

## **Dynamic stress regimes and their implications for the stability of earth materials**

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Our understanding of how soft sediments respond to applied stresses has greatly improved in recent years. By combining well-constrained field and laboratory data using computer modelling, understanding past or predicting future change can be undertaken with some confidence. There are many environments where stress regimes are complex and dynamic loading via natural processes is important. Dynamic stresses are imposed during earthquakes or from construction activity such as pile driving. Other subtle processes, such as tidal-induced changes in water column height and sedimentation rates in low lying coastal areas, impart a load to earth materials that changes on a regular and constant basis. The work reported here outlines a sequence of field and laboratory tests completed to improve our understanding of the effects of dynamic loading and the associated stress-strain characteristics of sediments on geomorphological processes. Laboratory apparatus has been designed and constructed to simulate complex loading scenarios. Results suggest that some improvement can be made to our knowledge of sediment behaviour and the response as seen through geomorphological processes, such as landslide activity patterns and rates of sediment compaction.

*Key words: dynamic stress, soft sediments, ground subsidence*

## Groundwater flow in a Large-Scale Landslide for Snow Melting Period

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In Japan many landslides occur in regions underlain by Tertiary mudstone. In heavy snow regions, they often occur in the snow-melting season. We investigated the characteristics of the groundwater flow as a cause of a landslide in order to clarify mechanism of landslide occurrence. Pore water pressure was observed in the large-scale landslide area, which was approximately 1.2 km long and has a deep slip surface in the mudstone layer. Result showed that the quantity of infiltration water from the ground surface increased in snow melting period, therefore the pore water pressure of the underground rose. High-density electrical prospecting was carried out along the longitudinal line to clarify the spatial distribution of the groundwater. A two-dimensional numerical model was constructed by geological profile and result of electrical prospecting. Groundwater flow was analyzed using this model to derive groundwater flow variation in the spring. The result of the analysis showed that the groundwater pressure was increased in top of the landslide by inflow from the surrounding areas. These flow characteristics of the groundwater seem to have greatly contributed to the occurrence of landslides.

*Key words: Landslide, Groundwater, Snow melting season, Numerical Analysis*

**Lake Morphology and River Suspended Solids Transport  
in the Internal Drainage Basin (IDB), Mongolia**

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Main tributary rivers in the IDB are originated from Altai and Khangai mountain ranges and ended in closed lakes: -Uvs, Khirgas, Boon-tsagaan, Orog and others. Total water resources of the closed lakes are 112.80 cubic kilometers from which 66.03 cub.km belongs to Khirgas lake, which is the deepest (80 m) in this region. The Uvs is known as the greatest lake of Mongolia (3641 sq.km), but it has only 21.5 m maximum depth. Discussed reasons of these different morphological situations and analyzed total suspended solids (TSS) concentrations in the main tributary rivers. TSS ranged from 6.5 mg/L to 60.2 mg/L and average is 31.6 mg/L for this basin. Its concentrations show remarkable seasonality. Load of suspended solids ranges from 89 (Tyi river) to 139000 tons/year (Khovd river). Average load for the basin is 18953 tons/year. Mechanical soil erosion is 0.02-4.17 t/sq.km.year. An average 0.257 tones of soil are eroded annually per sq.km. area in this basin.

*Keywords: hydrology, limnology, sedimentology, arid land, water quality.*

### Scaling Processes in Mountain Basins

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In the context of small mountain catchments, constant-rate processes are often driven by the occurrence of longer return periods phenomena such as mass movements and floods. These last generally behave as catastrophic processes controlled by a succession of random distributed pulses. In this case one of the principal mechanisms affecting the erosion and transport of sediment can be considered the formation and removal of temporary blockages at different scales, from the accumulation of small debris in hillslope rills to the formation of landslide dams in the main river channel. To test this hypothesis the paper discusses the case study of the Tegline creek in Central Tuscany (Italy) which exhibits a documented series of pulse processes at different scales. Among these, a large perturbation induced by an earth-dam built in the early '60 which impounded the lower reach of the creek and was subsequently breached in 1993 with sudden drainage of the artificial lake. Preliminary results show that this sequence of similar processes has scaling properties that could be used as a general framework for the comprehension of the interplay of the various parameters controlling the small mountain basin evolution.

*Keywords: mountain catchments, fractals, pulse processes.*

**Modelling Soil Erosion Around Buried Archaeological Sites in Lowland  
Scotland.**

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A predictive soil erosion model has been developed allowing evaluation of risk posed to archaeological sites. 2849 registered buried archaeological sites are in the study area (3800km<sup>2</sup>) across Perth and Kinross-shire and Angus with 67% being located on arable land. The model primarily considers a) Hydrological processes: a 2-D process-based hillslope storage model (Kirkby, 1978) forms the basis of a predictive model developed to simulate erosion/deposition. The model also focuses on the routing of flow (runoff) across the landscape. Pilot runs of the model show signs of good predictive ability at the plot and small catchment scale. Vegetation cover, soil type and field boundary controls are being incorporated into the model. b) Tillage: Investigations have been carried out on whether attention needs to be paid towards tillage as well as model integration. Results from the modelling are compared with <sup>137</sup>Cs derived mean soil erosion/deposition rates (calculated over the last 40 years) from soil core sampling at 4 field sites. These data will be compared with model predictions for the same sample field sites and used as validation.

*Keywords: soil, erosion, modelling, tillage, Scotland, <sup>137</sup>Cs.*

Experiment Study on the Effectiveness of Hedgerow Barriers in Reducing Soil Erosion on Steep Slopelands, Three Gorges Region, China

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Intercropping hedgerows have been proved to be an effective way to reduce soil erosion on cultivated slopes in tropical regions (Young, 1989). It also has a great potential to curb water erosion in subtropical areas where rainfall is often intense. This study uses simulated rainfall on experiment plots to investigate the effectiveness of hedgerows in Three Gorges region, China where utilization of steep slopelands is essential to the subsistence food production for the resettled population from inundated foothills. The experiments were conducted on six 10x2 m<sup>2</sup> plots of 25 degrees. Five plots were planted with hedgerows of *Vetivevia zizanioides*, *Coriaria sinic*, *Vitex negundo*, and *Leucaena leucocephala* along contours while the sixth were left hedgerow-free. For plots with hedgerows, the within-row plant spacing was 0.4 m while between-row spacing was 3 m. The hedgerows were planted one year earlier and were pruned a day before the experiments. Litters of leaves and small branches, where they were available, were intentionally placed on the upper-slope side of the hedgerows. The experiments lasted for 24 hours. The data revealed that intercropping hedgerows reduce runoff or overland flow by 22-43%, and reduce soil erosion by over 90%. In light of the lack of sufficient funds from central government, the cost saving measure of using hedgerows is a viable alternative to mechanic measures in reducing erosion and sustaining soil in Three Gorges region.

**Runout of fragmenting rock avalanches – dynamic analysis**\*T. R. DAVIES<sup>1</sup> and M. J. MCSAVENEY<sup>2</sup><sup>1</sup>Natural Resources Engineering, Lincoln University, New Zealand[Davidet@lincoln.ac.nz](mailto:Davidet@lincoln.ac.nz)<sup>2</sup>Institute of Geological and Nuclear Sciences Ltd, Lower Hutt, New Zealand

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A mass-referenced continuum model for dynamic analysis of rapid mass movements is verified by laboratory data. It is then used to represent the effect of fragmentation pressures inside a translating rock avalanche by increasing the earth pressure coefficients. This strategy is necessary because the rheology of fragmenting rock is presently unknown. It demonstrates that the increased runout of large rock avalanches can occur with normal friction coefficients if higher than normal lateral pressures such as those believed to be generated by fragmentation are present. The deposit extent of the Falling Mountain rock avalanche in New Zealand is shown to be reproducible with almost-normal friction and increased internal pressure due to fragmentation. It appears that fragmentation might cause slightly reduced internal friction – to test this requires investigation of the rheology of fragmenting rocks.

*Keywords* Rock avalanches; long runout; fragmentation; computer simulation.

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1<sup>st</sup> Choice: ① (one) 2<sup>nd</sup> Choice: - 3<sup>rd</sup> Choice: -**Causes of Landslides in the Balasan Basin of Eastern Himalayas**

Sunil Kumar DE

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The Balasan basin of Eastern Himalayas constitutes a fragile and unique ecological system. Ever since the independence (1947) the physico-cultural set up of the basin has been seriously disturbed. Tea plantation, population explosion, extensive heedless deforestation, haphazard construction works, inadequate drainage, in other words - unscientific and unplanned usage of land has led to the establishment of vicious cycle of denudation, heavy and concentrated rainfall aggravating soil-erosion and landslides. In order to have an insight into the probable causes of such increased vulnerability, the methodology employed in this present study, is comprising of quantitative determination of the instability factors of slope, analysis of soil properties, geological structures and geomorphological processes together with the study of the nature and extent of human interference. Five categories of susceptibility zone have been distinguished in the basin with the help of a 'check-list', topographical maps, landsat imageries and direct field observations at 42 sample sites. In the suggested conservation plan utmost priority has been given to develop mass awareness among both the local people and the tourists, so that they become aware of the possible dangers that they are inviting by interfering with natural laws.

*Key words : landslides, soil-erosion, susceptibility zone, conservation plan*

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### Hydrogeomorphological Modeling of Flood in Zohre and Khirabad Basins

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Flood is the most important natural disaster in Iran that has negative effects on the environment. In order to forecast this phenomenon, researchers use different methods such as statistical analyses, rainfall-runoff model, etc.. In this paper, to forecast the flood in Zohre and Khairabad basins morphology data were used. Therefore, 30 physiography variables such as area, slope gradient, gravlious coefficient, relief and other factors are studied for 15 sub-basins of case study area. Then, all of factors with maximum flood discharge, as independent factor, are combined in multiple regression model based on backward method. The Produced model is calibrate for sub-basias using correction coefficient. The result of this work indicates that the area, drainage frequency and the total of drainage length factors are main factors that can be used in the final produced model. The final model is evaluated based on regression coefficient which shows very good correlation between estimated and measured flood data.

*Key words: modeling, hydrogeomorphology, flood, muliple regression, physiography*

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## Session (1) Hillslope processes and hydrogeomorphology

### **Subsurface Erosion in Loess Sediments of the Eastern Harz Foreland**

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In the eastern Harz Foreland 20 km west of Halle (Saale) patterns of subsurface erosion processes have been investigated. In the study area periglacial sediments (loess, reworked loess and solifluction debris) were accumulated on plateau surfaces over large areas during the Weichselian glacial. Preconditions for subsurface erosion in this area are thick loess and loess deposits and underlying layers consisting of paleosols or Tertiary weathering zones. For pipe creation and enlargement, the in situ loess is cohesive enough to maintain the walls of the pipes. The underlying reworked loess is less stable and affected by entrainment of fine particles. Rapid macropore flow and subsurface flow (interflow) seem to have of great importance for hillslope hydrology and geomorphological processes. To clarify the implications of subsurface hydrology for subsurface erosion processes tensiometers and suction lysimeters were installed in a depth of 1, 2, 3, and 4 m. Detailed tensiometric recording indicate a two-component flow system of slow matrix flow and rapid macropore flow. In order to get some information about the residence time of seeping water different chemical data (anions, cations, tritium) were analysed.

*Keywords: subsurface erosion, Loess, soil water, eastern Harz Foreland*

**Differences in Hydrological Characteristics of Small Granitic Catchments  
between Japan and Korea**

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To elucidate the differences in hydrological characteristics of small granitic catchments between Japan and Korea, discharge and electrical conductivity of stream water were monitored. The study catchments are located in the central Abukuma Mountains, northern Japan, and located in a suburb of Seoul, northern Korea. Both areas are situated in similar latitude, and under similar climatic condition, i.e. mean annual temperature is about 10 °C and annual precipitation is about 1,100 mm. The Japanese and Korean study catchments have an area of 0.040 km<sup>2</sup> and 0.055 km<sup>2</sup> respectively, and have similar vegetation. Results obtained by hydrological measurements are as follows; 1) The value of electrical conductivity is similar. 2) The magnitude of runoff peak of Japanese catchment is large in comparison with Korean catchment. 3) The recession is slower in Japanese catchment.

*Key words: runoff characteristics, granite, small catchment, Japan, Korea*

**Relationships Between Streamflows and Suspended Sediment Concentrations in a Forested Headwater Catchment**

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Suspended sediment concentrations in streamflows (SSC) were measured at the gauging weir of Kamabuchi No. 1 experimental watershed (two-order basin). SSC in the base flow were higher in the temperate season, and increased according to rising of streamflows caused by thaw and rainfall. Although the time series of SSC did not always scaled to the streamflows, the trend of differentiated streamflows twice with respect to time were approximately inverse to the variation trend of SSC. And when a temporal isolation between adjacent peaks of water discharge was short, the second SSC peak's increasing rates to streamflows were relatively smaller than the first SSC peak's increasing rates in most cases. These results suggest that SSC in forested headwater catchment would be influenced by stationarity of streamflows, and also accumulation or changes of viscosity by water absorption of suspended sediment sources.

*Key words: suspended sediment, streamflows, headwater catchment*

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1<sup>st</sup> Choice: (4)2<sup>nd</sup> Choice: (8)3<sup>rd</sup> Choice: S 14**Modeling of Slope Erosion Process under Rainfall**M.S.KUZNETSOV<sup>1</sup>, SHAO MINGAN<sup>2</sup>, V.M.GENDUGOV<sup>1</sup>, O.V.KALAHNIKOVA<sup>1</sup>

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The new physically based equation of soil particles detachment by flow was proposed on the basis of fundamental laws of polyphase systems mechanic (Kuznetsov et al., 1998):

$$q = e^{\alpha} \frac{\tau}{v} B_{sc} \exp\left(-\alpha \frac{v_{sc}^2}{v^2}\right), \quad (1)$$

$q$  is rate of soil particle detachment ( $\text{kg}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ );  $\tau$  is shear stress at the bottom of flow ( $\text{N}\cdot\text{m}^{-2}$ );  $v_{sc}$  is scouring flow velocity ( $\text{m}\cdot\text{s}^{-1}$ );  $v$  is average flow velocity ( $\text{m}\cdot\text{s}^{-1}$ );  $B_{sc}$  is

parameter of mass-exchange when  $v = v_{sc}$ , that is  $B_{sc} = \left(\frac{qv}{\tau}\right)_{sc}$ ,  $\alpha$  is constant. This paper

is dedicated to verify the equation (1) on the base of the experimental data received under the simulated rainfall on experimental plots on the moderately eroded soils in Moldova: clay-loam chernozem ordinary and loam chernozem calcareous. As a result the following values of the parameters in the equation (1) were received:  $\alpha=0.23$  if  $v < v_{sc}$ ,  $\alpha=2.5$  if

$v > v_{sc}$ ;  $B_{sc} = 3.5 \cdot 10^{-6}$  if  $H/D > 1.5$ ;  $B_{sc} = 6.0 \cdot 10^{-6}$  if  $H/D \leq 1.5$  ( $H$  is depth of flow,  $D$  is diameter of drops).

*Key words: modeling, soil detachment capacity of water flow, impact of raindrops*

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**Formative History of Ridge-top Depressions and Uphill-facing Scarps in the Sedimentary Rock Mountain, Akaishi Mountains, Japan**

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Ridge-top depression and uphill-facing scarp are typical landforms made by gravitational deformation of mountain ridges. These forms are linear features, parallel or subparallel to contour lines, and are commonly observed distributed in mountains, consisting of sedimentary rocks with steeply-dipping foliation. We performed detailed investigation on geology and morphology of ridge-top depressions and uphill-facing scarps in the Akaishi Mountains. The relationship between landform and geological structure indicates that valleyward bowing of bedrocks occurred, producing ridge-top depressions and uphill-facing scarps. Sediments in depressions indicate that ridge-top depressions and uphill-facing scarps were made intermittently and those in higher elevations are older than those in lower elevations.

*Key words: Suckungen, mass rock creep, sedimentary rock, large-scale landslide, Akaishi Mountains*

**Landslide Typologies, Statistical Distribution and Inventory map of  
the Val Marecchia Area (Northern Apennines, Central Italy).**

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The Val Marecchia area is one of the most critical areas of Italy as regards slope-failures. A 1:10.000 scale geomorphological and geological survey project allowed the detailed study of the typological and spatial distribution of the about 4200 landslides recognised. The survey has been carried out through the interpretation of aerial photographs and detailed field checks, through geomorphological and geological mapping. The bedrock is characterised by allochthonous structural units, mainly made of clayey and marly sediments, emplaced by gravity induced tectonics (Val Marecchia Gravity Flow). Therefore, the typologies of slope-failures are mainly driven by the particular lithological and structural setting of the bedrock; they range from small-scale simple flows to active deep-seated gravity movements. However, most of the slope-failures show complex characters and some of them involve slopes exceeding 3 km in length. The GIS based techniques and the Geomorphological Database allowed a first rapid and quantitative analysis of the spatial distribution of slope-failures. For this purpose a 1:100.000 scale Landslide Inventory Map has been obtained, which constitutes the first and fundamental step for further landslide hazard determination.

*Key words: landslides, geomorphological mapping, GIS, inventory map, Italy.*

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**Slope Evolution by Landslides – a Multiscale Research Approach**

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To understand the dynamics of geomorphic systems, it is necessary to explore both recent geomorphic processes and changes over historic and geologic timescales. It is the purpose of this contribution to present an approach to the quantification of the geomorphic effectiveness of landslides as part of the slope system. In modelling mass movements over longer time scales, questions relating to unknown boundary conditions, process interaction and discontinuity or episodicity of slope processes have to be considered. The presented approach is based on the hypothesis that it is possible to define process domains and climatic regimes that represent distinct differences in the characteristics of mass movement behaviour relevant for slope evolution. The derivation of these domains and regimes is achieved by interpretation of available (historic) data in a geomorphic context. The aim is to derive a model of process variability in space and time, that will contribute to a semi-quantitative description of slope development as a geomorphic evolutionary system. Combining detailed modelling of slope stability and activity for well-known field sites with an estimation of spatio-temporal variability of boundary conditions within a higher scale geomorphic system leads to a spatio-temporal model of landslide contribution to landform evolution.



## Spatial Variability of Soil Erosion Rates at a Steep Slope

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Soil erosion rates were measured to analyse the spatial variability of denudation process on a steep bare slope. The slope, which is made of weathered granitic soil, has a steepness of 23.7 degree and an area of 8 m wide and 11.5 m long. During the measurement period from June to November in 1993 total sediment yield reached at 122 kg. Ground surface lowering was measured by using erosion pins installed at an interval of 0.1m along the measurement lines which were set transverse to the slope steepness. Total erosion loss measured at seven measurement lines with 560 sampling points is almost equal to the sediment yield. Means of the erosion rates for each measurement line were ranged between 0.40 mm and 0.99 mm. The maximum mean erosion rate was shown at the second line from the upper-end of slope. The minimum rate was observed at the seventh lowermost line. According to the semi-variogram, which is defined by the half of self covariance of erosion rates, sills were high and ranges were smaller than the sampling interval at the upper slope: This indicates that the similarity of the sample points were restricted within the 0.1m width. Nevertheless the ranges were over 0.5m at the lower slope: The denudational process at the lower slope was similarly occurred between the several sampling points.

Key words: erosion rates, steep slope, statistical analysis, weathered granite

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**Assessment of sediment yield in Lake Balaton catchment by the USLE and  
MEDRUSH models**

**ÁDÁM KERTÉSZ\***, GERGELY JAKAB, ADRIENN TÓTH

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The objective of the paper is to discuss the applicability of two models to answer the question how sediment generated on the hillslopes contributes to the sediment yield of the stream. The USLE was applied to assess soil loss for small areal units of a catchment of 24 km<sup>2</sup>. Adding these values for the whole catchment the total sediment production within the catchment was calculated. By comparing this value with the actual amount of sediment leaving the catchment at the outlet a sediment delivery ratio of only 2% was obtained. The applicability of this method can be disputed because of many reasons treated in the paper. The MEDRUSH model was applied to predict runoff for different land use types for long time-perspectives for another catchment of 102 km<sup>2</sup>. A difference of 20-30 % of infiltration values of arable land, vineyard, pasture and forest was established by the model. In case of arable land 10-20 % of the rainfall leaves the slope by subsurface flow, 2-6 % in vineyards and almost nothing in forests. The amount of runoff depends on land use as well. The conclusion is that the USLE gives a very rough estimate of sediment delivery, while the MEDRUSH model can be very well applied to determine the details for different land use types.

*Key words: soil erosion, sediment yield, modelling, land use, catchment hydrology*

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In Japan, 70 % of this small national land is covered with mountains and the area where human can live is limited, also 125 million people lives in the Japanese islands, more and more places have been put at risk of the sediment-related disaster (so called sediment disasters) through the development of piedmonts and hill zones for residence. Therefore the Japanese people cannot help living such places where sediment movement, attended topographical variation, occurs easily because of topographical, geological, meteorological condition. So sediment disasters occur frequently. Then I will introduce examples of these sediment disasters and prevention and mitigation measures, that is called Sabo Works, against them, based on the volcanic eruption of Mt. Unzen since 1991 and its countermeasures.

*key works: sediment disasters, Sabo works, sediment movement, topographical variation*

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