Is Geology Destiny?: The Interaction Among Geology, Geomorphology, and Hydrologic Regime in the McKenzie River Basin, Oregon, USA

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An analysis of seasonal and event-based hydrographs in the McKenzie River Basin in Oregon revealed strong relations among geology, climate, topography, and flow regimes. A new hydrograph separation technique was used to compare peak and low streamflows from streams draining both older, dissected and younger, undissected volcanic terrains. Flow regimes clearly demonstrate underlying geologic control, with streams from the younger volcanic region exhibiting less pronounced peak streamflows and more sustained base flow, than streams draining the older platform. These differences in streamflow are also reflected in distinctive sediment transport regimes and channel morphology.

\textit{Key words: Streamflow regimes, hydrograph separation, hydrogeomorphic control, peak flows, low flows}
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Soil pipe morphology and runoff process of pipeflow at a forested hillslope in Ashiu, Japan
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Digging was used to investigate the morphological characteristics of a soil pipe in a steep unchanneled hollow. The digging indicated that the soil pipe developed nearly parallel to the soil surface and along the longitudinal hollow. The shape of soil pipe was almost circular, with a diameter of about 3 to 5 cm. The length of soil pipe was larger than 2.0 m and the depths at which soil pipe were existed ranged from 70 to 80 cm from the soil surface. Before the digging, we conducted the simultaneous measurement of soil pore water pressure and pipeflow. The discharge rate of pipeflow was responsive to the temporal variation in rainfall intensity, although the soil pore water pressures at the 0.5 and 1.0 m upslope from the pipe outlet remained almost constant. In this case, the pipeflow was closely related to pore water pressures at 1.5 to 2.5 m upslope from the outlet. Further, we estimated a saturated groundwater volume using results of pore water pressures and found that the discharge rate of pipeflow was closely related to the groundwater volume. These morphological and hydrological results suggested that the infiltration from soil matrix into soil pipe occurred not only at near pipe outlet area, but also at the upslope area.

Key words: soil pipe morphology, runoff generation, pipeflow, forested hillslope

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Role of Bedrock Spring in Runoff Generation Processes in a Steep Granite Basin

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Stable isotopic composition and inorganic solute concentrations in bedrock springs were observed to investigate the role of bedrock subsurface outflow in runoff generation processes in a headwater basin with large relief underlain by granite in central area of Japan. The specific discharge rate of spring water was higher in lower altitude than that in higher altitude, and electrical conductivity and SiO₂ concentration of spring water in lower altitude were higher than that in higher altitude in summer high flow season. The oxygen-18 isotopic ratio in spring water showed a negative correlation with the altitude in summer, whereas no clear correlation was obtained in low flow season. These data suggests that the bedrock springs at the lower altitude would have relatively long residence time with long distance flow path especially in high flow season, whereas the springs at the higher altitude would have short residence time.

Key words: bedrock spring, runoff generation processes, granite basin
Heavy Rainfall Episodes and Geomorphological Dynamics in the Serra da Estrela Plateaus, Portugal
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The Serra da Estrela is a plateau mountain with a maximum altitude of 1,993 m located in Central Portugal. The climate is Mediterranean. Higher precipitation occurs from October to March and surpasses 2,500 mm/year in the summit area. The granite plateaus are poorly vegetated with small shrubs and grasses. In many areas bare surfaces of rock and weathered material dominate and distinct types of microforms formed by coarse sand and granules are present. Recent studies of these microforms led by Vieira indicate that they are very dynamic features controlled by the interaction of different geomorphological processes. The role of wind-driven rainfall has been pointed as a prominent process on the present-day morphogenesis in the plateaus and as the main agent on the formation of the coarse sand microforms. In this study we characterize the precipitation regime in the Serra da Estrela using two principal approaches: the analysis of the synoptic conditions responsible for the different types of precipitation events; and the analysis of data from the Penhas Douradas meteorological station. The main characteristics of the precipitation events are presented and their morphogenetic significance is discussed.

Key words: heavy rainfall, soil erosion, rainsplash, Mediterranean mountain.
The Role of the Bedrock Permeability on Soil Water Movement, Landslides and Landform in Steep Mountainous Areas in Japan

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Hydrometric observation has been conducted to study the contrasting landslide occurrence and drainage density between the granite and the shale mountains in the Japan Alps, central Japan. Six (three are in shale and three are in granite) small watersheds were monitored in forest covered with very steep slope angles (>40°) with 0 to 1m of soil mantle. Tensiometric and TDR data in hillslopes indicate that soil water percolated vertically downward into bedrock even during storm event, whereas subsurface stormflow parallel to the hillslope was observed in granite basins. The hillslope soil water and stability analysis for the granite and shale watersheds indicates that the granite has lower safety factor because of high susceptibility for soil water saturation. This suggests that the landslide occurrence and resultant landform is strongly controlled by the degree of the bedrock permeability.

Key words: Landslides, stability analysis, tensiometric analysis, bedrock springs, bedrock permeability
Numerical Modeling of Soil Pipe Flow and its Effect on Slope Stability
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A chain of connected macropores, which develops nearly parallel to the soil surface, is commonly found in hill slopes and referred to as a horizontal soil pipe. Field observations have revealed that water flow in such pipe (pipe flow) has large hydrogeomorphic effects since it contributes to rapid transfer of storm water and subsurface soil erosion. Hence, modeling of the pipe flow is essential for predicting geomorphic changes induced by hydrological processes. Besides field observations of pipe flows, we conducted laboratory experiments using an acrylic rectangular flume filled with sand. Acrylic pipes of 0.8 cm in inner-diameter and 30 cm in length, which worked as pseud soil pipes, were buried in the sand. The whole flume was leaned at 15 degrees and water was supplied from the top end of the flume with an intensity of 0.5 cm³/s. We examined several situations including "open pipe" (i.e., the end of the pipe was open to the air at the lower end of the flume) and "closed pipe" (i.e., the whole pipe was buried in the sand), and found that Richards equation can describe the water dynamics in every situation by assigning a larger conductivity value for the soil pipe. Analyzing field observed data by the developed numerical model, we examined processes of shallow landslides triggered by choking of soil pipes.

Key words: soil pile flow, shallow landslide, numerical modeling, Richards equation
Coupling of Hillslope Hydrological Processes and Sediment Transport in Small Watersheds Underlain by Mesozoic Sedimentary Rocks

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To study the coupling of hillslope hydrological processes and sediment transport, two experimental watersheds were established in chert (0.5ha) and sandstone (0.7ha) area in Ashio Mountains, Japan. The runoff and sediment transport were monitored at several gauging points in the watersheds. The hillslope landform consists of bedrock cliffs and talus-like accumulation of rock fragments in the chert watershed, whereas the soil-mantled (as much as 3 m) convex slope in the sandstone watershed. In the chert watershed, the rock fragments were found to be supplied from the cliffs to downslope by rockfall and were transported by the fluvial processes at the runoff events characterized by sharp runoff peaks. In the sandstone watershed, in contrast, the runoff events with delayed and attenuated peaks were generated by the bedrock groundwater outflow from the spring, and seepage erosion occurred during the runoff events. The dominant process for landform evolution is considered to be the seepage erosion in the sandstone watershed, whereas combination of the rockfall and the fluvial transport in the chert watershed.

Key words: hillslope landform, runoff, sediment transport, sandstone, chert
Water flow paths and sources of weathering-derived solutes in headwater catchments

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In order to evaluate the flow paths and source of weathering-derived solutes from catchments, observations were conducted in two small headwater catchments in Tanakami Mountains, central Japan. Two catchments, Fudoji (forested; 0.10ha) and Rachidani (bald; 0.18ha), share the same bedrock geology (granite) and similar climatic conditions, but are different in vegetation and soil depth. Hydrometric and isotopic measurements were conducted to determine the flow paths. Concentrations of Na⁺, K⁺, Ca²⁺, Mg²⁺ and SiO₂ in rainfall, throughfall, soil water, groundwater, spring and stream waters were measured to evaluate the spatial distribution of solute concentrations within catchments. Hydrometric and isotopic measurements indicated the substantial downward vertical water flux into the bedrock in upslope area and emerging of this water from bedrock to soil layer in near the perennial spring point. Based on these results, it was possible to partition the solute source within catchments into soil layer and bedrock. The results presented that solutes originated from bedrock contributed as substantial portion in both catchments. Contribution of bedrock was larger at the forested catchment than bald catchment.

Key words: bedrock flow, chemical weathering, headwater catchment, solute source
Similarities and Differences of Hydrological Cycle in Mountains of Monsoonal Climate

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The type and intensity of geomorphic processes in monsoonal climate are closely connected with hydrological cycle, which may be modified by various bedrock lithology and tectonic tendencies. These differences are illustrated by two examples from uplifted mountains in India. Both are affected by high annual rainfalls, which in Darjeeling Himalaya reach 2000-2500 mm and in Cherrapunji region of the Meghalaya fluctuate between 10 000 and 15 000 mm per year. The raising Himalaya with steep slopes and channel gradients are built in this part of metamorphic rocks with sandy-silty regoliths. The southern slope of the Meghalaya has preserved old mature landscape built of sedimentary rocks dissected at its margin by deep canyons. Both areas are considerably deforested. The Darjeeling Hills are modelled during extreme events reaching 1000 mm or more in 2-3 days (with recurrence interval 20-50 years). In Cherrapunji region events of similar scale appear every year and caused just a total loss of soil cover due to predominating overland flow over the horizontally bedded impermeable rocks and residuals of lateritic crusts.

Key words: monsoonal climate, extreme rainfalls, bedrock type, runoff
No. 1

Hydrological Effect of Pine Forest on Slop Process in the Alpine Gorges, SW China

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As a typical representative in the gorges and deep valleys in the upper reaches of the Yangtze River, SW China, soil erosion in the Hutiaoxia gorge area is a serious environmental problem. To tackle the erosion problem, a large area of suitable mountains has been reforested. Yunnan pine is one of the most widely used tree species for reforestation. This study is trying to investigate the hydrological effect and its potential of the pine forest on soil erosion control, taking the Hutiaoxia gorge area as an example. The study has found that the dense pine forest was able to intercept up to 31.1% of total rainfall throughout the rainy season in 1993. The total splash detachment in the forest (4.9 kg.m⁻²) was 19.7% lower than the one on the bare land (6.1 kg.m⁻²). The total soil loss in the forest was considerably decreased to 32.9 g.m⁻², as compared with 57.9 g.m⁻² on the bare land, showing a soil erosion reduction by 43.19%. As experiments indicated, rain intensity here was the most affecting factor on soil erosion and the hydrological effect of the forest as well. On the other hand, the dense forest was also found to cause drip splash detachment by producing large leaf drips; and it did not actually reduce surface runoff. Considering the comprehensive role, however, the dense forest has a net positive effect on erosion limitation. Compared with dense grasses, the forest seems to be less effective on soil erosion control.

Key words: pine forest, potential, erosion control, alpine gorges

No. 2

Mechanic Effect of Pine Forest on Slop Process in the Alpine Gorges, SW China

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Soil reinforcement of tree's roots of shelter-forest has the most effective mechanical effect on soil stability and slope protection, and the traction effect of lateral roots plays an important role on this concern in mountainous areas. The magnetite of this role rises positively with the roots' tensile strength. This study developed a mechanical model of relationship between the tensile strength of roots and the traction effect, and the model was used in Pinus and Cyclobalanopsis forest. The results show that, the tensile strength of the Pinus and Cyclobalanopsis lay respectively in a range of 30-5 MPa and 40-10MPa, and increase negatively with diameter of the roots. In depth interval of 0-60cm, the density of lateral roots of the two trees are relatively high, and the roots are able to increase the tensile strength of the rooted soil by 6.85-12.41kPa, through traction effect. Though the strength of the pine's roots and its role in increasing strength of the rooted soil are significant, however, the root strength of the Pinus is lower than the Cyclobalanopsis and other broad leaved trees. This means that, the Pinus has certain limitation in maintenance of shallow slope stability.

Key Words: root system, shelter forest, slope stabilization, model prediction
Sediment transport dynamics are typically related to sediment supply events and channel morphology or hydraulics, but rarely are links made to peakflow generation processes. The hydrologic pathways by which runoff reaches the stream channel may have a significant influence on the sediment transport dynamics in forested headwaters. These linkages between hillslope or zero-order basin hydrologic response and thresholds of sediment transport in the channel system are investigated in the Takiya River basin, Niigata Prefecture, Japan. Peak flows occur during summer and fall rainy seasons, and during spring snowmelt. Discharge, water temperature, and sediment transport are monitored at a range of nested scales within the catchment: (1) incipient first-order drainage; (2) 1.32 km² second-order drainage; and (3) 19.45 km² third-order drainage. Differences in peakflow generation between rainfall and snowmelt events, and differences in antecedent soil moisture produce different patterns of sediment transport. Full mobilization of bed sediments and channel-forming events occur with peakflows generated by preferential flow paths and non-linear hydrologic response.

Key words: peakflow generation, forest hydrology, snowmelt, bedload, non-linear hydrologic response
Episodic and chronic sediment movement in headwater streams, Maybeso Experimental Forest, southeast Alaska

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A series of studies on episodic and chronic sediment movement in headwater streams has been conducted after basin wide clear-cut logging in late 1950's. Landslides and debris flows transported and redistributed sediments and woody debris in headwater tributaries in 1961, 1979, and/or 1993. Such processes formed exposed bedrock reaches, logjams, and fans along channels. The termini of deposits did not enter the main channel because gradients were less than 7% at the bottom of a U-shaped glaciated valley. Chronic sedimentation in a channel scoured by recent landslides (1979 and 1993) was 2 to 10 times larger and finer than that in a young alder riparian channel (landslide in 1961), based on sediment deposited behind a weir during storm seasons. Both surface erosion on glacial tills and bank sloughs are the major chronic sources of sediment to channels. Episodic mass movement affected distribution of sediments and woody debris and modified channel morphology, while chronic sediment movement was affected by regeneration of riparian vegetation and storage behind recruited woody debris.

Key words: sediment movement, debris flow, woody debris, headwater stream
Intra-Catchment Dynamics of Water and Sediment

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Understanding the changing behaviour of water and sediment flows from points on a hillslope to a whole 'experimental catchment' is critical to the identification of the hydrogeomorphic effects of specific land-use practices. Such terrain manipulations may be associated with forestry, agricultural, or urban development. This paper utilises a novel modelling technique (that allows the data to indicate the form and complexity of model structure) to characterise rainfall-waterflow and rainfall-sediment flow within a small tropical catchment. This experimental catchment is recovering from the complex patchwork of disturbance associated with the practices of 'selective timber harvesting'. Differences in the dynamic behaviour at scales ranging from 0.1 ha slope plots to the 44.1 ha catchment can be captured by the DBM-modelling undertaken. Explanation of differences in sediment mobilisation with scale change, can be seen to be closely associated with changing waterflow behaviour, in terms of responsiveness and process (i.e., the balance of infiltration-excess and return-flow pathways). These analyses provide: (a) the basis for a conceptual model of the relationship between intra-catchment hydrogeomorphic scales, and (b) a demonstrable linkage between forestry-induced landforms and landscape-scale behaviour.

Keywords: forestry, modelling, rainfall-runoff, scale, suspended-sediment, tropical
Suspended solids discharge from a small-forested basin in humid tropics
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Observation of rainfall, suspended solid concentration, EC, DO and simple surface runoff experiments were conducted in a small-forested watershed in Bukit Tarek, peninsular Malaysia. Clockwise hysteresis loops were recognized in the relationship between SS concentration and water discharge in four storms, and SS concentrations positively correlated with rainfall intensities. Peaks of water discharge and EC show larger time gaps to rainfall peaks than DO. SS concentration during a storm event shows 3 orders of magnitude higher than that of an artificial overland sheet flow experiment without raindrop of the forest road site. These results conclude that the SS source exists near the stream, and it could be strips along the stream and damp areas, which corresponds with the so-called contributing area of water discharge. Investigation balancing of tractive stream power and rain drop energy related to catchment scale will be necessary for the argument of the suspended solids issue.

Key words: Suspended Solids, Hysteresis loop, Tropical Rain Forest, Malaysia
Significant erosion occurred from both forest logging roads and skid trails in a small headwater catchment in Peninsular Malaysia that was recently harvested. Cumulative surface erosion from skid trails was conservatively estimated as the height of well-preserved soil pedestals. On steeper skid trails, some large rills and small gullies contributed to erosion. Rills and gullies are major sources of sediment from forest roads due to compaction and generation of infiltration-excess overland flow during intense storms. Roads had no designed drainage systems; at 25 ‘nodes’ along the road system, sediment and water discharged onto and off of the road fill. Sediment from 56% of these discharge nodes directly connected to headwater channels. Erosion from skid trails exacerbated road erosion in some cases and contributed to the road-channel connectivity. Greater connectivity of roads and skid trails to channels alters hydrogeomorphic processes in catchments; such information is useful for adopting better road location and erosion control measures.

Key words: surface erosion, hydrogeomorphology, sediment pathways, road runoff