Hydrogeomorphologic Models for the Assessment of Soil Erosion
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The Virginio river basin is located in central Tuscany (Italy) and is characterized by the presence of geomorphologically active processes and human activities whose overall effect results in an environmental impact on soils and water. On this subject, a large amount of data is available concerning land use evolution throughout time and agricultural practices. These data have been combined with those derived from ground truth and ground survey campaigns concerning geology and geomorphology. At the same time, rainfall simulations have been carried out in order to evaluate the principal parameters involved in the soil erosion processes. On these data an hydrologic model has been applied based on a DTM of the whole area, providing information on the spatial prevalence of the different erosion processes. Then, a distributed version of the USLE model, opportunely revised, has been applied to the hillslopes and then compared to the outcomes of the WEPP model on local control sites. Results clearly show the different meanings of the two approaches, demonstrating that a complete comprehension of the sediment production and delivery processes in this basin can be achieved by the coupling of such models in the framework of the general theory of hydrogeomorphology.

Keywords: Hydrogeomorphology, Tuscany, soil erosion models.
A Geomorphological Explanation of the Unit Hydrograph Concept

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Through a statistical physics reasoning applied to the topological and geometrical organization of the river network, and after experimental validation using GIS, we can expose structural characteristics of the basin width function. Indeed, the hydraulic path length can be broken up into components through the Strahler cascade. With the exception of the highest Strahler orders because of hierarchy topological constraints, the probability density functions of each of these components appear to follow self-similar decreasing gamma laws. The whole hydraulic length probability density function is thus based on a left-shifted gamma law. By translating these geomorphological results into hydrological travel time probability density functions through the hydraulic linear hypothesis, we provide deterministic explanations of some famous a priori assumptions of the Unit Hydrograph theory, including Nash’s (1957) gamma law shape and Rodriguez-Iiturbe and Valdès’s (1979) exponential distributions of Strahler states residence times.

\textit{Key words: gamma law, river network, transfer function, rainfall-runoff model.}
Distributed Simulation of Landslides for Different Hydrologic Scenarios

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Heavy rainfall initiates landslide due to increase in water table in the soil mantle and subsequent buildup of pore water pressure. Storm intensity, storm duration, and antecedent rainfall influence ground water levels and thus landslide occurrence. A physically-based, distributed slope stability model (dSLAM2000) incorporates a combined surface-subsurface kinematic wave module to address ground water fluctuations related to slope stability. The model also includes spatial and temporal aspects of vegetation change. Major storms that occurred between 1978 and 1991 in the Carnation Creek, British Columbia were examined to determine their influence on slope stability. These storms varied in maximum intensity from 10 to 35 mm, mean intensity from 2 to 6 mm, and rainfall duration from 17 to 62 hours. The small catchment was partitioned into vector-based stream tube elements using topographic analysis sub-model dSLAMTOPO. Hyetographs of selected large storms during the 14-year record were used to simulate ground water and produce the factor of safety maps. The number of unstable elements, failure time, and total rainfall and intensity at the time of failure were examined to determine the different characteristics of event rainfall to slope stability.

Key words: landslide, ground water, rainfall, hyetograph, factor of safety
Landslides in Rio de Janeiro: The Role Played by Variations in Soil Hydraulic Conductivity

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Discontinuities inside the thick soil profile, inherited from the partially weathered gneiss, seems to play an important role controlling hillslope hydrology around Rio de Janeiro slopes, most of them already occupied by slums. This idea is supported by the fact that, during the catastrophic event of 1996, many landslide scars were placed inside the weathered profile, associated with differential weathering. In order to investigate in situ lateral and vertical variations in soil hydraulic conductivity, detailed field studies were conducted with a Guelph permeameter, around and inside landslide scars, from the surface to 3.0m depth. For each studied site, a pit was excavated in order to allow soil description and sampling for physical and hydraulic tests. The results, derived from 50 measurements along 14 soil profiles, showed that hydraulic conductivity, in spite of a heterogeneous material, varied in general less than two orders of magnitude (1.0 x10⁻⁴ - 9.0 x10⁻³ cm/s), with a tendency of increasing hydraulic conductivity with depth. However, sudden variations in soil hydraulic conductivity take place in less than 30cm of the soil profile, which may locally contribute to the development of high pore-water pressures.

Keywords: landslides, hillslope hydrology, hydraulic conductivity, Guelph permeameter.
Theoretical Research on the Relationship between Return Period of Rainfall and Shallow Landslide

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A stochastic process-based model for shallow landsliding on weathering limited condition is proposed, which utilizes the slope stability analysis, seepage (saturated throughflow) analysis, regolith development model and the statistics of rainstorm. This model was applied to a test field where a lot of shallow landsliding occurred at a heavy rainstorm in 1988. The distribution map (a DEM of 5 m grid interval) of the average recurrence interval of landsliding is a kind of hazard map. Using this model, some simulations of landslide time series were tried. The stochastic rainfall values were yielded for 10,000 years by a random number generator. It was confirmed that the landsliding rate(area percentage) for each rainfall is highly influenced not only by the amount of rainfall but also by the historical sequence of landsliding, and that each grid point has the most effective return period of rainfall for landsliding. The very heavy rainfall is not necessarily effective for landsliding because it rarely occurs. Comparing some cases of landsliding simulation for different probability distributions of rainfall leads to the conclusion that the larger the probability of rainfall is, then larger is the critical rainfall value for landslide occurring, as well as smaller is the landslide area (number) for the same amount of rainfall.

Key words: Shallow landsliding, Return period, Random number, Simulation.
Rainfall, runoff and sediment yield were observed at bare land watershed, 60% forest recovered watershed, vegetation recovery watershed and forested watershed to study difference of the runoff and sediment yield characteristics with vegetation recovery in granite mountain. Peak discharge, runoff coefficient and sediment discharge of bare land watershed was higher than those of forested watershed. Peak discharge, runoff coefficient and sediment discharge of the other watersheds are between those of bare land watershed and forested watershed. The runoff peak and sediment yield characteristics are found to be changed with vegetation recovery, but more time is required for runoff response recovery than the surface vegetation change.

Key words: vegetation recover, runoff generation processes, sediment yield, human impact, granite mountain
The landform underlain by serpentinite in humid regions is significantly different from surrounding mountains underlain by other geologies. To study the cause of the landform difference, runoff responses from small watersheds were measured in the serpentinite mountains. The landforms are characterized by two types: One is the slope with few deeply dissected valleys (S1; 0.07 km²), another is the slope with many shallow valleys and some large-scale landslide landforms (S2; 0.05 km²). The runoff ratio of quick flow and peak discharge were in proportion to the cumulative precipitation in S1 watershed, but not in S2. Since the rate of occurrence of debris flow must be higher than in S2, particularly high rainfall event, a valley in the S1 would be deepened. In contrast, most of precipitation flow out as groundwater in S2 because of shortage of total discharge for water budget. It suggests that the S2 slope is prone to large-scale landslide by deep groundwater and the landslide block would reset the channel system, resulting in the slope with shallow valleys.

Key words: valley form, landslide, serpentinite, bedrock, hydrological processes
Analysis of Morphologic Structure of Step-pools in a Forested Mountain Stream, Central Japan

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We analyzed the structure of step-pools of a forested mountain stream in the headwaters of the Misawa River in the Chikuma River System as a first step in clarifying the influence of streamflow patterns on changes of step-pool sequences. Steps of the research site are made up of approximately 20 cm gravel (mean diameter) and are almost constant in height, which is related to mean gravel size. This suggests that the step height depends on the gravel size. In addition, the step length of the reach decreases with increasing channel gradient, similar to examples of other countries. This suggests that the stream does not adjust the step height to suit the increased gradient, but adjusts the step length or number of steps because the step height is almost constant throughout the reach. The pool structure of the reach has a depth of 0.14±0.07m, length of 1.53±0.66m, width of 1.20±0.34m, and volume of 0.13±0.10m³ (mean and variance). In the reach where the channel gradient is steeper than roughly 14 degrees, the pool length is 1.5m or less and the pool volume is 0.2m³ or less because the relationship between the gradient and step length or number affects pool length and volume. However, we could not find a significant relationship between the gradient and pool width or depth. Finally, this research revealed that steps composed of woody debris accounted for approximately 30 percent of all steps. However, pools composed of woody debris accounted for only 20 percent.

Key words: step height, pool structure, mountain stream, gravel size
The Influence of Debris Cover on the Hydrological Regime of the Dome Glacier, Canadian Rocky Mountains

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The 1994 and 1995 meltwater discharge patterns of two glacierized mountain basins in the Canadian Rocky Mountains are compared. The glaciers under study are the Dome and Athabasca; both situated in the Columbia Icefield. The two glaciers lie adjacent to one another and are similar in size, orientation, and range in elevation. They differ however, in their surficial characteristics. While the ablation zone of the Athabasca Glacier is debris free, the ablation zone of the Dome Glacier displays an extensive debris cover. It is postulated that this debris cover significantly influences the diurnal and seasonal discharge patterns of the Dome Glacier's meltwater stream producing different discharge patterns than those observed in the Athabasca Glacier meltwater stream. Results indicate that the debris cover on the Dome Glacier acts as a regulator of stream flow producing annual variances of volumetric discharge of only 1.0% between 1994 and 1995 as compared with 24% for the debris free Athabasca Glacier over the same interval.

Key words: debris cover, meltwater discharge, annual variance
Dissolution processes in different flow path in humid granitic catchment

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To confirm dissolution processes in humid headwater area soil water and spring water were monitored with hydrological observations and dissolution rate of elements in soil layers and a catchment were calculated in a forested granitic catchment, western Japan. The dissolution rate of $\text{Ca}^{2+}$ was extremely high at surface soil layer, whereas the dissolution rates of $\text{Na}^+$ and $\text{SiO}_2$ by chemical weathering were high at deeper soil layer. During base flow periods, dissolution rate of $\text{Na}^+$ and $\text{SiO}_2$ take high values, but dissolution rate of $\text{Ca}^{2+}$ takes negative value in the catchment. Weathered granite has high adsorbed $\text{Ca}^{2+}$ saturation as well as surface soil. These results suggest the adsorption of $\text{Ca}^{2+}$ in deeper soil layer after weathering. During rainfall events dissolution rate of $\text{Ca}^{2+}$ in the catchment became bigger with decreasing of pH. This flush loss of $\text{Ca}^{2+}$ indicated the contribution of shallow subsurface flow through surface soil layer with higher $\text{Ca}^{2+}$ concentration. Our results determine the short term transport of dissolved $\text{Ca}^{2+}$ and long term transport of dissolved $\text{Na}^+$ and $\text{SiO}_2$ in humid headwater area.

Key words: granite, catchment, dissolution, flow path, subsurface flow
Base Cation Leaching and Soil Acidification after Forest Fire in a Small Cachment, Western Japan

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To clarify the effect of acid rain and forest fire on chemical property of stream water in Setouchi region, western Japan, we investigated the temporal variation in soil and stream water chemistry in small catchments after forest fire. Though the exchangeable base cation content in soil increased by mineralization after two weeks since forest fire, it and soil pH decreased extremely after six months. The strong acid of rainwater was buffered in surface soil by ion exchange process with base cation and Al3+. Metal ion in stream water is composed of base cation except for rainfall period. On the other hand, Al3+ concentration of stream increased and base cation concentration decreased with stream discharge during the rainfall event. Both of H+ and Al3+ concentration was high in upper stream than that in lower stream. This suggest more acid neutralization in lower catchment by more groundwater discharge.

Keyword: soil acidification, base cation, Al, storm runoff, acid rain
Evapo-Transpiration and Runoff in a Forest Watershed

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We have been researching the characteristics of runoff and evapo-transpiration in the forest experimental watershed, locating in the western part of Japan. We have observed precipitation, streamflow, and meteorological factors in the experimental watershed since 1992. We have installed two towers with several windvane, anemometers, ventilated psychrometers and net radiation-meters and also put the gauging weir to observe runoff of the head hollow catchment besides measuring the streamflow of whole watershed. The amount of precipitation per year was about more than 2000 mm and the amount of evapo-transpiration estimated with Bowen ratio method was about 900 mm per year in this watershed. And some large precipitation events made different types of hydrograph between the whole watershed runoff and the head hollow catchment runoff. The occurrence of the contributing area was expected during the heavy rainfall events.

Key words: evapo-transpiration, contributing area, head hollow catchment
A Contour Based Distributed Hydrological Model to Simulate Effects of Vegetation Recovery on Runoff Process


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A contour based distributed hydrological model was applied to hilly basins in Seto city in Japan, where vegetation had been recovered on weathering granite land during the last several decades. To calibrate and validate the model, the rainfall and discharge data were collected from basins with different types of vegetation cover. Digital elevation data were surveyed by airborne laser scanner and preprocessed by geographic information system (GIS) to describe the microtopography of hillslope adequately.

Key words: contour based distributed hydrological model, runoff process, vegetation recovery, airborne laser scanner, GIS
An Integrated Approach to Hydrogeomorphology in a Japanese Hilary Land
Occurrence of Rain-induced Regolith Slides on Segmented Hillslopes
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Detailed observation of hillslope microforms in presently humid-temperate Japan found that most hillsides are divided by a convex break of slope into upper and lower segments. Tephro-chronological investigation of the segmented hillsides and climatogenetic geomorphological interpretation of the results presented the model that the upper segments developed mostly in the cool environment are in the stage of destruction by the more frequent occurrence of regolith slides induced by heavy rain which has become popular in the Postglacial warm environment and thus the steeper segments have been developing upward from incised valleys. It seems to prove the model that c. 2000 rain-induced regolith slides were concentrated in the lower segments of the hills north of Sendai in August 1986. On the other hand, the majority of c. 800 slides which were induced by the heavy rain in September 1994 in the hills south of Sendai took place in the upper segments, particularly the headmost walls. We attempted to explain the difference by soil geomorphological observation in combination with hillslope hydrological measurement.

Keywords: hillslope, regolith slide, Postglacial Dissection Front, pipe flow, soil creep
Sediment yield caused by subsurface water discharge in a forested 0-order basin, Hokkaido, northern main island in Japan
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In order to obtain information regarding subsurface hydraulic erosion, hydro-geomorphological observations and experiments were conducted in a forested 0-order basin in Hokkaido, northern Japan. The hydrological observations and the experiments on pipe flow disclosed that the changes in the drainage capacity of soil pipes were important in subsurface hydrological processes and sediment yield caused by subsurface water discharge under a partly full depth condition in soil pipes. Wash load yields were directly proportional to the rate of change in subsurface water discharge and their peaks appeared when the partly full depth condition in soil pipes occurred. In contrast, bed load yield (from coarse sand to fine pebble) was linearly correlated with subsurface water discharge. The characteristics of bed load yield were different from those expressed by power functions which were described generally for water flow and sediment yield at streams. Antecedent soil moisture conditions in slopes affected sediment yield below the diameter of granule (including wash load). The above findings indicate that the subsurface water flow under the partly full depth condition in soil pipes and the antecedent soil moisture condition must be important items to understand sediment yield in subsurface hydrological processes.

Key words: pipe flow, sediment yield, 0-order basin, subsurface erosion
A Large-Scale Laboratory Experiment on the Effect of Subsurface Flow
Movement with Bedrock Fissures on Runoff Generation and Landslides

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The effect of the bedrock fissure on runoff generation mechanisms were studied in the
large-scale rain simulator at the National Research Institute for Earth Science and
Disaster Prevention in Japan. The experimental slope with 6.25m long, 1.5m wide and
30 degrees has three fissures with a opening of 1cm×15cm in the middle part. The
subsurface flow through the bedrock fissure stored in a 500L tank, and it returned to
the flat part of the soil tank. The soil thickness is 30 or 50cm, and the precipitation can
be changed 40-100mm/h. Two differentiated slope forms were made a) without a flat
area, and b) a flat bottom below the slope. The runoff peak coincided with the rainfall
peak were observed in open fissure, but delayed runoff peak (5-10min) in closed. This
result suggests that the effect of subsurface flow in soil, fissure flow and the change of
air pressure in tank would contribute much for the hydrograph shape.
Key words; air pressure, bedrock fissure, large-scale sprinkling experiment, runoff
generation mechanism, landslides
Hydrological Effect of Pine Forest on Slope 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 wildly 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

Mechanic Effect of Pine Forest on Slope 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