Stochasticity controls and the central role of “internal variability” in soil erosion system

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Accurate prediction of soil loss rates remains a problem because erosion exhibits a non-unique behavior given the same rainfall/runoff forcing. The effects and causes of uncertainties in soil surface erodibility resulting in such a behavior have not been fully addressed from a mechanistic perspective in previous research. We use a large database of empirical data on soil loss and a comprehensive physical model of runoff –overland flow –erosion –transport processes that dynamically updates the mass and composition of soil substrate at the hydrologic-event scale to address reasons of unpredictability in soil erosion. We explain the role of micro-scale erodibility (referred to here as ‘geomorphic internal variability’) on geomorphic response, which acts as an intermediary between larger-scale forcings and soil loss response. Accounting for a possible range of internal variability illustrates the high sensitivity of erosion response to initial conditions of soil bed, resulting in extremely large uncertainties in short-term predictions. Furthermore, the reduction of geomorphic response variability at larger temporal scales is primarily attributed to a ‘compensation effect’: temporal alternation of events that exhibit either ‘source-limited’ or ‘transport-limited’ regimes. We relate this reduction to a novel stochasticity index that reflects the degree of variability of intra- and inter-event hydrometeorologic conditions. A higher stochasticity index implies a larger reduction of soil loss variability (higher predictability) at the aggregated temporal scales with respect to the mean hydrologic forcing.

Acknowledgement:
This study was supported by the Basic Science Research Program of the National Research Foundation of Korea funded by the Ministry of Education (2016R1D1A1B03931886).

Keywords: Soil erosion, Geomorphic Internal Variability, Geomorphic External Variability, Stochasticity index, Soil erosion variability

Mediation of sediment dynamic processes by vegetation within a rapidly developing saltmarsh

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Nowadays, the rapid reduction of coastal saltmarshes has become a worldwide problem and the practical needs of restoration and creation require the understandings of the basic physical mechanisms controlling the development of saltmarshes. The pioneer zone has been widely recognized to be the key of saltmarsh development. Generally, the pioneer zone is occupied by pioneer species in the form of dynamic patches or tussocks. The positive and negative feedbacks among vegetation, sediment dynamics and morphology determine the pattern and the rate of saltmarsh development, as a representative case for biomorphodynamic study.

In order to examine the processes and relevant mechanisms affecting the development of saltmarsh pioneer zones, observations over a timescale from vegetation patches to fully developed saltmarsh are in need. The Andong Shoal, located at the turbidity maximum zone of Hangzhou Bay, is a typical area of high sediment supply in the world. The saltmarshes, mainly covered by *Scirpus mariqueter,* are developing at a high rate and thus, it is possible to observe the development of saltmarsh pioneer zone within a relatively short period. Our study attempts to understand the feedbacks between vegetation and morphodynamics from vegetation patches to a fully developed saltmarsh in the pioneer zone of the Andong Shoal saltmarsh. *In situ* observations of sediment dynamics were carried out in two seasons, comparing the bare mudflat, the vegetation patch and the gap between two patches. Meanwhile, *in situ* biological investigations and geomorphological surveys were undertaken.

The preliminary results revealed that: 1) the tidal flat of the Andong Shoal received a large amount of sediments, resulting in a vertical accretion rate up to 50 cm a^{-1}; 2) due to the high sedimentation rate, the patches could convert into a fully developed saltmarsh at a seasonal scale; 3) the geomorphological surveys indicated that both vegetation patches and the gaps between them were depositional; 4) in the pioneer zone, the vegetation patches with diameters of several meters were able to reduce 36% of the flow speed in comparison with the adjacent bare mudflat, whilst the gaps between patches accelerated the flow speed to 157%, as such, a positive feedback occurred within the patches but the negative feedback within the gaps was suppressed by a high sediment input; 5) when the vegetation patches merged together to form a fully developed saltmarsh, the vegetation reduced 65% of flow speed in comparison the previous bare mudflat; and 6) the mean suspended sediment concentration increased after the patches merged together, and this pattern implied that the presence of vegetation patches was likely to be a more efficient sediment trap than the fully developed saltmarsh, in order to accelerate the vertical accretion which was crucial for the saltmarsh establishment.

Keywords: Saltmarsh, Vegetation patch, Sediment dynamics, Geomorphology, high sediment supply

Consideration of paleolake and paleo-inflow in Olgoi basin, upstream of Valley of the Gobi Lakes, Mongolia.

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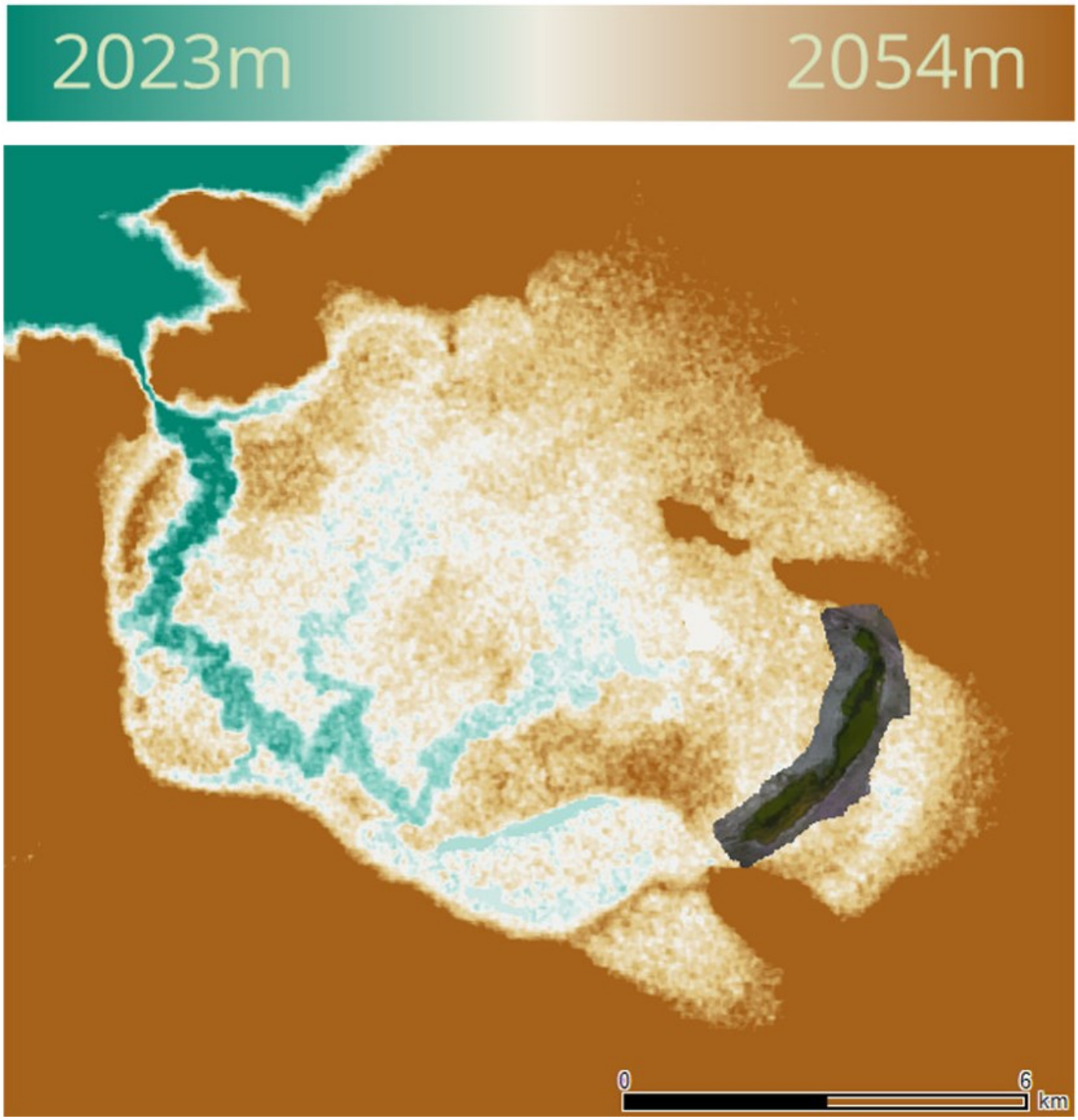
Valley of the Gobi Lakes is between north Khangai Mountains and south Altai mountains in Bayankhongor Province, Mongolia. There are several closed lakes such as Böön Tsagaan Lake, Tsagaan Lake and Orog Lake in the valley. Previous geological studies indicated that there was once a large lake, but the geological history of this area has been still unclear. This study focuses on the basin including present Olgoi Lake upstream of Böön Tsagaan Lake flows. We found paleo shorelines in the east of the basin through a satellite image, and reconstructed Olgoi Paleolake, which was 70 times larger and 15 m deeper than present Olgoi Lake. We also numerically simulated the paleo-inflow with criteria regarding the shear stress necessary to transport the gravels measured in the field research. The calculation suggested two orders of magnitude larger discharge than the bankful discharge in the modern period estimated based on the present topography. Although this flow does not seem to occur under present precipitation there, this region should have experienced much wetter environment in the past whether the stream was caused by precipitation or melting of snow and/or glaciers.

Keywords: Valley of the Gobi Lakes, Olgoi Lake, Paleo hydrology, Photogrammetry, Fluid analysis, GIS



Land classification in Surkhandarya region, southeastern Uzbekistan

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In the Surkhandarya river basin, southeastern Uzbekistan, there are many Buddhism temple excavations which were established after 1st century. The aim of this study is to clarify the distribution landforms and geomorphic environment in this area as a part of excavation of the Kara-Tepe Buddhism temple, which is one of the most important temples between 1st century and 3rd century.
The land classification map was created by interpretation of counter maps derived by Alos-2 data and satellite images of Google earth. Field surveys were also performed in September 2016 in southern part of the Surkhandarya valley.
The region consists of major five topographic regions: high mountain range, frontal mountain range, Surkhandarya valley floor, central hill, Amdarya river floodplain. The high mountain ranges are including the Hisor mountain range, which is the west extension of the Pamir, the Bobotag mountain range and Kohitangdog mountain range, whose elevation are up to about 4700m. The frontal mountain ranges are located on the front of the high mountain ranges facing the eastern and western fringe of the Surkhandarya valley. They consist of several rows of ranges whose elevation is up to about 1000m. The Surkhandarya valley floor is formed by the Surkhandarya River. That is consists of terraced flat surfaces, alluvial fans formed by tributaries flowing down through the frontal ranges, which includes dissected alluvial fans, the Surkhandarya flood plain. Although terraced flat surfaces are extended, the floodplain along the Surkhandarya is narrow. The central hill divides the terraced flat surface of the Surkhandarya valley. The hill is raised a couple of hundred meters from the terraces flat surface of the Surkhandarya valley and have five levels of backs. The Amdarya river floodplain is several tens of kilometers wide and eroding the lower ends of terraced flat surface of the Surkhandarya valley creating the boundary between Uzbekistan and Afganistan.
After formation of the Surkhandarya valley floor the central part of the valley floor and frontal zone of the high mountain ranges began to be uplifted and formed the central hill and frontal mountain ranges.

Keywords: land classification, fluvial process, uplift, Surkhandarya River, Amdarya River, Uzbekistan

Designing evacuation drills using GIS-based disaster prevention maps of cultural properties for Hanno City, Saitama Prefecture

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Serious disasters such as the Great East Japan Earthquake of 2011 and the Kinugawa floods of 2015 have highlighted the need for contingency plans to evacuate and rescue important cultural properties. Firstly, it is necessary to identify where and what types of Cultural Properties exist, and then, to know how to evacuate them from disasters. This study aims to identify the risk of damage to cultural properties and design appropriate means to evacuate them during landslide emergencies. Here, we focus on landslide disaster hazard mapping in Hanno City, Saitama prefecture using GIS. Potential landslide risk zones were identified using data provided by the National Land Numerical Information. Nine categories of Cultural Properties, including buildings and natural monuments etc., were mapped using GIS. Three regions: the Hanno City area, Agano area, East Agano area, were chosen for detailed investigation.

Keywords: cultural property, desaster prevension map, Hanno city, GIS

Geomorphic Characteristics and Settlement Location along the Tsunami-hazardous mid-Sanriku Coast in Northeastern Japan

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In contrast to the north Sanriku Coast where higher marine terraces are well developed, scattered distribution of small terrace patches were formerly reported along the mid-Sanriku Coast. However, most of the scattered terrace patches show the characteristics of piedmont gentle slopes particularly in the zone composed of granitic rocks. We investigated this type piedmont gentle slopes in the Funakoshi Peninsula and its surrounding, and revealed the followings: (1) Gentle slopes of around 3 - 15 degrees are distinguished from steep slopes around the zone of 70 - 90m above the sea-level and are subdivided into the higher gentle slope and the lower ones. (2) The higher ones are composed of deep weathered granite and slope deposits including weathered angular gravels. On the other hand, the lower ones have slope deposits including fresh granitic angular gravels, by which deep weathered layer is truncated. (3) The lower end of the lower gentle slopes are in some places cut by Holocene sea cliffs and the upper continuation of the lower gentle slopes in the back-hills show the dell-like form. The geomorphic characteristics as above suggest the processes of piedmont gentle slope formation in the late Quaternary climate and sea-level changes.
The several landforms along the coast, including near-shore lowlands and piedmont gentle slopes, have been used as the location of fishery and agricultural settlements. Histories of location and relocation of several settlements were retraced. The histories are the results of residents' cognition of geomorphic setting as resources for living including usual fishery and agricultural activity and for evacuation from unusual but repeating tsunami hazard in changing socioeconomic and technologic conditions. The changing residents' cognition can be reassessed from the viewpoint of geomorphologists. The knowledge should be applied to wise use of geomorphic resources.

Keywords: piedmont gentle slopes, tsunami, human activity

The Experiment of Alluvial Fan Evolution Induced by Debris-Flow Tributary

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Rainfall events with high intensity cause many landslides, slope avalanches and debris flows in Taiwan. As a debris flow flows from a tributary to mainstream, an alluvial fan usually forms at the confluence. Villages and infrastructures adjacent to these alluvial fans are in high risk. The more understanding of the morphological processes of alluvial fans need to be explored for the disaster prevention.
A simplified laboratory experiment is conducted in this study to simulate the morphological process of alluvial fans formed by debris flows at the confluence. The tributary is set to be perpendicular to the mainstream with mobile bed. In fixed volume of debris flow, sediment concentration of debris flow is modified by the different water volume. In mainstream, discharge is altered in distinct amount to erode the accumulation of the debris flow at confluence. By using Particle Tracking Velocimetry (PTV) method, velocities of mainstream and tributary are measured. The impact of flows velocities at confluence can be observed to analyze.
During the process of deposition, the real-time morphological change is recorded by using images analysis. Cameras from different angles of views are used to monitor process. The Digital Terrain Model (DTM) is built to observe morphology elevation evolution through time by Digital Photogrammetry. The results show that experiments might reach a dynamic equilibrium elevation in late stage from an initial stage of elevation growth.

Laboratory experiment of river terraces formation under tilting uplift

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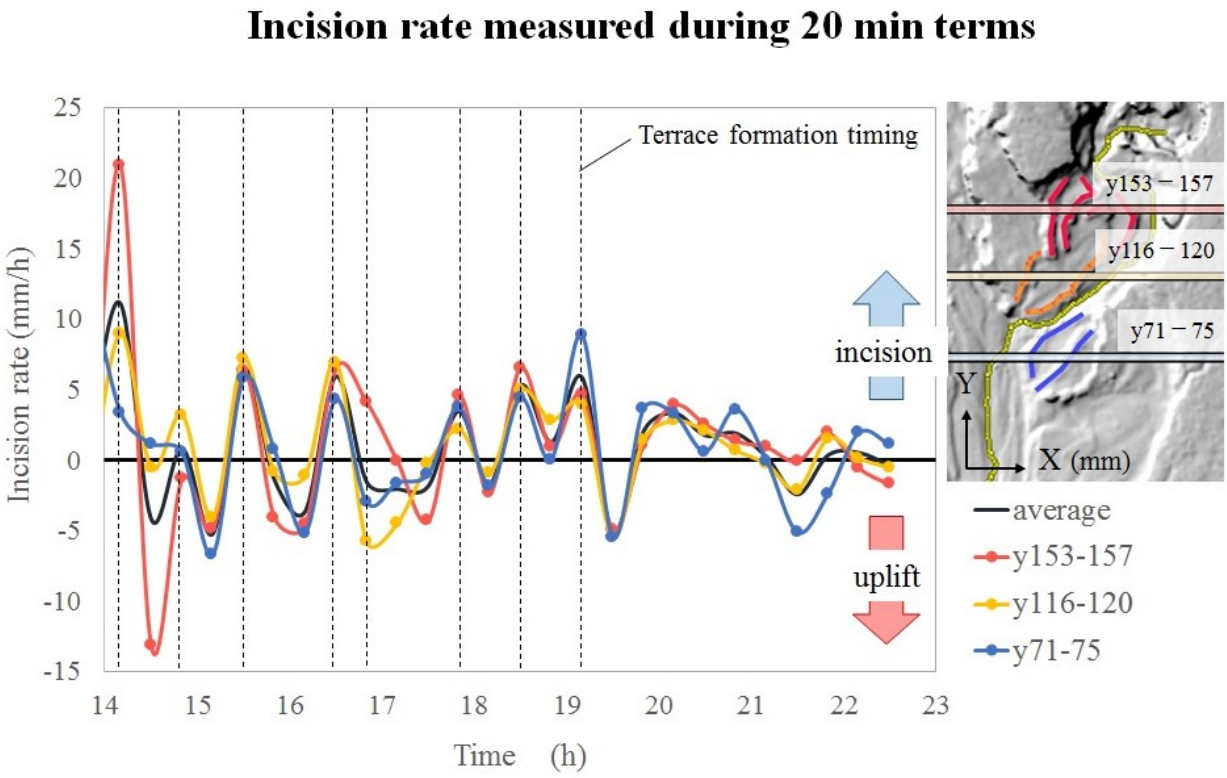
Formation of river terraces is not simple in response to external forcing. Previous experimental studies showed that multiple terraces can be formed even by a single sudden sea level or a continuous change. It is so far difficult to precisely reconstruct a history of landform development from remaining topographic features along time axis. In this research, we conduct model experiments that allow observation of time development. It was aimed to investigate the timing of terrace formation, temporal change of longitudinal profile of channels and terraces, flow path position, and terrace heights and lengths, in response to temporally-constant tilting-uplift where the uplift rate linearly increases landward.
In the experiment, we simulated bedrock by the mixure of sand and kaolinite at a volume ratio of 10.5 : 1, which was installed into a tank to make an initial flat slope of 1 degree. Sprinklers supply misty rain to develop the topography. During the first 40 minutes, rain was supplied without no uplift in order to promote the development of the terrain for preparation. Later, the following procedures were repeated during the run: both uplift and rain were realized for 20 minutes, and then the run was paused temporally for photographing of topography to make 1 mm-mesh DEM by photogrammetry using more than 200 photos.
Many terraces were formed in the experiment, and we selected a series of eight terraces along a single flow path to analyze. Temporal change of longitudinal profile of the river and terraces showed that the terraces become steep after formation with time due to the tilting uplift, which resulted in a topography where higher terraces dip more steeply relative to the channel profile, as pointed out by a previous theoretical model. A formed terrace could be not only shorter due to lateral erosion, but also longer owing to downcutting of floodplan at downstream side, which means, in some time-scale, a terrace does not necessarily show an isochronal face. The terraces tended to form when both lateral and downward erosion were large.
It is still difficult to predict when and where a new terrace emerges. The terrace formation relates with not only the uplift but also the lateral and downward movement of channel, but it is not clear so far how discrete topographies (i.e., terraces) are made by continuous forcing, which has been called complex response. In this experiment, we confirmed fluctuation of vertical and lateral incision rates through the quantitative measurement, which resulted in oscillation of river bed elevation and presumably triggered the development of discreet landforms. This fluctuation is thought to be an autogeneous phenomenon that does not require meander cutting. While some previous studies pointed out that river bed elevation can fluctuate because of change in sediment production rate due to glacial-intergracial cycles, the present experiment suggests that the river bed elevation can fluctuate even in a low latitude area free from glacier, without strong external forces.

Keywords: terrace, formation



Geometry and dynamics of braided channels and bars under experimental density currents

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Submarine channels convey turbidity currents, whose deposits are key hydrocarbon reservoirs and indirect records of continental denudation. Submarine channel patterns resemble those of their subaerial counterparts, but controls on the form and dynamics of submarine channels and associated deposits remain comparatively uncertain. Existing laboratory experiments show that braided channels can develop under similarly high flow width-to-depth ratios for both subaerial and submarine conditions. We conducted a new set of experiments with net-depositional density currents to (1) further test the conditions for channel formation; (2) test the response of channel and bar geometry to changes in the ratio of water-to-sediment flux, inlet conditions, and submarine versus subaerial conditions; and (3) quantify the relative timescales of channel lateral migration, abandonment, and aggradation. We generated density currents within a freshwater basin using saline inflows that transported plastic sediment as bedload across a platform 2 m long and 1 m wide. We find that across a 2.7-fold range in the ratio of water-to-sediment flux, submarine braided channels consistently develop, are more pronounced upstream, and can transition to zones of sheet flow downstream. We measured topographic statistics directly, and using a reduced-complexity flow model. The topographic analysis showed that braiding index is higher for subaerial than for submarine conditions with other variables fixed. For a representative submarine experiment, channel lateral motion decorrelated in double the time to move laterally one channel width, and one-third the time to aggrade one channel depth. We propose a new stratigraphic model for submarine braided channels, wherein sand bodies are more laterally connected and less vertically persistent compared to those formed by submarine meandering channels. These results suggest that channel pattern is a key variable for predicting stratigraphic architecture in submarine environments.

Keywords: Geomorphology, Sedimentology, Submarine channels, Braided rivers, Turbidity currents

