a Scientific Consensus in the International Association of Hydrological Sciences(IAHS)

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The International Association of Hydrological Sciences(IAHS) is the oldest and foremost international nongovernmental organization which deals with hydrology and water resources. It was established in 1922 with the aim of bringing together hydrologists from all countries to promote the hydrological sciences. International meetings are held once every two years, first, in concert with the General Assembly of the International Union of Geodesy and Geophysics(IUGG)(which is held every four years), the parent body of IAHS, and then in the midterm between IUGG General Assemblies in IAHS Scientific Assemblies. In addition, IAHS organizes and co-sponsors conferences, symposia, workshops, and courses, primarily through the efforts of its nine International Commissions on Remote Sensing(ICRS), Surface Water, Groundwater, Continental Erosion, Snow and Ice, Water Quality, Water Resources Systems, Atmosphere-Soil-Vegetation Relations, and Tracers. IAHS offers memberships to individuals for no annual fee. IAHS maintains close collaboration with UNESCO, WMO, and IAEA through their respective hydrology and water resources programs.

IAHS recently decided that although its scientific meetings have been successful, some new additional activities were merited. In addition to holding international meetings, the IAHS Bureau decided that IAHS should become more proactive by focusing on critical worldwide water problems and developing research programs to address these problems. Particularly, IAHS needs to address global water issues through direct involvement in policy oriented activities such as those of the World Water Council and World Water Forum 3 as well as many ongoing UN and ICSU science programs. IAHS plans to take strong leadership in such programs by demonstrating scientific solutions of problems of hydrologic uncertainty and resulting improvements for water management. In order to focus our scientific activities and make the scientific potentials practical, IAHS followed a strategy to build a consensus on a few critical water resources issues and to identify the research needed to contribute to solutions. To accomplish this, IAHS first initiated a unique science discussion over the Internet. The experience shows that the discussions were first dominated by IAHS officers who had responsibilities to promote such discussion, but the discussion soon spread to individual members and to those interested people outside IAHS. Many exchanges occurred and numerous areas of research focus were proposed. One proposal that received enthusiastic support

from various Commissions and individuals was the subject of research on ungaged basins. It was accepted as a preliminary IAHS focus because of the need for fundamental research and its relevance to societal needs in all countries of the world. This focus topic was brought forward for discussion at the 6th Scientific Assembly of IAHS at Maastricht, The Netherlands in July 2001 in a Workshop on the Science Agenda of IAHS. The Maastricht participants recommended that a Working Group(WG) on Prediction of Ungaged Basins(PUBS) be established, and that this PUBS WG hold a series of open discussion meetings and workshops to define the appropriate research approaches to follow in addressing the ungaged basins problem. The Maastricht participants also recommended that a second WG on Global Water Assessments be established. The leadership of IAHS has been pleased with the process used and considers this one example of successful consensus building.

H51E-06 0945h INVITED

Policy Statements Issued by Scientific Societies: Why Less can be More

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The results of hydrological research are increasingly important to decision-makers grappling with problems as diverse as global climate change, non-point source pollution, extreme weather events, and damage from flooding. In some cases scientific aspects of these problems are interwoven with economic, political and social disputes, and policy makers often seek the consensus scientific opinion to help shape the debate. Policy or position statements issued by scientific societies like AGU can embody scientific consensus and thus inform the public and policy makers. But this is not always the case. The potential for creating public misunderstanding is ever present. Therefore, the process leading to a policy statement needs to be deliberative, inclusive to the extent possible, and circumspect. In contrast to advocacy organizations or trade groups, as a learned society AGU and members acting on its behalf should only advocate positions on political or social issues that are based solely on available geophysical data and recognized scientific debate. That does not mean that AGU and other scientific societies must refrain from entering a political debate. AGU has a responsibility to its members to adopt positions of advocacy on geophysical science issues based on their intrinsic merits and needs. However, a learned society like AGU should state only what is credible about the scientific aspects of a political debate and not overstep its authority as an objective source of analysis and commentary for the geophysical sciences. Before adopting an advocacy position, AGU's volunteers follow a process that includes checks and balances so that the final statement is based on sound scientific issues and reflects the interests of the Union as a whole. Any AGU member or committee can propose a position statement, but the Committee on Public Affairs (COPA) decides whether the proposal fall within the guidelines for advocacy. If it does and if COPA considers the issue worthy of an AGU position statement, then the AGU President appoints a panel to draft a statement. AGU informs the membership via Eos and invites comments. The AGU Council, which represents the membership, is asked to vote or to comment on the proposed statement; a two-thirds majority is required for adoption. If adopted, COPA is charged with making advocacy of the statement as effective as possible, which often includes encouraging AGU members to use the statement in their individual efforts as citizen-scientists. Policy statements that reflect scientific consensus yet respect the boundaries between scientific and political debate should help policy makers and maintain the integrity of the scientific society.

H51F MC: 130 Friday 0830h

Watershed-Scale Sediment Routing Through River Networks II *(joint with T)*

Presiding: **T Lisle,** USDA Forest Service**; J Pizzuto,** University of Delaware

H51F-01 0830h

Stochastic Sediment Delivery in a Semi-Arid Landscape

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Watersheds in semi-arid regions of the American West are subject to a variety of disturbances, including grazing, fires, and vegetation cover changes. We have developed a model to investigate how these disturbances affect the magnitude, frequency, and spatial distribution of sediment production from hillslopes. We explicitly calculate sediment delivered by shallow landsliding, creep, post-fire dry ravel, and runoff. Through field experiments and monitoring, we have developed physically-based transport equations for each individual process. These equations are then driven stochastically by sequences of rainstorms and fires randomly chosen from probability distributions. This model is applied to a watershed near Santa Barbara, California, that is predominantly vegetated by coastal sage scrub. We present simulation results to illustrate how sediment delivery changes when vegetation is converted from sage to grass, a common land management strategy in the region.

H51F-02 0845h

A Distributed Sheet Erosion Process Model For Sediment Runoff Prediction in a Catchment Scale

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A distributed sheet erosion process model is constructed for sediment runoff prediction in a catchment scale. The model dealing with spatial information such as flow direction, slope, land cover, GIS has generated DEM and land cover map by ADEOS/AVNIR images acquired on June 4, 1997. Constructed here is a grid-cell based distributed rainfall-sediment runoff model. Surface and subsurface flows on each grid-cell are simulated by the Kinematic Wave model, and the transportation capacity of overland flow is calculated based on the unit stream power theory for modeling sediment yield and deposit processes physically. Yielded sediment in slope cells moves in the flow direction derived from the DEM to river grid-cells. To make riverbed change more realistic bed load and suspended load in the channel are calculated in river grid-cells by incorporating elevation change caused by sediment movement.

The model is applied to the Lesti River basin (625 km^2) located in the upper Brantas River basin Java, Indonesia. The performance has been verified with historical hydrological data (hourly rainfall and discharge sequences during a rainy season from November 1995 to April 1996). The verification indicates that the model reproduces the sedimentation record at the Senggruh dam, which is located at the junction of the Lesti River and the Brantas main reach. Further, the volume of eroded material at the cultivated hillslope of Mt. Semeru is found larger than other parts of the basin, which is analogous phenomenon to the natural physical process of sediment erosion.

H51F-03 0900h

Sediment Production and Delivery from Forest Roads in the Central Sierra Nevada, California

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In many forested catchments unpaved roads are the primary sources of sediment, but the effect of this sediment on downstream water resources depends on both the magnitude of the road erosion and the connectivity of the roads to the stream network. The objectives of this study were: (1) measure sediment production from unpaved roads in the Central Sierra Nevada of California; and (2) determine the proportion of the road network that is directly connected to the stream channel network. Sediment production at the road segment scale was measured by 50 sediment fences that were monitored for either 1 or 2 years. Road connectivity was evaluated on 20 km of unpaved roads, determining the length of concentrated flow and sediment plumes, and measuring the volume of gullies induced by concentrated road runoff.

Sediment production rates in the first year of monitoring ranged from 0.01 kg/m2 to 2.8 kg/m2 for road segments. Recently regraded or heavily used roads had high initial rates of sediment production, but showed a rapid decline after the first few storms. Sediment production rates were much lower in the second year because most of the precipitation fell as snow rather than rain. Sediment production rates from skid trails and harvest units were generally low.

In contrast to most other studies, only 20 percent of the road segments were directly connected to the stream channel network. Stream crossings accounted for 80 percent of these road segments, as road-induced gullies and sediment plumes rarely extended for more than 20 m. The length of sediment plumes was more dependent on geology than slope steepness, slope position, or vegetation type. The one road segment with a much higher connectivity was on a relatively impermeable lava cap and ran along the valley bottom. These results suggest that most of the sediment generated by unpaved roads in the study area will not be delivered to the stream network. Road crossings and sites with atypical drainage characteristics should be focus of design and mitigation efforts.

H51F-04 0915h

Modeling Sediment and Wood Storage and Dynamics in Small Mountainous Watersheds

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We examine controls on supply and transport of sediment and wood in a small (approximately two square kilometers) basin in the Oregon Coast Range, typical of streams at the interface between episodic sediment and wood delivery by mass movements and frequent fluvial sediment transport. We hypothesize that wood deposited by mass movements forms dams that lead to persistent sediment storage and inhibit coherent propagation of sediment pulses. Field data show that much sediment is stored behind such dams and in terraces after the dams breach. We developed a drainage basin-scale model driven by stochastic storm and fire sequences that combines empirical, stochastic and physical models of forest growth, tree fall, wood decay, soil production and diffusion, landslide initiation, debris flow runout, and fluvial sediment transport. In a 3000-year simulation of the study area, woody debris flow deposits form dams on the main channel and lead to steps in the channel profile and terraces on the valley floor that persist in place even after nearly all deposited wood has decayed. Simulated sediment output from the network is relatively steady and shows little evidence of episodic input. Our results suggest that abundant wood plays a key role in moderating sediment flux from small basins following debris flow events. Debris flow events coincident with a lack of abundant wood, such as might occur following forest harvest, could lead to more episodic sediment flux to downstream, fish-bearing reaches.

URL: http://www.fsl.orst.edu/~slancast

H51F-05 0930h

Sediment Flux and Storage in a Rural Southeastern Piedmont River System

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A sediment budget was developed for a representative rural southeastern Piedmont watershed to provide information on the relative importance of sediment sources. Sediment issues in the southeastern Piedmont are complicated by the so-called legacy sediment produced by poor farming practices during the cotton-farming era, approximately 1810-1930. The Murder Creek basin near Monticello, GA was chosen because: it featured forestry and agriculture as the principal land uses; a USGS gage provided a flow record; and the creek deposited in a reservoir built in 1948. Suspended load export was calculated using a sediment rating curve and the USGS flow time series. Bed load export was determined by estimating the volume of sediment deposited in the reservoir since construction. Unpaved road erosion was estimated using the WEPP model, and other surface erosion was estimated using USLE and delivery ratios. Historical floodplain storage was determined by coring floodplain deposits, measuring the depth to the pre-historic/historic sediment interface, and multiplying by the area of the floodplain. Recent accretion rates were estimated using dendrogeomorphology. Results showed that the practices of the cotton farming era deposited an average of 1.6 meters of sediment on the floodplains. This depth was relatively uniform across the watershed. The cotton-farming sediment in storage exceeds the current annual export by a factor