to the predominant vegetation, climate, topography, and soils of the footprint. Surface soil texture, rolling topography, and row cropping dominated the spatial structure within the field, whereas precipitation patterns and vegetation cover were important contributors at the watershed and regional scale. The evolution of soil moisture structure is also considered using geostatistical and fractal analysis tools.

H71E-08 1055h

A New Distributed Hydrologic Model Based on ARHYTHM and RiverTools

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ARHYTHM is a distributed hydrologic/thermal model that was developed by Hinzman and colleagues (Zhang et al., 1999) for use in both arctic and nonarctic watersheds. It incorporates a number of important physical processes, including snowmelt, evapotranspiration, precipitation, subsurface (multi-layer, Darcy-law) flow, overland flow and channel flow. The snowmelt process can optionally be modeled with either the degree-day or energy balance method. Similarly, evapotranspiration can be modeled with either the Priestley-Taylor or energy balance method. The model is physically-based and has been tested for several watersheds on Alaska's North Slope. It consists of a geometric component that extracts a D8 flow grid from a DEM, in addition to the dynamic modeling component.

During the past year, the dynamic component of the ARHYTHM model has been rewritten and significantly extended using IDL (Interactive Data Language) and endowed with a user-friendly graphical interface. This interface has been designed to make it easy for users to code up new methods for any of the physical processes. Rather than rewrite the network extraction component, the model now draws on the powerful capabilities of RiverTools for the geometric component and visualization of results. Together, RiverTools and this new version of the ARHYTHM model make a powerful hydrologic modeling toolkit.

H71E-09 1110h

Assessing the impact of soil moisture initialization on seasonal predictions using the NCEP AGCM

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Due to the lack of long-term consistent soil moisture analysis, numerical studies of the impact of soil moisture on medium to seasonal range forecasts are often based on extreme or idealized conditions. In this study, the atmospheric predictability at seasonal scale is investigated using soil moisture analyses that are more realistic and model consistent. This is accomplished using the Air Force Weather Agency (AFWA) Agricultural Meteorology modeling system (AGRMET), an operational global database of land surface states and energy/water fluxes, and the NCEP Global Forecast System (GFS), a state-of-the-art general circulation model.

AFWA incorporated the NCEP community NOAH Land Surface Model (NOAH LSM) into AGRMET in late 1999. The soil hydrology physics are forced with analyses of shelter height temperature, relative humidity, and wind speed, short and longwave radition, and precipitation. As part of the efforts to unify land model in all NCEP global and regional models, NOAH LSM has been implemented into GFS in 2002. As AGRMET land states have spun up using same land physics that GFS executes, they provide ideal source of initial land states that are strictly self consistent with GFS land physics.

Two sets of summer-time ensemble integration of atmospheric model will be performed, one using climatological soil wetness derived from the NCEP/DOE Reanalysis (R-2) and the other using AGRMET soil wetness analysis as initial conditions. The geographical variations of the predictability of soil wetness, precipitation, and near surface temperature will be examined from this dataset.

H71E-10 1125h

Determination of Soil Water Regime Based on Ground-Based Microwave Radiometry Measurements

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The primary objective of this project is to link remotely sensed surface water contents to the soil water regime, in particular to the regime of structured soils. We attempt to use the dynamics of spatially averaged surface water contents measured with microwave radiometry to predict preferential infiltration and drainage. Under field conditions the so-called macropore flow plays an important role in the infiltration and drainage behavior of a soil, as well as in the mass transfer of all sorts of solutes. These rapid processes are only detectable during the first few hours after a rainfall event, when most of the larger pores are still water filled. The main focus of our project lies in an areal integration of such processes on a field scale. For this reason, we depend on areal data with a high temporal resolution that allow to characterize the soil water dynamics.

We present a field experiment with two different ground-based radiometers (1.4 GHz and 11.4 GHz, respectively) centered at a 5 m x 10 m bare soil plot. The brightness temperature measured with passive microwave sensors contains information on surface water content that is already spatially averaged. Furthermore the water content was measured in-situ with time domain reflectometry probes (TDR) assembled at five depths. In the same depths we measured matric potential (pressure head of soil water) and soil temperature. These data were recorded every 30 min from May to July 2002.

We illustrate the implications of the results from this field campaign on the determination of the soil water regime.

Based on the van Genuchten-Mualem model for the soil hydraulic functions we investigate how the hydraulic properties affect the dynamics of the topsoil water content and in how far we can estimate the hydraulic properties with inverse modeling.

URL: http://www.ito.umnw.ethz.ch/SoilPhys/staff/schneeberger/work.htm

H71F MCC: 103 Sunday 0830h

The Science and Uncertainty of River Management and Restoration I *(joint with B, T, PA)*

Presiding: **A Collison,** Philip Williams and Associates**; S Darby,** University of Southampton**; P Downs,** Stillwater Sciences**; D Sear,** University of Southampton

H71F-01 0835h INVITED

Uncertainty at the Source: Science for River Restoration

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Sustainable river restoration depends on effective predictive science leading to sound planning, design, and decision-making. Recent American experience has shown that fluvial geomorphology must address the following sources of uncertainty to reach its full potential as a partner in river restoration. (1) Science must take a more active role in establishing realistic goals for restoration; (2) established theory should be more fully exploited applications in restoration; (3) established theory must be improved by including role of humans and their societies; (4) site-based approaches need to be supplemented by improved watershed perspectives; (5) geomorphic science must build better connections with the biological sciences and engineering; (6) uncertainty needs to be more fully explored and quantified in geomorphic predictions; (7) uncertainty should be more effectively communicated to decision-makers and the public in quantitative and qualitative terms; (8) researchers and decision-makers need to deal more effectively with their biases and avoid advocacy science. From a philosophical perspective, researchers in fluvial geomorphology must come to recognize that their work must not only be good science, it must also be useful science.

H71F-02 0850h

The Grand Canyon Monitoring and Research Center's Role in Colorado River Ecosystem Science Below Glen Canyon Dam: An Overview on Science-Based River Management

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Impacts of Glen Canyon Dam (GCD) operations on downstream resources have been intensively studied by scientists and engineers since the early 1970s. In 1989, the Secretary of the Interior directed the Bureau of Reclamation to conduct the first-ever retroactive environmental compliance on operations of a large dam. Studies focused on linkages between flows and depletion of sand bars, endangered species conservation, including the humpback chub (*Gila cypha*), recreation and economic resources, as well as archeological sites preserved in fluvial deposits. The Grand Canyon Monitoring and Research Center (GCMRC) was established in 1995, following completion of this major environmental impact statement (EIS). The EIS preferred alternative, was incorporated into the Secretary of the Interior's Record-of-Decision (ROD) in 1996, following successful completion of a large-scale flow experiment. The modified-low-fluctuating-flow operating strategy at Glen Canyon Dam allows for continued diurnal fluctuations to meet power demand, but restricts up-ramp and down-ramp rates and total daily range of fluctuations. In 1997, the Secretary established the Glen Canyon Adaptive Management Workgroup (AMP) as a Federal advisory committee. The purpose of the committee is to provide recommendations to the Secretary on the effectiveness of the ROD, as well as to identify and recommend science-based adjustments to the ROD that might better achieve restoration and maintenance of downstream resources.

Adaptive management is based on the premise that ecosystem responses to management actions are often unpredictable. However, if such actions are undertaken as scientific experiments, then outcomes can provide new information to managers on the range of possibilities that exist for achieving restoration objectives. Large-scale flow experiments at Glen Canyon Dam, as well as ongoing monitoring and research since 1995, have refuted some of the original EIS hypotheses. Some resource trends under the ROD have been opposite to EIS predictions, such as continued declines in native fishes and sand resources. While new information from the science program has helped managers identify false hypotheses, it has also led to many new hypotheses about ecosystem responses to dam operations, especially related to native and non-native fish population dynamics and interactions. Although the scientific method has reduced uncertainty in some areas of the program, uncertainties have increased in other critical areas.

The GCMRC has recently proposed a multi-year plan of large-scale experiments to the AMP as a means of reducing uncertainties related to sediment and fisheries. The initial elements of the science experiment have been embraced by most managers in the AMP, and hopefully will be implemented in winter 2002-03. Although the process of adaptive management experimentation is proving to be an effective approach for reducing management uncertainty, it requires a long-term commitment on the part of river managers to be successful. The investment in science-based river management and restoration programs can result in multiple returns when new knowledge about fluvial ecosystem processes and responses is transferable to other projects.

H71F-03 0905h INVITED

Science, Uncertainty, and Adaptive Management in Large River Restoration Programs: Trinity River example

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Following construction of Trinity and Lewiston dams on the upper Trinity River in 1964, dam induced changes to streamflows and sediment regime had severely simplified channel morphology and aquatic habitat downstream of the dams. This habitat change, combined with blocked access to over 100 miles of

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salmon and steelhead habitat upstream of the dams, caused salmon and steelhead populations to quickly plummet. An instream flow study was initiated in 1984 to address the flow needs to restore the fishery, and this study relied on the Physical Habitat Simulation (PHABSIM) Model to quantify instream flow needs. In 1992, geomorphic and riparian studies were integrated into the instream flow study, with the overall study completed in 1999 (USFWS 1999). This 13-year process continued through three presidential administrations, several agency managers, and many turnovers of the agency technical staff responsible for conducting the study. This process culminated in 1996-1998 when a group of scientists were convened to integrate all the studies and data to produce the final instream flow study document. This 13-year, non-linear process, resulted in many uncertainties that could not be resolved in the short amount of time allowed for completing the instream flow study document.

Shortly after completion of the instream flow study document, the Secretary of Interior issued a Record of Decision to implement the recommendations contained in the instream flow study document. The uncertainties encountered as the instream flow study report was prepared were highlighted in the report, and the Record of Decision initiated an Adaptive Environmental Assessment and Management program to address these existing uncertainties and improve future river management. There have been many lessons learned going through this process, and the presentation will summarize:

1)The progression of science used to develop the instream flow study report; 2)How the scientists preparing the report addressed uncertainty remaining after all the studies had been completed; 3)How could the scientific process been improved if we had the foresight in 1984 when the study was initiated; 4)Suggestions of how to prioritize uncertainty resolution in flow management (e.g., where do you prioritize spending research dollars); 5)The gaps between research and practitioners, information needs and analytical tools; 6)Abuses of adaptive management: a) use uncertainty to preserve the status quo, and b) use adaptive management to avoid predictive thinking.

URL: http://www.ccfwo.r1.fws.gov/trflow.html

H71F-04 0920h

A Large-Scale Experiment to Determine the Effectiveness of Controlled Floods and Tamarisk Removal in Rehabilitating the Green River, Dinosaur National Monument, Colorado

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A large-scale field experiment is underway on the Green River in the Canyon of Lodore to evaluate the effectiveness of tamarisk (Tamarix ramosissima) removal and increased magnitude and duration of floods released from Flaming Gorge Dam (FGD) for the purpose of increasing active channel width and increasing entrainment rates on gravel bars where there are large proportions of fines. Results to date demonstrate that effectiveness varies with small scale geomorphic setting, and that channel widening in some parts of the river may be impossible without regular removal, which is unlikely. Our approach is important in channel rehabilitation planning, yet the difficulties of conducting such experiments are apparent in the first 2 yrs of the project. All tamarisk are being removed in 3, 0.8 to 1.6 km long study reaches. Three control reaches, immediately upstream or downstream from removal reaches, are also being monitored. We are making detailed measurements of scour and fill, substrate, and composition of riparian vegetation communities in removal and control reaches, and in response to high flood releases from FGD. Difficulties in implementation of the experiment include the multi-year process of tamarisk removal. Tamarisk immediately reestablishes itself on moist substrate following removal; thus, some parts of removal reaches have young tamarisk seedlings and other parts have tamarisk not yet removed. Experimental dam releases have not yet occurred due to drought in the watershed and other water delivery imperatives. We have also compared the distribution of tamarisk on the nearby Yampa River, where an unregulated flow regime exists and where tamarisk are absent or in low densities. The comparison between the distribution, density, and age characteristics of tamarisk on the 2 streams will lead to recommendations as to the sites on the Green River where eradication efforts are best directed. Despite the difficulties of experiment implementation, such large-scale efforts are an essential component of developing a long-term plan for dam releases, because they will lead to definition of a schedule of floods, or repeated removal activities, necessary to achieve project goals.

H71F-05 0935h

An Historical Approach for Specifying Restoration Flow Regimes for the Duchesne River, Utah

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Historical data describing channel changes are essential for the development of stream restoration goals, and provide a basis for defining the magnitudes and durations for channel maintenance discharges. We have developed a strategy for determining in-stream flow requirements for the lower Duchesne River, Utah, that includes an historical analysis of channel morphology that quantifies the magnitudes of historic channel change and provides a direct linkage between changes in channel morphology and changes in hydrology resulting from water development and climatic variability. This method for defining recommended flow regimes for channel maintenance or restoration is superior to traditional approaches based on the measurement of present conditions only.

Management objectives for prescribed flows may include restoration to pre-disturbance conditions, rehabilitation to intermediate conditions, or maintenance of existing conditions. Identification of restoration or rehabilitation objectives requires that prior states of the system be determined. Historical analysis also identifies probable modes of stream response to future changes in hydrology or sediment regime by supplying spatially-explicit information about past channel adjustments. Historical analysis of the lower Duchesne River demonstrates that this 27-km-long stream segment contains four discrete zones whose recent history of channel change differs. Thus, the task of restoration varies spatially, such that managers may choose to assign different targets to different portions of the stream.

The hydrologic record for the lower Duchesne River shows oscillations on a decade time scale, with the bulk of geomorphic activity on the river occurring during wetter-than-average periods containing relatively large floods. Our approach for defining recommended magnitude/duration regimes for channel maintenance or restoration incorporates this hydrologic variability by calculating the cumulative flow volumes in excess of a specified threshold during past time intervals, and relating those volumes to the levels of geomorphic activity within the same intervals. Geomorphic activity during each interval is quantified by activity metrics derived from analysis of changes in channel configurations shown on historical aerial photographs. Although most non-historical approaches for specifying maintenance flows are capable of identifying geomorphically-effective flow magnitudes, they are poorly suited for identifying the optimal durations for these discharges. Recommended flow durations are typically estimated using flow duration curves that obscure hydrologic variability, and using sediment rating curves that may incorporate substantial errors in the estimated sediment transport rates.

H71F-06 1010h

Stochastic Analysis of Sediment Flux in the Context of River Management

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A basin-scale, sediment transport study which models the uncertainty in mainstem flow conditions was initiated along the Sacramento River, California. The study incorporates: HYDROCARLO, a stochastic event-based flow generator; HEC-RAS, a flow-routing software; and the Engelund-Hansen sediment transport equation for total load. Inflow hydrographs from major tributaries were simulated with HYDROCARLO over the desired time period and routed through the mainstem Sacramento using HEC-RAS. Daily stage data output from flow routing were used to calculate water surface slope and velocity at desired cross sections. Stage and velocity were then used to drive the Engelund-Hansen sediment transport equation and predict sediment flux in various grain size classes (determined from field data) and in distinct portions of the channel cross section. The technique was cross-checked against results from statistical models employed to predict suspended sediment flux at the same cross sections. Stochastically-driven sediment transport calculations can be formulated as probabilities thus suggesting a range of uncertainty and a central tendency. Such calculations could provide river managers with constraints on sediment flux estimates in river channels that are undergoing adjustment to natural perturbations or management scenarios.

H71F-07 1025h

How Uncertain is the Geomorphology Used to Design River Restoration Projects?

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To be sustainable, river restoration projects must be designed to recreate appropriate functional characteristics, often within a context of physical (i.e. morphological) stability. Hence, much restoration science has focused on the development and application of geomorphic principles for river restoration design. Generic frameworks underpinning geomorphic approaches to river restoration design have now been proposed and are supported by a wide range of design tools and models. Unfortunately, the state of the art is that existing tools are either entirely empirical or empirically calibrated in nature, so different results are obtained when applying different models to the same problem. Accordingly, designers of stream restoration projects are confronted with rather high levels of uncertainty (Brookes and Shields, 1996).To date, no study has yet attempted to constrain or quantify the actual level of uncertainty involved. River restoration science has instead focused on the management response (e.g. post-project appraisal, adaptive management strategies) required to confront the assumed uncertainty. This is unfortunate because institutional and public confidence in river restoration and management could in the future be undermined if the limitations of restoration science are not adequately communicated. To address these issues, we herein present a case study in which we have quantified the uncertainty involved in developing a (geomorphic) restoration design for the highly disturbed River Cherwell, a typical British lowland stream. Although our restoration design is based on geomorphic principles, the level of quantified uncertainty is very high. We hypothesise that the impact of uncertainty in restoration designs based on geomorphic principles is greatest in lowland landscapes. In such environments geomorphic evidence that might be useful in reconstructing pre-disturbance conditions, and hence informing restoration design, is often not available due to the extent and severity of prior human modifications. It is ironic that these types of disturbed landscapes are precisely those most in need of restoration.

H71F-08 1040h

Addressing the Uncertainty in Prescribing High Flows for River Restoration

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Flow prescriptions for environmental benefit in regulated rivers are commonly focused on the provision of minimum flow depths to achieve fish passage and holding habitat objectives. Assessment of these flows can be achieved readily and with reasonable confidence by using low-flow hydrological records and channel morphology data in combination with one dimensional hydraulic modeling. More recently, as understanding has increased of the critical role played by high flows in maintaining a wide range of habitats for instream and riparian flora and fauna, attention has turned to prescribing high flows to invoke the geomorphic processes that maintain suitable habitat niches. Prediction of the effects of these flows may require high-flow discharge and sediment transport data, high resolution topographic data, hydraulic and sediment transport modeling (often in two or three spatial dimensions), knowledge of the watershed historical context, and an understanding of the thresholds for channel morphological

change. Not surprisingly, the associated level of uncertainty in this analysis increases tremendously. High flows are defined by a combination of magnitude, frequency, timing and duration parameters and their impact varies according to antecedent events. High flow bedload sediment transport records are rare, sediment transport equations are reliable usually to only an order of magnitude, practical applications of two and three-dimensional sediment transport models are in their infancy, the watershed historical record may be patchy with the link between cause and effect difficult to ascertain, and thresholds of channel morphological change are poorly understood.

As the first step in reducing uncertainty, it is essential to state precisely the ecological target objectives of prescribed high flows, and to link these objectives to the hydraulic and geomorphic thresholds to be achieved or exceeded. Such thresholds provide the basis for a systematic classification of high flows. Here we recognize a spectrum of ten high flow types grouped in four classes encompassing flows to maintain: flow depth and velocity, channel bed texture and mobility, channel width and bar morphology and migration, and floodplain sedimentation and disturbance regime. We review the predictive ability associated with a selection of flow types to illustrate the difficulties faced. Progressively greater flows are required in each class to achieve the habitat objectives and the level of uncertainly increases in parallel. In general, because of a lack of suitable data and predictive process models, the primary practical means of reducing uncertainty is to prescribe high flow releases using best available understanding, to treat high flow releases as experiments as much as restoration projects and to be rigorous in generating hypotheses against which to monitor and evaluate their geomorphic impact.

H71F-09 1055h

Integrating Science and Engineering to Reduce Uncertainty of Stream Naturalization: An Example from the Chicago Metro Area

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Many communities in the Midwest, through consultation with scientific and technical experts, are seeking to establish sustainable, morphologically and hydraulically varied, yet dynamically stable fluvial systems that are capable of supporting healthy, biologically diverse aquatic ecosystems - an integrated social, scientific and engineering enterprise referred to as stream naturalization. In highly modified urban streams, such as the West Fork of the North Branch of the Chicago River (WFNBCR) in downtown Northbrook, Illinois, naturalization often is severely constrained by existing infrastructure. The goal of the Northbrook naturalization project is to enhance in-channel morphologic, hydraulic and habitat diversity, while ensuring that channel planform remains stable and flooding is not exacerbated. To achieve these objectives, an innovative pool-riffle design has been developed for straight urban streams through integration of geomorphological, ecological and engineering principles. The design is based mainly on geomorphological understanding of pool-riffle structure and function, yet also considers habitat needs of fish. Engineering analysis has focused on the hydraulic performance and hydrological effects of the pool-riffle structures through numerical and physical modeling. Eleven pool-riffle structures were constructed in a 900 m reach of the WFNBCR between November 2001 and May 2002. Initial field analysis suggests the structures are performing as expected hydraulically and geomorphologically, and have enhanced habitat for fish.

H71F-10 1110h

Lessons from a Spawning Gravel Rehabilitation Program

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Altered sediment and flow regimes in dammed and regulated rivers limit available spawning habitat to salmonids. River managers have attempted rehabilitation of spawning habitat with gravel augmentation and riffle construction projects, but often neglect well-established conceptual models of geomorphic and ecologic processes, let alone apply them in a predictive manner. Application of such models could not only improve rehabilitation projects, but also serve to further test and evaluate the underlying scientific theories against the rigors of real-world uncertainties. For the past two years a new science-based approach to rehabilitate spawning gravels for salmonids has been under development and testing to overcome these deficiencies. The approach includes a balance of science-based quantitative tools from multiple disciplines and qualitative local knowledge relevant to the region in which it has been applied. In 2001 and 2002 it was used to design and implement the placement of 907 and 2787 metric tons of gravel, respectively, on separate reaches of the lower Mokelumne River in Central California. A long-term monitoring program to quantify outcomes and assess sustainability is on-going. Lessons from these efforts are providing for adaptive management and will be presented.

URL: http://lawr.ucdavis.edu/faculty/gpast/shira/shira_contents.htm

H71F-11 1125h

Modelling the Geomorphological and Ecological Dynamics of River Corridors: Developing a Simulation Tool for River Management

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Interest in the integrated restoration of managed river corridors has arisen in response to falling levels of riparian and floodplain biodiversity due to flood control works including channalization and flow regulation by headwater impoundments. This decline is in part, a direct response to the impact of engineering works on the geomorphological dynamics of rivers and in particular, upon rates of channel migration. Channel instability, through the processes of bank erosion, avulsion and cutoff, and within and overbank sedimentation, continuously renews the floodplain creating virgin territory for plant colonization. The varying age of alluvial surfaces, in combination with differences in topography and sediment calibre influence plant succession pathways and gives rise to a mosaic of floodplain plant communities. This geomorphological influence underpins the intermediate disturbance hypothesis which suggests a non-linear relationship between floodplain turnover rates and biodiversity, which is low in both highly stable and unstable rivers regimes. In the former case, diversity is limited as stable regimes promote succession towards relatively uniform stands of floodplain forest while the in the later case, extreme instability results in the sole dominance of early coloniser species. By contrast, diversity is maximized for intermediate levels of disturbance, which result in a range of habitats at varying positions along successional pathways.

While conceptually satisfying, calibration and validation of this perceptual model is confounded by the differing local conditions and environmental history of individual rivers, which complicates simple empirical inter-comparisons. Prescription of the appropriate levels of disturbance necessary to optimise habitat and biological diversity therefore remains unclear and difficult to translate into practical frameworks for river management. This paper presents an alternative approach to investigate this interdependence through the development of a numerical model which captures the primary geomorphological and ecological dynamics of river systems at appropriate levels of complexity tuned to reach and decadal space and time scales. Here a prototype model is presented for braided rivers, in which a simplified flow routing procedure is used to drive predictions of sediment transport and sorting based on a cellular spatial discretization, a force-balance entrainment model and a step-length advection and grain sorting procedure. This sub-model provides the topographic and sedimentological boundary conditions for a stochastic plant succession model which simulates colonization and community development on the evolving braidplain. The model is parameterised and validated against distributed datasets from the braided River Feshie, Scotland. A Monte-Carlo based sensitivity analysis is used to explore the one-way interaction between channel migration and habitat development, with an emphasis placed on the structure of the evolving timeseries of reach-scale biodiversity indicators. Importantly however, the framework also permits full coupling of this interrelationship by modelling the influence of vegetation on bank stability so that feedback can occur to affect channel migration and floodplain turnover. Such feedback is critical in understanding the autogenic switching between channel planform types (meandering and braiding) and a new computational framework for simulating this behaviour is presented.

URL: http://www.geog.cam.ac.uk/people/brasington

H72A MCC: Hall C Sunday 1330h

Hydrology From Time Variable Gravity and Other Space-Based Remote Sensing Techniques Posters *(joint with G)*

Presiding: **I Velicogna,** University of Colorado**; M Rodell,** NASA Goddard Space Flight Center

H72A-0837 1330h POSTER

Measuring local hydrological effects on the long-term gravity variation in Membach, Belgium

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Absolute (AG) and superconducting (SG) gravity measurements have been performed since 1996 at the underground Membach Station (Ardenne, eastern Belgium). Two effects can be distinguished: one seasonal-like and a long-term geophysical trend.
The first effect is a 5 μGal seasonal-like term due most probably and mainly to hydrological variations. To determine the thickness of the porous unconsolidated layer covering the fissured bed-rock (low-porosity argillaceous sandstone with quartzitic beds) through which the tunnel was excavated, electrical tomography measurements were performed above the Membach station. Results of these measurements, as well as preliminary geological investigations are presented here. This will allow us to correct the gravity variations induced by the highly variable mass of water stored in the shallow partially saturated soil. This work can be essential to correct local effects that can mask regional effects such as changes in continental water storage. Local effects, indeed, could prevent the combination of satellite data (e.g. GRACE) with ground-based gravity measurements. On the other hand, studying the local seasonal variations also contributes to investigate the influence of the water storage variations in small river basins on the time dependent gravity field.
The second effect is the detection of a very low geophysical trend in gravity of -0.9 μGal/year. The SG drift, the hydrological effects, and the origin of the low trend are discussed. In particular, we show a good correlation between the gravity measurements and the continuous GPS measurements being made since 1997 at 3 km from the station. Possible crustal deformations could be linked to active faults in the Ardenne and/or bordering the Roer Valley Graben, or perhaps linked to the Eifel plume.

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Sensitivity of In-situ Gravity Measurements to Local Hydrometeorological Processes

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