Abstracts

Strategies on Soil Erosion and Conservation in Korea

Jae Yang[1*], Kyung Jae Lim[2], Sung Chul Kim[3], Youn Shik Park[4], Giha Lee[5], Sang il Hwang[6]

[1]School of Environment, Kangwon National University, Korea
[2]Department of Regional Infrastructure Engineering, Kangwon National University, Korea
[3]Department of Bio Environmental Chemistry, Chungnam National University, Korea
[4]Department of Rural Construction Engineering, Kongju National University, Korea
[5]Department of Construction & Disaster Prevention Engineering, Kyungpook National University, Korea
[6]Korea Environment Institute, KEI, Sejong, 30147, Republic of Korea

Corresponging authorDr. Jae Yang; yangjay@kabgwon.ac.kr

Soil erosion and conservation including soil quality enhancement and soil pollution prevention are main concerns for both researchers and policy makers in Korea. For this reason, Korea Ministry of Environment initiated GAIA (Geo-Advanced Innovative Action) Project managed by the Soil Environment Center of KEITI (Korea Environmental Industry and Technology Institute). The research center of **S**urface **So**il **R**esources **I**nventory and **I**ntegration (SSORii) is one of the GAIA project and main task of SSORii research center is to assess accurately the value of surface soil and quantity of soil erosion in various aspects on which to base the development of sustainable soil management strategies in the national scale. In order to achieve main goal of SSORii research center, three individual research teams has been cooperated for 1) development of soil erosion prediction model based on the long-term monitoring data in Korea to reflect various factors affecting soil erosion which are specific to Korean weather, crops, soil and management conditions; 2) development of soil erosion assessment techniques from mid/long-term perspectives with satellite image and GIS; and 3) development of environmental impact assessment technique integrating comprehensive soil characteristics. After complishing each tasks, SSORii research center can provide a meaningful message that surface soil is not one of dirt or pollutants but invaluable natural resources. Through the convergent researches of SSORii projects, it is expected that the appropriate ready-to-use action plans for integrated surface soil management policies and subsequent system would be constructed.

Soil Erosion in Europe: Current Status, Challenges and Future Developments

Panos Panagos[1], Pasquale Borrelli[2]

[1] European Commission, Joint Research Centre, Directorate for Sustainable Resources, Ispra, Italy.

[2]Environmental Geosciences, University of Basel, Switzerland.

*Corresponding author: Panos Panagos, Panos.PANAGOS@ec.europa.eu

Soil erosion is the most widespread form of soil degradation worldwide.Major policy responses should reverse the impact of soil erosion in degraded areas taking into account the population increase, the climate change trends and the water crisis. The United Nations Convention to Combat Desertification (UNCCD) recognized soilerosion by water and wind as the major cause for land degradation globally. The Intergovernmental Technical Panel on Soils (ITPS) of the FAO recognized that globally the most significant threats to soil function at the global scale are soil erosion, loss of soil organic carbon and nutrient imbalance. Soil degradation due to erosion is also a European problem. During the past decade, the problem of soil erosion has become part of the environmental agenda in the European Union (EU) due to its impacts on food production, drinking water quality, ecosystem services, flooding, eutrophication, biodiversity and carbon stock shrinkage. The EU Soils Thematic Strategy, adopted by the European Commission in September 2006, indicated accelerated soil erosion as major threat to European soil. The Common Agricultural Policy (CAP) of the European Union recognizes the importance of protecting our soils and address the issue of reducing soil erosion and maintaining soil organic carbon at European agricultural lands. In this policy framework, it is important to have an updated 'picture' of the current status and address policy measures to challenge the problem of soil erosion. The mean soil loss rate in the European Union's erosion-prone lands (agricultural, forests and semi-natural areas) was found to be 2.46 t ha^{-1} yr^{-1}, resulting in a total soil loss of 970 Mt annually; equal to an area the size of Berlin at 1 metre deep. Policy interventions (i.e. reduced tillage, crop residues, grass margins, cover crops, stone walls and contouring) in the EU such as the Common Agricultural Policy and Soil Thematic Strategy have served to introduce measures to decrease erosion during the last decade by around 9%. However, a lot has to be done as soil erosion rates are higher by a factor of 1.6 compared to soil formation rates. The European Commission's Joint Research Centre has developed a modelling framework to incorporate climate change scenarios, future land use projections and policy interventions. This framework has been expanded with important components on sediment distribution, soil erosion by wind and effect of soil erosion in current carbon balance.

The Global Significance of Neglecting Soil Erosion for Earth's Future

Dr. Adrian Chappell
School of Earth and Ocean Science, Cardiff University, Wales, UK
*Corresponding author: Adrian Chappell, chappella2@cardiff.ac.uk

Since agriculture began, soil erosion has accelerated the loss of fertile topsoil to orders of magnitude greater than soil production, perturbed the land surface carbon (C), dust (D), energy (E) and water (W) cycles and consequently degraded ecosystems. More than 3.7 billion people are currently malnourished, most live in drylands which will sustain 51% of the global population growth to 2025. Despite much speculation, knowledge remains limited of how accelerated soil erosion is triggered and how land management may adapt or mitigate it. The impact of human activity on ecosystems and water resources and their response to climate are commonly explored using climate models. However, the current representation of C, E and W cycles in LSMs omits soil erosion andits feedback and interaction on those cycles. There is a need to realistically represent lateral fluxes of soil in LSMs, particularly by wind erosion and dust emission because they persistently and preferentially remove SOC- and nutrient-rich fines from the fertile topsoil changing soil surface conditions and gradients within the soil causing change in C, E and W cycles. The C decomposition is very sensitive to changes in micro-environment influenced by wind erosion and dust emission which occurs over the majority of Earth's surface. Consequently, these omitted feedback and interactions are very likely to explain the uncertainty in current LSM simulations, resolve the debate about whether SOC erosion is a source or sink of CO_2 emission and enable the development and implementation of policy for adaptation and mitigation of climate change for future agriculture.

Ongoing and emerging questions in soil erosion science

Dr. Santiago Beguería
Estación Experimental de Aula Dei, Consejo Superior de Investigaciones Científicas (EEAD-CSIC)
*Corresponding author: S. Beguería, santiago.begueria@csic.es

Soil erosion is a major cause of land degradation and threatens our ability to produce food in the medium and long terms. As such, it has been a subject of scientific study for more than a century. However, and unlike other environmental problems such as the conservation of water quantity and quality, soil erosion is perceived as a long-term marginal issue affecting only the rural environment. As a consequence, there is little social interest in developing environmental policies for soil conservation. This situation may be attributed to the fact that soil erosion has not been incorporated into market prices due to technical advances in food production that hinder the problem that soil degradation poses to food production. Many scientists, however, feel that this situation is also partially due to our inability to provide answers to the big questions about soil erosion: Where is erosion happening? What are non-acceptable soil erosion rates? When does erosion occur? How serious is it? What does it cost? What can we do about it? How will soil erosion change inthe future? In this talk I will discuss about some issues that hinder the progress of soil erosion science, such as the absence of a universally accepted definition of soil erosion; the problems related to how to measure soil erosion, and how to compare soil erosion rates from different experiments or the uncertainties involved in modelling soil erosion. Examples of our own (and others) research will serve to illustrate the main points.

As Wind Interacts with Rain, Water Erosion Processes Vary

Gunay Erpul
Faculty of Agriculture, Department of Soil Science and Plant Nutrition, Ankara University, Ankara, Turkey.
*Corresponding author: G. Erpl, erpul@ankara.edu.tr.

The installation of a rainfall simulator inside the wind tunnel of the International Center for Eremology (I.C.E), Ghent, Belgium enabled researchers to begin to study the combined effects of wind and rain on the erosion processes. Thus, the research on wind-driven erosion processes has increased overthe last twenty years as wind tunnel experimental studies provide new insights into the mechanism by simultaneous wind and rain tests. Clearly, the processes under conditions in which wind and rain act together differ significantly and conceptually from those under windless and rainless conditions. Here wind-driven rain erosion research performed in the I.C.E wind tunnel rainfall simulation facility is discussed and reviewed by analyzing the processes in place and methods to measure model parameters as influenced by horizontal wind currents. Additionally, concepts and mechanisms for rainsplash detachment and transport and sediment transport by raindrop-impacted shallow overland flow is provided. The simulated characteristics of wind-driven rains were assessed in the tunnel in multiple research studies. Kinetic energy of the simulated rainfalls of I.C.E. was determined by the splash cup technique. Also, a two-dimensional numerical model and a kinetic energy sensor were used to estimate wind-driven raindrop trajectories. A series of tests was conducted to assess the effects of wind velocities on sand detachment from splash cups. The combined effect of rain and wind on the rainsplash transport process was also examined in depth. Experimental data on the effects of slope aspect, slope gradient, and horizontal wind velocity on the splash-saltation trajectories of soil particles under wind-driven rain were presented. Total interrill erosion under wind-driven rain was defined as the sum of wind-driven rainsplash and sediment transport by rain-impacted thin flow transport, which accounted for the transport processes occurring before and after runoff onset, respectively. Additionally, an I.C.E tunnel study under wind-driven rains was conducted to determine the effectsof horizontal wind velocity and direction on sediment transport by the raindrop-impacted shallow flow. Wind velocity and direction affected not only energy input of rains but also shallow flow hydraulics by changing roughness induced by raindrop impacts with an angle, on flow and the unidirectional splashes in the wind

direction. To examine the roughness effect in particular of impacting raindrops with an angle on sediment transport capacity of thin flow, KE was divided into its components and the partitioning of the KE into two components provided a better insight into the processes for which they independently played a role. A vector approach with kinetic energy fluxes of raindrop splashes and flow were used instead of vector-free parameters of rainfall intensity and interrill runoff. In summary, this presentation provides a review of wind-driven rain erosion research performed in the I.C.E wind tunnel rainfall simulation facility. The review contains analyses of the processes in place and methods to measure wind and rain parameters in action. Also, the concepts and mechanisms for rainsplash detachment and transport, and sediment transport by raindrop-impacted shallow overland flow are reviewed by providing research results.

Possibility of Soil Erosion Control Concurrently Enabling Livelihood Improvement - Some Cases in Africa

Ueru TANAKA
Research Institute for Humanity and Nature, 457-4 Motoyama, Kamigamo, Kita-ku, Kyoto,
603-8047 Japan
*Corresponding author: Ueru TANAKA, tanaka.ueru@chikyu.ac.jp

Soil erosion as an old new issue:Studies on soil erosion and its control measures are old and new issues. Expanding population and human activities increase pressure to land resources and further move toward marginal areas under fragile environment. At the same time, rural communities facing depopulation due to the outflow of youth and adolescent population reduce the margin to distribute the labor force to soil conservation. Both population increase and depopulation exacerbates the problem of soil erosion. Mechanisms and processes of soil erosion are almost elucidated. Various techniques for soil erosion control based on the results have been devised and tried. Even so, soil erosion still remains as the local and regional environmental issues. Why is not techniques for soil erosion control fixed at the local level, and how can it be effective? That is the question of this presentation. Gaps between conventional techniques and peoples' needs: Conventional techniques for soil erosion by wind are, for example, 'windbreak fence' and 'windbreak forest', and those by water are 'terracing', 'contour ridge' and 'stone lines". It is certain that these will reasonably reduce soil erosion. Nonetheless,scientific and technological rationality alone is not enough to be accepted by local people. Local people are interested in getting short-term benefits, such as yield increase and cash income, from their efforts as soil of agricultural field is conserved. It seems necessary to take a technology-human interface that matches people's needs and circumstances (expenses, labor force, availability of materials etc.). Practical measures for soil erosion control and livelihood improvement: This presentation introduces some practical techniques to reduce soil erosion by wind and water occurred in flat and gently undulating sandy terrain in semi-arid West Africa. 'Fallow-band system', where the bands with 5 m width and stretching from the north to the south were set with the interval of 30 m to 60 m in cultivated field., prevented 74 % of soil loss and 58 % of organic matter loss. By shifting the fallow-band(s) on the windward every cropping season, the yield of pearl millet increased 50 % to 75%. This technique never require additional input of labors and materials. 'Line of Andropogon'was designed to control soil erosion by water and to improve household income. Three rows of Andropogon, a local wild perennial grass (*Andropogon gayanus*), were planted to the pit, which is known as an indigenous technique '*Zai*'. By allocating the rows along contour-lines, run-off water was

intercepted, soil erosion was reduced and water harvesting was encouraged. The straws of Andropogon from three rows with the length of 100 m were sold in local market as a material of granary and, sometimes, the cash income reached equivalent to the pearl millet grains sufficient for one to two month consumption. It is noted that the technique is also helpful for vulnerable people, such as elders and widows, who never have a land plot or compete with the others to collect wild Andropogon. Concluding remarks: Together with local people, some practical techniques such as ‘fallow-band system’and ‘line of Andropogon’ was designed and demonstrated. These are effective both for soil erosion control and livelihood improvement, with little input of cost, labor, time and materials, and with special consideration to vulnerable people. Entirely, the possibility of practical techniques for soil erosion control and livelihood improvement at local level was shown. If time allows, a similar case in the mountainous area of sub-humid East Africa, is also introduced.

Establishment of Potential Soil Erosion Map in Western Taiwan and Its Best Management Strategies

Shih-Hao Jien[1] and Zueng-Sang Chen[2*]

[1]Department of Soil and Water Conservation, National Pingtung University of Science and Technology, Pingtung 91201, Taiwan, email: shjien@mail.npust.edu.tw

[2]Department of Agricultural Chemistry, National Taiwan University, Taipei 10617, Taiwan.

*Corresponding author: Zueng-Sang Chen, e-mail: soilchen@ntu.edu.tw

Soil erosion has been considered as a major problem of soil degradation, which is also getting worse in last decade. Obvious climate change gives raise to increases of rainfall amounts and intensity, so that re-evaluation of potential soil erosion sites is necessary. Our research now aims to assess current soil erosion and disasters in sloplands in Taiwan and try to re-establish new parameters of USLE model to draw new soil erosion map of Taiwan. Since the year 2016, we have finished to collect rainfall data per 30 minutes from 200 meteorological station to calculate the rainfall erosivity (R factor) and re-survey the soil properties based on the distribution of different soil series of Taiwan Soil Map (1:25,000 scale) to obtain soil erodibility factor (K factor). We also collected the geomorphological data for calculation of factors of L and S. The NDVI index (based on 2017 satellite photo from Sentinel II, Europe) was also obtained from public website. The newest (2017) soil erosion map in central-southern Taiwan was therefore finished according to USLE by the datum obtained above-mentioned. Our new results revealed that rainfall is concentrated in the mountain areas and moved toward to north, and extreme high soil erosion risk is found in mudstone areas in southern Taiwan. Regarding the best management practices (BMPs) of soil erosion in Taiwan, agronomic techniques, contour planting and bench terrace, are much suitable for slopelands with $< 40^{o}$slope gradient, and engineering techniques, application of rolled erosion control products (RECPs), are much suitable for slopelands with $= 40^{o}$slope gradient. Recently, another two popular innovative methods are provided and tested in Taiwan, which are grass cultivation and biochar technique. Many case studies have confirmed that these two innovative methods could effectively improve soil physical properties, increase soil fertility, and prevent soil erosion during rainfall events, in fruit farm of slopeland in Taiwan.

Soil Erosion Control and Assessment in Hilly Red Soil Region of Southern China

Yu Dong-sheng, Zhang Hai-dong, Sun Jia-jia, Zhang Wen-tai, Gu Zu-jun, Shi Xue-zheng
State Key Laboratory of Soil and Sustainable Agriculture, Institute of Soil Science, Chinese Academy of Sciences, Nanjing 210008, China
*Corresponding author: Yu Dong-sheng, dshyu@issas.ac.cn

Hilly Red soils (Humic Acrisols) are widely distributed in southern China, covering about 118×10^4 km^2, including 8 provinces, such as Fujian, Guangdong, Hainan, Jiangxi, Hunan, Hubei, Zhejiang and Anhui. Soil erosion was a serious environmental hazard in the region, once referred to as the "Red Desert", and was characterized by annual disasters and an extremely deteriorated environment. Area of soil erosion occupied maximum 21.9% of the total land in 1986, according to the investigation of Ministry of Water Resources of the PRC (MWR) using remote sensing (RS) technology in the region. A lot of policy and measures have been taken to control soil erosion from 1980s in southern China. China promulgated and implemented theSoil and Water Conservation Law of the PRC (SWCL) from 1991. China also have taken projects and measures, such as Measure of Closing Mountain and Hill to prohibit livestock grazing and fuel gathering and to facilitate vegetation restoration; Measures of Comprehensive Control in Small Watershed (CCSW), planning and management of mountain, water, cultivated-land, forest and road; Project of Turning Farmland to Forest and Grass Land (TFFGL), in which all cultivated upland at steep slope degree (= 25°) should be turned to forest or grass land; Project of Shelterbelt Construction (PSC), planning afforestation total area of 72.5×10^4 km^2in the middle and upper reaches of the Yangtze River. From early 1980s, China promulgated and implemented land contracting policy of "Rural Land Contracting Policy"(RLCP), contracting for a period of 70 years to forest land, 30-50 years to grass land and 30 years to cropland, which villager often called "Dividing Farm and Forest Lands to Households". The contract also can be continued. General Secretary Xi Jing-ping announced at the 19^{th}National Congress of CPC holding in Beijing during Oct. 18-24, 2017, that rural land contracting policy will remain stable and unchanged on a long term basis, the current round contracts will be extended for another 30years upon expiration. The land contracting policy have encouraged farmers willing to take long-term effective measures controlling soil erosion, preventing soil and water loss from their contracted land. China had obtained great achievements in control of soil erosion for the past three decade's years. Area of soil erosion in the hilly red soil region decreased to 15.1% in 2012. Even though, various forms of severe soil erosion still happened due to the driving of different artificial and natural factors.The forms of soil erosion, e.g. from cultivated upland, fruits and commercial forest land, mining and constructing land, eroded badland, collapse and slide, mud-rock flow etc. Soil erosion control needs continuation in the region. Soil erosion under high density forest canopy (HDFC) is one form of erosion, no or rare growing grass on ground in the forest is a main cause. It hides under forest canopy and cannot easily be found using one normal index of vegetation fraction coverage (VFC) and RS image. An efficient method for assessing soil erosion using RS image was developed, combining with vegetation leaf area index (LAI) and VFC and their logical expression, to distinguish and map soil erosion suffered under the secondary forest canopy. A case study was carried out in Hetian Town, Changting County, Fujiang Province, which shown that the area of soil erosion under HDFC occupied 29% of the town's total land. Thirty survey points were chosen at random in the areas with HDFC mapped as eroded. Subsequent field survey and validation revealed that, twenty-nine points occurred in locations with no or raregrowing grass under the forest canopy, and exhibited various degrees of soil erosion, resulting in a distinguishing precision of 96.7%.

RUSLE-based Soil Erosion Modelling: From Field to Global-Scale and Back

Pasquale Borrelli[1], Panos Panagos[2]
[1] Environmental Geosciences, University of Basel, Switzerland. [2] European Commission, Joint Research Centre, Directorate for Sustainable Resources, Ispra, Italy.
*Corresponding author: Pasquale Borrelli, pasquale.borrelli@unibas.ch

Erosion-prediction technology rests on a set of mathematical equations that are used to compute soil erosion variables by using input data such as climate, soil, topography, land use and land management information. At present, many mathematical models categorized as empirical, conceptual, physically-based or process-oriented are available to estimate soil erosion at different spatial and temporal scales. The choice of which model is applicable, however, primarily remains linked to a matter of data availability rather than what type of information has to be obtained. Scaling in space and time remains a great challenge for the new mechanistic models. As a result, old fashion grey-type models such as USLE and the Revised USLE (RUSLE) are still by far the most widely applied soil erosion prediction models globally. A Web of Science query (http://apps.webofknowledge.com/) for the period 2007-2017 resulted in 1,149 hits corresponding to the keywords 'Universal Soil Loss Equation', 'USLE', 'Revised Universal Soil Loss Equation' or 'RUSLE'. Modelling approaches independent of the USLE technology, such as WEPP, LISEM, EUROSEM and PESERA result in only 254 hits all together. At the current state-of-the-art, process-based physical models are not yet mature enough and input data availability is a continuing source of concern for large-scale scale applications, simple physically plausible empirical methods for predicting soil erosion such as RUSLE can provide reasonably accurate estimates for most practical purposes. In this talk, we will illustrate the major steps done to improve the comprehensiveness and usefulness of large-scale RUSLE-based soil erosion assessments. We will share insights into the proposed geo-statistical approaches to thoroughly incorporate land uses and their changes, the extent, types, spatial distribution of croplands and the effects of the different regional cropping systems into national as well as global soil erosion models (Borrelli et al., 2018). In addition, we would also like to discuss a novel object-oriented soil erosion modelling approach to assess large-scale spatial conditions and inter-annual variability of soil cover conditions at ?eld-scale in order to bring RUSLE modelling back to its original dimension.

Impact of Land use Dynamics on Soil Organic Carbon in the Agricultural Soils of Bangladesh

Md. Jashim Uddin[1], Peter Hooda[2], A. S. M. Mohiuddin[1]
[1]Department of Soil, Water and Environment. University of Dhaka. Bangladesh
[2]Faculty of Science, Engineering and Computing. Kingston University London. UK
*Corresponding author: Md. Jashim Uddin, mjuddin66@yahoo.com

In Bangladesh, high population pressure (more than 160 million) has forced the production of two, three or more crops a year on the same land, resulting in a very short fallow period. This short fallow period leaves little or no time for the land to regain all its natural attributes, which are essential for its biophysical conditions. Such intensive land use could cause widespread land degradation due to loss of soil organic carbon (SOC) and its associated effects of nutrient mining. Considering the above, 190 soil samples were collected from the Brahmaputra and the Ganges alluviums by revisiting the sites sampled previously (1989-92) to quantify the SOC loss or gain. SOC datasets of current soil samples (2012) and the historic data sets (1989-92) revealed that SOC declined across the study sites as well as across the alluviums. Loss of SOC is significant in the highlands (HL) and medium highlands (MHL) sites but its loss is insignificant in the medium lowland (MLL) and lowland (LL) sites. The reason for such losses of SOC in the HL and MHL sites are at least partly due to intensive cropping with little addition of crop residues and even improper management. So, policies based on recommended management practices (RMPs) should be formulated for SOC sink and sequestration in the alluvial soils of Bangladesh.

How Pixel Size Affects a Sediment Connectivity Index in Central Belgium

Vincent Cantreul[1*], Charles Bielders[2], Aleix Calsamiglia[3], Aurore Degré[1]
[1]Liège University, Gembloux Agro-Bio Tech, BIOSE, 2 Passage des Déportés, 5030 Gembloux, Belgium
[2]Universitécatholique de Louvain (UCL), Faculty of Bioscience Engineering & Earth and Life Institute, 2 Croix du sud, L7.05.02, 1348 Louvain-La-Neuve, Belgium
[3]University of the Balearic Islands, MEDhyCON Research Group, Cta. Valldemossa km7.5, 07122 Palma de Mallorca, Spain
*Corresponding author: Cantreul Vincent, vincent.cantreul@ulg.ac.be

Connectivity has become an increasingly used concept in hydrological and sediment research. In order to quantify it, various indices have been proposed since the start of the 21stcentury including the index of connectivity developed by Borselli et al. (2008). This index is based on a limited number of factors, the most important one being topography. Sediment connectivity indices values are likely to depend on the digital elevation model (DEM) resolution. The aim of this study was, first, to compare the effect of DEM pixel size (between 0.25 and10 m, using an UAV) in the Belgian loess belt, a lowland area. We show that the index values were lower when the pixel size decreased (a difference of about 20 % in value between 0.25 and 10 m). In addition, the impact of linear features in the watershed (e.g., grass strip, bank and road) was lower with the largest pixel sizes, and the connectivity pattern was affected with a pixel size of 5 m or more. At lower pixel sizes (1 m or below), some more disconnected regions appeared. These corresponded to zoneswhere there had been water stagnation during and after rainfalls, and was corroborated by field observations. This confirmed the need for a proper resolution according to the objectives of the study. The second aim of this study was to deduce a minimum pixel size for connectivity study, helping local erosion or sedimentation location and consequent land management decisions. In our context, 1 m stands as the optimum DEM resolution. This pixel size permitted to locate all "key areas" in terms of erosion. Very high resolutions (<0.5 m) did not generate much more information, and their calculation time was far greater.

Wind Erosion Prevention Actions at the Saemangeum Reclaimed Tideland project

Seung-Heon Lee*
Rural Research Institute, KRC, Ansan, Republic of Korea, 15634
*Correspond author: Seung-Heon Lee, shyi@ekr.or.kr

Through long history, our country has been securing agricultural land and expanding land as a tideland reclamation project. The agricultural land acquired through tideland reclamation projects has been mainly used for paddy field. The reclaimed tideland was sold to farmers who used as paddy, and has contributed to self - sufficiency of rice which is main grain in Korea. Due to overproduction and low consumption of rice in recent years, reclaimed tideland policy was converted from sale to lease, and land use was also converted from paddy to upland field. The tidal flats that were submerged in the water were exposed at all times when the water level was managed through the draining gates after final sea wall closing. The exposed land was in a state where vegetation could not settle because of the high soil salinity at the initial stage. In winter and early spring, when strong northwest winds were blown, scattered dusts were generated and civil complaints were occurred. Therefore, the study was carried out on the prevention of soil erosion in the exposed areas before project completion. At the early stage of the exposure, the soil salinity was very high and the cover crops could not be cultivated. So, we performed the crushing work to raise the roughness of the soil surface, investigated halophytes those could be gained seeds, and artificially sow the exposed soil surface. Time and money were spent on seed sampling of halophytes. In the second step, forage crops were grown to prevent soil wind erosion. Only a certain amount was used as feed, and the remainder was input again to the soil,so that organic matter content of the soil was increased and the soil was aggregated. In order to prevent wind erosion, forage crops were selected Italian ryegrasss, barley and wheat which could cover soil surface in winter and spring. The field adaptation test was conducted to determine the suitable crops. Italian ryegrasss was determined by high salt tolerance, moisture resistance and high germination rate. As the action to prevent soil wind erosion from early tideland reclamation project, biological methods were found to be more cost effective than physical fence installation.

Soil Erosion and Management Policy in the Upper Region of the Han River

Jun man-sig[1*], Kim moon-sook[1], Lee sang-soo[2], Oh se-jin[3]
[1]Research Institute for Gangwon, Chuncheon 24265, Korea
[2]Institute of Environmental Research, Kangwon National University, Chuncheon 24341, Korea
[3]Korea South-East Power Co. Yeongheung Power Division, Incheon 23120, Korea
*Corresponding author: JUN Man-sig, jms@rig.re.kr

The upper region of the Han River has outstanding clean water quality throughout the nation. However, the management of water quality in several rivers and lakes is being a big issue since early 2000 due to soil erosion came from grouping of high land. The conflict between the upper and lower regions of the Han River was occurred along with astronomical social cost because of soil erosion problem. Therefore, the Korea Ministry of Environment designated the five regions located in upper Han river as Non-point Source Pollution Management Regions since 2007 by revising the Water Environment Conservation Act as one of the highest laws in Korea. The main reasons of severe soil erosion are mechanization of agriculture and characteristics of high land farming having the bare sites during a flood season. Excessive sediments destroy the habitat of riparian ecosystem. Moreover, the generated turbid water is maintained in lakes for a while because these regions are commonly located in the upper site of dam and it is releasing into the lower Han river resulted in water quality degradation. The generation of turbid water negatively affects not only ecosystem but also the use of water resources, as well as various recreation industries especially in summer season. In the last 10 years, the Korean Government made a huge investment to reduce soil erosion in Non-point Source Pollution Management Regions; however, there is critical limitation because they focused on the post management such as bypass channel, grit chamber, etc. rather than suggesting ultimate solutions. This presentation will propose institutional management strategies for mitigating soil erosion problem in Non-point Source Pollution Management Regions.

Establishing Policy Towards Sustainable Soil Management in South Korea

Sang-Il Hwang and Jong-Sung Kim*
Korea Environment Institute, KEI, Sejong, 30147, Republic of Korea
*Correspond author: Jong-Sung Kim, kimjs@kei.re.kr

Interest in soils is growing and it is time to develop a comprehensive management plan for soil degradation. However, the current legislative framework provides justice and management measures for soil pollution, lacks the institutional basis for managing the soil environment due to the lack of uniform definitions and concepts of soil degradation and soil damage. In this study, the concepts of soil degradation, soil pollution and soil damage are defined, and the domestic and foreign legal systems related to soil pollution and soil damage management are analyzed. Through this study, suggestions for revision of relevant laws were proposed by drawing policy implications and establishing policy direction for integrated management of soil pollution and soil damage. The analysis of the laws and systems that are considered to be related to soil pollution and damage management are analyzed. In the case of foreign countries, laws and systems related to soil environment of the United States, the Netherlands, Germany and the European Union (EU) were analyzed, and in particular, the soil conservation laws and soil degradation management systems of each country were analyzed. Domestic cases include the current status of the Environmental Policy Basic Law, the Soil Environmental Conservation Act, the Environmental Impact Assessment Act, the Natural Environment Conservation Act, and the Natural Parks Act, which are considered to be related to soil pollution and damage management in Korea. In Korea, unlike other countries, there is no legal basis for managing soil pollution and soil damage causedby soil degradation. Therefore, it is necessary to urgently revise the related legal system. The purpose of this study is to clarify the necessity of soil conservation management at the highest level of environmental regulation as a policy direction of domestic soil pollution and damage management considering the above considerations, and to provide concrete specification of the soil function in the regulation for conservation and management. The results of this study will provide a basis for integrated management of soil pollution and damage, and it can be utilized in the field of establishing integrated management strategy of long-term soil and development of soil environmental management technology at national level.

New Technologies for Soil and Water Conservation in the Czech Republic

Miroslav Dumbrovsky*
BrnoFacultyVeveri 331/95,
60200 Brno, Czech Republic
*Corresponding author: Miroslav Dumbrovsky, dumbrovsky.m@fce.vutbr.cz

The presented article and poster will provide basic information about new technologies and technical means for soil erosion control and flood prevention type use a special bags as a barriers for slope length reducing and bulit- up area protection. This technology is based on the use of newly developed technical means, serving as an alternatives for construction especially soil erosion control measures. The soil erosion control and flood prevention system expands the range of the nature friendly solutionsleading to dampen the impact of extreme natural phenomena on urban human settlements areas which simultaneously capable to be applied as a solution to strengthen measures to stabilize the erosion processes and water regime in the landscape. New technologies have been tested by Hydraulic tests in the Laboratory of Water Management Research at Brno University of Technology for verification of key parameters for barrier construction - and the stability of the tested system of erosion control measures. Soil erosioncontrol system is based on the use of Fabric bags as a barrier to divide the slope length against the surface runoff The bags are Filled mixtures to form composite comprises- in addition to binder - cement and water, in particular filler, which areenvironmental materials, such as soil obtained at the site of construction. Presented technology for Soil and Water Conservartion is being developed under grant programs TACR(Technology Agency of the Czech Republic) since 2015 as new technologies for soil erosion control and flood prevention system.

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Seung-Heon Lee *
Rural Research Institute, KRC, Ansan, Republic of Korea, 15634
*Correspond author: Seung-Heon Lee, shyi@ekr.or.kr

Through long history, our country has been securing agricultural land and expanding land as a tideland reclamation project. The agricultural land acquired through tideland reclamation projects has been mainly used for paddy field. The reclaimed tideland was sold to farmers who used as paddy, and has contributed to self - sufficiency of rice which is main grain in Korea. Due to overproduction and low consumption of rice in recent years, reclaimed tidelandpolicy was converted from sale to lease, and land use was also converted from paddy to upland field. The tidal flats that were submerged in the water were exposed at all times when the water level was managed through the draining gates after final sea wall closing. The exposed land was in a state where vegetation could not settle because of the high soil salinity at the initial stage. In winter and early spring, when strong northwest winds were blown, scattered dusts were generated and civil complaints were occurred. Therefore, the study was carried out on the prevention of soil erosion in the exposed areas before project completion. At the early stage of the exposure, the soil salinity was very high and the cover crops could not be cultivated. So, we performed the crushing work to raise the roughness of the soil surface, investigated halophytes those could be gained seeds, and artificially sow the exposed soil surface. Time and money were spent on seed sampling of halophytes. In the second step, forage crops were grown to prevent soil wind erosion. Only a certain amount was used as feed, and the remainder was input again to the soil, so that organic matter content of the soil was increased and the soil was aggregated. In order to prevent wind erosion, forage crops were selected Italian ryegrasss, barley and wheat which could cover soil surface in winter and spring. The field adaptation test was conducted to determine the suitable crops. Italian ryegrasss was determined by high salt tolerance, moisture resistance and high germination rate. As the action to prevent soil wind erosion from early tideland reclamation project, biological methods were found to be more cost effective than physical fence installation.

Vulnerability Assessment of Soil Erosion Affected by Climate Change

Kangho Jung* and Jeonghoon Ok
National Institute of Agricultural Sciences, RDA, Wanju, Republic of Korea, 55365
*Corresponding author: Kangho Jung, stealea@korea.kr

The government has enormous responsibility to sustain soil health because soil is a base resource that the present generation should bequeath to the next generation to provide other resources in future such as food, energy, and water. Soil loss prevention is the fundamental practice to manage soil sustainability as soil erosion is a process to lose the resource itself. Water erosion is the dominant process of soil erosion especially by torrential rains in summer season in Korean Peninsula located in Asian monsoon belt. With climate changes, it has been predicted in Korea that annual precipitation would increase with increased summer rainfall. Rainfall intensity of torrential rains was also predicted to increase. Actually, climate data in recent decades presented that regional torrential rains increased, which raised risk of soil erosion even in similar rainfall amount. The Korean government, therefore, was requested to measure effects of climate changes on soil loss and diagnose whether current technical practices and policies to conserve soil resources would work in future as much as the government pursued. Rural Development Administration (RDA) started the project to survey climate factors and their effects on agricultural productivity and numerous parameters involved in productivity such as soil quality and biotic season. The impact evaluation and vulnerability assessment for the first period will be performed in 2020 based on the four-year survey from 2017 to 2020; they will be repeated every five years after then. The USLE has been used to evaluate the risk of soil erosion so far but was not appropriate to evaluate effects of climate changes because USLE gives an annual soil loss on average; more detail data collected at each rainfall event or at a short-term period were needed to analyze impacts of climate changes on soil erosion. RDA, consequently, decided to revise rainfall erosivity factor (R factor) and a cover-management factor (C factor) and included sub-projects in the survey projects to determine RUSLE R factors and C factors.Soil loss of upland crop fields will be evaluated with updated factors in 2020 and re-calculated every five years. Based on the data, propriety of policies such as the agro-environment conservation program will be reviewed and soil resources would be possibly conserved under changed climate conditions.

Modeling Studies for Desertification and Soil Erosion Monitoring in Turkey

Ahmet Yalin YENER[1*], Suat SAHIN[2], Gunay ERPUL[3]
The Scientific and Technological Research Council of Turkey
[2]General Directorate of Combating Desertification and Erosion, Turkey
[3]Faculty of Agriculture, Department of Soil Science and Plant Nutrition, Ankara University, Turkey
*Corresponding author: Ahmet Yalin YENER, yalin.yener@tubitak.gov.tr

A Basin Monitoring and Evaluation System of Turkey is developed in cooperation with General Directorate of Combating Desertification and Erosion and TUBITAK (The Scientific and Technological Research Council of Turkey) in order to manage natural resources and provide infrastructure for integrative policies by evaluating the themes which are intertwined within a watershed level. Out of the nexus of diverse themes, this paper pulls desertification and soil erosion as an interactive focus. The "National Desertification System"taps into 48 main and 37 sub indicators under 7 criteria; Climate, Water, Soil, Land Cover and Land Use, Topography and Geomorphology, Socio-Economy, and Land Management and a geographically-based mathematical model specific to Turkey underpins the system. A first "National Desertification Risk Map of Turkey" including 9 classes from "Very Low Risk" to "Very High Risk, has been produced in 2016 and the model validation works has been performed at the basin scale. As a simultaneously running sub-theme, a "Dynamic Erosion Model and Monitoring System is complementarily established to predict soil losses at the micro, meso and macro watershed levels. The RUSLE technology highly integrated with GIS computes the average annual soil erosion in ton ha^{-1} $year^{-1}$as a product of rainfall-runoff erosivity factor R, soil erodibility factor K, slope length factor L, slope steepness factor S, cover-management factor C, and support practice factor P. The methodology then compares the calculated soil loss to the tolerable soil loss for a specific soil type, which is accepted as the maximum level of soil erosion that would still allow a high level of crop productivity in a sustainable and continuous way, in order to design the different land use systems and conservation practices. Furthermore, soil loss predictions by the RUSLE/SDR technology at the micro-catchment scales are also compared with the suspended sediment loads directly measured at monitoring stations available in the most of the catchments of Turkey in order to calibrate and validate the model capability. Lastly, at

the national scale the integrated assessment system of both desertification and erosion dynamically operates to detect susceptible areas to land and soil degradation and to develop measures of avoiding, mitigating and reversing degradation, ensuring the sustainable use of land and restoration of degraded lands in Turkey.

Reliability of Soil Erodibility Estimation in Areas Outside the US: a Comparison of Erodibility for Main Agricultural Soils in the US and China

Keli Zhang, Li Lian, Zhuodong Zhang*
State Key Laboratory of Earth Surface Processes and Resource Ecology, Faculty of Geographical Science, Beijing Normal University, Beijing 100875, China
*Corresponding author: Zhuodong Zhang, zzhang@bnu.edu.cn

Soil erodibility (K), which has important influences on the accuracy of soil loss prediction, is a critical factor in the universal soil loss equation (USLE) and the models modified from it. As an effective tool to estimate soil loss, USLE has been widely applied in the US and around the world. Since the 1980s, the USLE framework for soil erosion prediction and assessment has been adopted in China. During its application in China, it has been noticed that the K values appear to be considerably lower than those in the US. This fact means that the estimated values of soil erodibility from existing methods, such as the nomograph-based database in the US, might be unreliable for their application in China and other areas. In this study, the K values for the main agricultural soils in China with those in the US were systematically compared based on the database from field runoff plots. Possible reasons for the differences were analyzed, and the reliability of soil erodibility estimation in areasoutside the US was assessed. Results show that the average K factor for soils in the US is two to three times greater than that in China. For two typical stations with similar soil types located in the US and China, soil loss per rainfall erosivity is higher in the US than in China, although erosivity for the given rainfall in the US is sometimes smaller than that in China. There might be a great bias in soil loss prediction in China if the K value formulas derived from the database of the United States are used directly. This implies that the erodibility estimation formula currently used in the USLE model may need to be verified and revised.

Environmental Impact Assessment on Water Foot-Print for Rice

Seung-Oh Hur *, Sun-Gun Choi, Sung-Chang Hong and Dong-Ho Choi
National Institute of Agricultural Sciences, RDA, Wanju-gun, 55365, Korea
*Correspond author: Seung- Oh Hur, oilssohuri@korea.kr

Human activities like as agriculture, industry etc. pollute a lot of water. Water pollution from agriculture can be associated with specific activities, such as irrigation, fertilization, soil erosion. The water footprint is an indicator of freshwater use that looks not only at direct water use of a consumer or producer, but also at the indirect water use(WFN, 2011). The water footprint is the amount of water consumed to produce 1 kg of agricultural product, in units of L / kg. Green water footprints that are naturally supplied through rainfall, blue water footprints representing water that can be used only when energy is applied, such as irrigation, and gray water footprints, which are necessary to purify pollutants in accordance with natural concentration and surrounding water quality standards .The environmental impact assessment of water footprints should not be done in the calculation of water footprints but should be assessed as to whether they can be used continuously to use the produce. In this study, green water scarcity, blue water scarcity, and water pollution levelwere evaluated to determine whether the calculated water footprint was sustainable in environmental aspect. Green water scarcity determines the availability of green water at an environmentally problematic point and water pollution determines the ability to clean up pollutants. The results of the evaluation for the sustainability of rice production based on the water footprint of the 40 municipalities, which are rice main production complex, are shown to be sustainable.

Development of Sloping Agricultural Fields with Soil Degradation Controls

Sang Soo Lee*
Institute of Environmental Research, Kangwon National University, Chuncheon 24341, Republic of Korea
*Correspond author: Sang Soo Lee, sslee97@kangwon.ac.kr

Erosion is a phenomenon of removal or transportation of sediment, soil particles, and rock particles caused by water, wind, or gravity. The term of erosion is from "erosion"which means "eating away", derived from Middle French erosion, from L. erosionem (nom. erosio), from erodere "gnaw away", or from ex- "away" + rodere "gnaw". The first known occurrence of the term "erosion" was used in 1541 from the Guy de Chauliac's medical text "The Questyonary of Cyrurygens" which translated by Robert Copland. He used "erosion"to describe how ulcers developed in the mouth. Currently, soil erosion has been gradually increased by human land use such as deforestation, overgrazing, unmanaged construction activity, and road-building across the world. Soil erosion is one form of degradation phenomena such as compaction, salinization (accumulation of salts), nutrient depletion, and contamination. Soil erosion is distinguished from the physical or chemical weathering of minerals. Soil erosion on cropland in the U.S. was estimated to be $1.8*10^9$ tons in 2003. Over 78% of areas in Korea consist of sloping lands. Farmers are mostly not aware of the vulnerability of their soils to degradation, especially in mountainous or sloping land areas, where unpredictable erosion causes irreversible damage to soil and environmental sustainability. Excess nutrients supplied to crops in those degraded rural soils can be released into water bodies through surface runoff and eroded sediment or leaching, also known as non-point source pollution, thereby reducing surface water and groundwater quality.

Development of Korean Soil Loss Equation (KORSLE)and Arc GIS-based Sediment Assessment Tool for Effective Erosion Control

Youn Shik Park*
Department of Rural Construction Engineering, Kongju National University, Korea
*Corresponding author: Youn Shik Park, parkyounshik@gmail.com

Soil loss has been pointed out as the cause of environmental problems that worsen the water quality of streams and rivers in watersheds as well as in South-Korea. Therefore, various methods have been developed and applied to solve the problems caused by soil loss in watersheds. Prior to apply these models in a watershed, estimating the soil loss amount and estimating how to reduce soil loss is required so that the approaches to control soil erosion are efficiently designed and applied. Universal Soil Loss Equation (USLE) is a simple and convenient equation developed to estimate soil loss and is used in integration into geographic information system (GIS) based software.One such approach is the Sediment Assessment Tool for Effective Erosion Control (SATEEC). Integrating the equation into the GIS software, various watershed characteristics (i.e. disconnection of slope fields, monthly rainfall changes, crop growth, etc.) are become possible to consider. SATEEC has the advantage of less input data and easier to use in soil loss estimation, but it can be used on the basis of ArcView software, which is rarely being used by GIS users in general. Therefore, there is a need to redevelop the model with the ArcGIS software with various modules currently supporting SATEEC based on ArcView software. In the study, SATEEC was redeveloped to work as ArcGIS Tools programmed in ArcPy, to enhance compatibility of models for users' computer.ArcSATEEC, the reprogrammed SATEEC, has been designed to maintain all the modules provided by previous versions. Monthly rainfall and crop growth are also taken into consideration to enable estimation of monthly soil loss. The model was applied to the Daecheong dam watershed, and its monthly rainfall and crop growth characteristics were reflected and compared with the annual soil loss estimates by the Ministry of Environment's 'Notice on the Topography Erosion Status'. Compared with the annual soil loss by ArcSATEEC, the total soil loss did not show any significant difference, but the location of soil loss was significant.

Soil Quality under Grazing Grassland Soil in Zoige area, China

Junfang CUI[1,2*] , Xiangyu TANG [1], Chuandong LIU [2,3]
[1] Institute of Mountain Hazards and Environment, CAS, Chengdu, China
[2]University of Chinese Academy of Sciences, Beijing, China
[3]Hainan University, Haikou, China
*Corresponding author: Junfang CUI, jfcui@imde.ac.cn

Zoige grassland is located in Northeastern Qinghai-Tibet Plateau. The cruel natural condition makes this area the 'Third Pole'of world and its sensitivity of climate change intensifies its fragility. All pasture was public and animals were driven to fields with better grasses traditionally. This organization was changed in this decade with pasture divided to farms for use based on the number of their family members. Farms have right to manage their fields and decide how many animals fields can keep. Unfortunately, over-grazing is spreading and it deteriorates soil quality, thus causes zokor and rabbit disaster spreading, ending with even worse soil quality. However, few studies focusing on soil structural quality had conducted in this area. This paper investigated 15 fields varying on grazing management. Visual evaluation of soil quality (VESS) method (represented by Sq score) was applied to evaluate soil structural quality. Smaller Sq score indicates better soil quality. Soil penetration resistance was also conducted in fields. The results found Sq score of Zoigegrassland varied between Sq 1.0 and Sq 4.0 with the mean score of Sq 1.43. At depth, surface soil has better soil quality than that in the second layer. Penetration resistance increased with soil depth as well. Soils in Co. Hongyuan have smaller Sq score than that in Co. Zoige, indicating better soil structural quality. Single grazing in summer season or in winter season did not show any changes of soil quality. The high Sq score was found in soil with mix-season grazing fields, indicating a deterioration of soil quality. Three fields where were experienced soil desertification were also investigated. Three is no grazing anymore in these three fields and they are under different managements to recover. Of these three fields, two pieces were heavy damaged. One piece of heavy damaged field is re-planted this spring, and the second piece is developed to new ecosystem naturally. The third piece of field is light damaged by zokor pressure, and there is no grazing anymore too. The results showed management of no grazing alone is helpful to get new ecosystem developed but it is not sustainable for grazing as new species are inedible. For heavy damaged soil, no grazing plus re-planting is sustainable and effective to both improve soil quality and grass productivity.

Multiple-scale Transport of Fine Sediment and Associated Phosphorus in a Hilly Catchment

Xiang-Yu Tang[1]*, Qing-Song Xian[1], Pei Zhang[1], Guan-Qian Ren[1], Bo Zhu[1] and Jae E. Yang[2]

[1] Institute of Mountain Hazards and Environment, Chinese Academy of Sciences, Chengdu 610041, China.

[2] Department of Biological Environment, Kangwon National University, Chunchon 200-701, Korea

*Corresponding author: Xiangyu Tang, xytang@imde.ac.cn

It has been well recognized that selective soil erosion and sediment transport can lead to downstream fining and an enrichment of organic matter content along sediment cascades at the catchment scale. Natural or anthropogenic disturbances (e.g., agricultural practices, deforestation or timber harvests, construction activities and wildfires) are the main causes of excessive fine sediment production and loading to surface water (e.g., ditches, rivers, reservoirs). Multi-scale monitoring system for eco-hydrological processes and nitrogen and phosphorous transport was established in 2005 in a small hilly catchment in Yanting, SW China. Residential areas and sloping farmlands are the main sources of P loading to the river system of this agricultural catchment accommodating a populated Linshan town. Long-term dataset obtained at the plot scale showed that the majority (on average 78%) of P export from sloping (6) farmland was through surface runoff in particulate form. At the catchment scale, it has been evidenced that rainfall intensity governs transport dynamics of sediment and particulate phosphorus (PP). PP is more responsive than the bulk sediment to rain intensity peaks at gentle lowland positions of the catchment. The concentrations of colloid, total phosphorus and PP were much higher in 2015 than in 2013 after the start of construction activity in 2014 in Linshan town in the catchment. Correlation analyses in 2013 and 2015 were performed among rain intensity, particulate P concentration, colloid (defined as the <10 m fine sediment) concentration and bulk suspended sediment concentration. Results imply that colloid concentration can be used as an easily measured proxy parameter to estimate the concentration of particulate phosphorus using the established calibrations for concerned locations of the channel system based on long-term monitoring data.

Suspended Solids Export by the Outflowing Water from Irrigation Paddy Field during Rice Growing Season of Korea

Yongseon Zhang, Kangho Jung, Hye-Rae Cho, Kyeong-Hwa Han, Min-Kyeong Kim, and Yeon-Kyu Sonn*
National Academy of Agricultural Science, RDA, Wanju, 55365, Korea
*Corresponding author: Yongseon Zhang, zhang@korea.kr

This experiment was conducted in Suwon and Iksan city from 2012 to 2014 to evaluate soil erosion and nutrient loss from irrigated paddy fields during cropping period. Rainfall amount and rainfall erosivity of EI30 were, on average, 1,026 mm and 3,922 mm ha -1 yr -1 hr -1 for the cropping period, respectively, and the rainfall event with maximum EI30 occurred in July. Annual average of runoff was 2,508 MT ha -1 yr -1 in Suwon and3,375 MT ha -1 yr -1 in Iksan, accounting for 36% of rainfall of the cropping period. Nutrient loss by runoff, on average, was 7.0 kg N ha -1 yr -1 , 1.3 kg P ha -1 yr -1 , and 16.6 kg K ha -1 yr -1 ; N, P, and K loss were 5.0, 0.6, and 8.3 kg ha -1 yr -1, respectively, in Suwon and 8.9, 1.9, and 16.7 kg ha -1 yr -1 in Iksan. Soil loss in Korean paddy rice was evaluated as 0.33 MT ha -1 yr -1 ranging from 0.05 MT ha -1 yr -1 to 0.88 MT ha -1 yr -1 . Amount of soil loss, however, depended on areas and yearinfluenced by variation of rainfall amount and intensity. Interestingly, soil erosion in Iksan in 2012 was remarkably greater than those in other periods due to heavy rainfall between late May and June with soil flake dispersion right after the rice-planting season.

Application of ArcGIS-based Tool for Potential Soil Loss

Youn Shik Park
Department of Rural Construction Engineering, Kongju National University, Korea
*Corresponding author: Youn Shik Park, parkyounshik@gmail.com

Universal soil loss equation (USLE) had been used to predict potential soil loss since it was developed from the statewide data observed and collected in the United States. USLE had an origin in average annual soil loss estimation though, it was improved and modified to provide better opportunities for soil loss estimation outside the United States. One such noticeable features in use of the equation are that the equation is to estimate potential soil loss and that the equation has five factors to be adapted to applied watershed. Therefore an approach using the equation was provided and suggested in the study, an ArcGIS-based model for the opportunity to employ of adapted the five factors to South-Korea was selected to solve the first feature. And monthly potential soil loss from 2003to 2016 were computed in the 38 water protection districts for soil loss grading. Distinct feature was found in characteristics of potential soil loss prediction, the districts of low potential soil loss had low five factors in the aggregate, of course. However, if one or more factors are dominantly large enough, the potential soil loss was computed severely, compared to the other districts. It is concluded that the estimated soil loss were used to classify the districts to define the classification of most severe soil loss, as the estimated soil loss means potentiality.

Development of Sustainable Land Management (SLM) Framework to Combat Desertification: the Case of SATREPS-Ethiopia Project

Nigussie Haregeweyn[1] & Atsushi Tsunekawa[2]

[1]International Platform for Dryland Research and Education, Tottori University, 1390 Hamaska, 680-0001 Tottori, Japan

[2]Arid Land Research Center, Tottori University, 1390 Hamaska, 680-0001 Tottori, Japan.

*Correspond author: Nigussie Haregeweyn, nigussieharegeweyn@alrc.tottori-u.ac.jp

Desertification, land degradation and drought affect one-third of the earth's dryland surface. The situation might get worse due to the unsustainable use of soil and water under present scenarios of climate change and population growth. Such problems are more severe in low income countries of the sub-Saharan Africa including Ethiopia. In Ethiopia, various land management initiatives have been carried out totackle land degradation problems since the 1970s in the form of Food-for-Work, Productive Safety Net Programme, and free labor mobilization mainly driven by external donors. However, most of the implemented measures were unsustainable due to inappropriate use of technologies, lack of co-ordination between the different farming sectors, and poor command and control systems. As a result, even if measures were implemented, they were not maintained. It is against this background that Tottori University together with other Japanese institutes including the University of Tokyo and Ethiopian institutes is currently conducting a collaborative research project titled, "Development of Next-Generation Sustainable Land Management (SLM) Framework to Combat Desertification". The project is being funded under the framework SATREPS (Science and Technology Research Partnership for Sustainable Development) jointly by JICA and JST. In this seminar, an overview about Tottori University research activities particularly taking the case of Ethiopia will be presented and discussed. Tottori University has been engaged in collaborative researches with Ethiopian institutes on areas of land degradation and management especially since 2010. Since then, collaborative research activities are expanding over diverse thematic areas on the principles of a landscape approach through integrating several disciplines. There have been good achievements made so far in terms of scientific paper publications and dissemination of the results using available avenues that all in the end could contribute at large towards the UN's global agenda to achieve a Land Degradation Neutral (LDN) world by 2030.

Soil Erosion and Organic Carbon Management Using Polyacrylamide and Biochar

Sang Soo Lee[1], Yasser M. Awad[2], Sandeep Kumar[3], Yong Sik Ok[2*]

[1]Institute of Environmental Research, Kangwon National University, Chuncheon 24341, Republic of Korea

[2]O-Jeong Eco-Resilience Institute (OJERI) & Division of Environmental Science and Ecological Engineering, Korea University, Seoul 02841, Republic of Korea

[3]Department of Plant Science, South Dakota State University, Brookings, SD 57007, USA

*Corresponding author: Yong Sik Ok, yongsikok@korea.ac.kr

Soil organic carbon (SOC) is one of the most critical factors determining soil quality or fertility. Recent survey has reported the severe degradation of SOC by soil erosion in agricultural fields throughout the world. To maintain soil quality or productivity, biochar (BC) or anionic polyacrylamide (PAM) has been recently suggested; however, the combination effects of BC and PAM have not been reported to date. This study evaluated the effect of BC, PAM or their mixture (BC+PAM) on soil quality, plant growth, and runoff and soil loss under simulated and natural rainfalls. Applications of BC promoted growth of soybean (C3 type) and maize (C4 type) plants and maintained soil physical properties such as water retention and stability. Our findings showed that BC+PAM was the best for plant growth, even other subject amendments were not worse. Addition of BC may lead to accelerate the metabolic-performance capacity of plants, especially C3 plant, due to sufficient C source. For runoff and soil loss tests, all amendments increased runoff compared to the control possibly due to clogging soil pore by viscous PAM solution application and decreased soil loss due to clay flocculation and aggregate stabilization by PAM, and water adsorbing capacity of BC. The use of BC+PAM can be a new, excellent strategy to promote plant growth and reduce soil loss; however, optimum application method should be considered carefully prior to its practical use.

Development of Watershed-based Surface Soil Information System based on Web GIS

Yunsoo Sung and Jonggun Kim*
Dept Regional Infrastructure Engineering, Kangwon National University
*Correspond author: Jonggun Kim, kimjg23@gmail.com

Surface Soil is important resource that have many functions human needs, such as conservation of water resource, purification of contaminated materials, and productivity of food or energy. However, the surface soil is limited source that not has been recovering for the long time in case the resource eroded. In Korea, the Ministry of Environment enacted the notification on the investigation of the erosion of the surface soil and countermeasures and has been studying to assess complex characteristics of soil. As the results, database of soil quality assess criteria (Biomass, Ground Water Recharge, Habitat, Carbon Storage, Buffer, and Soil Loss) was constructed and Web-based system that can evaluate conditions of surface soil was developed. However, non-experts have a difficulty to use and understand this system due to the system requires specialized knowledge about soil qualities. In this study, the Web Geographic Information System (GIS) watershed-based surface soil information system was developed to improve availability and accessibility of database of soil quality assess criteria. The Web GIS watershed-based surface soil information system provides current condition of surface soil characteristics in the place where user selected, and GIS-based soil data to specialized-users who need. The users are able to download data of soil qualities by administrative district, watershed, and special region where set by TauDEM module. The developed system in this study would be expected for being used as baseline data of soil study, environmental effects evaluation and contributing to soil conservation laws.

Development and Application of Web GIS-based Soil Erosion and Soil Quality Information System

Dongjun Lee*
Dept Regional Infrastructure Engineering, Kangwon National University
*Correspond author: Jonggun Kim, kimjg23@gmail.com

The purpose of this study is to develop the Web GIS-basedsurface soil erosion prediction system which provides various information, such as daily soil erosion, soil quality, and BMPs. This newly developed system includes 1) the soil erosion prediction module based on MUSLE to estimate soil erosion; 2) the user-friendly system to be easy-to-use for user of the module; 3) various soil qualities information with BMPs suggestion for improving the soil qualities; and 4) the application to improve availability of the developed system. To achieve these purposes, the core engine module for soil erosion prediction was developed and assessed by comparing the observation measured at two test fields which have 3% and 9% slope. The verified module was included in the Web GIS-based system. The system was applied into four study areas (e.g., Jaun-Cheon, Bukhan-Gang, Namhan-Gang, and Gyoungan-Cheon) to provide soil erosion prediction at field scales. The system can analyze soil erosion for single and multiple fields in the study areas. Furthermore, the system including the database of soil qualities and various BMPs can provide the level of soil quality at a selected field. It also suggests several recommended BMPs to improve the current soil quality. These functions of the system is also available in the mobile application. Therefore, the Web GIS-based surface soil erosion prediction system and the application were developed to enable non-experts to obtain soil information without understanding complicated processes and complex models. It can be expected to recognize the importance of soil resources and help enact laws relative with soil conservation.

A Study on the Installation Effect of Settling Basin for Reducing Soil Loss

Min Hwan Shin*
Korea Water Environment Research Institute
*Corresponding author: Min Hwan Shin, uv2000wind@nate.com

In 2016 year, Soyang (Mandae, Gaya, Jaun district) and Doam lake in Korea have been designated as the nonpoint source management areas, and management plans have been established for nonpoint pollutant reduction. The Ministry of Environment provides the standards of installation for the nonpoint pollutant treatment facilities. However, a manual is needed for managing the nonpoint pollutant treatment facilities, especially settling basins reflecting the site-specific characteristics which are not accounted for in the current standards. Since the number and timing of management showed a big difference locally, their standards need to be established for maintaining the efficiency of settling basins. The management cost also varied with thesize and management method of settling basins. Thus, standards for proper management plan and cost estimates is needed for managing the nonpoint pollutant treatment facilities effectively. The watersheds of settling basins mostly consist of forest (50~87%) and agricultural (10.6~55.9%) areas. In particular, the settling basin in Yongsan 2 mainly consists of agricultural areas (55.9%) that may cause a large amount of muddy water even with a small rainfall. Annual precipitation for recent 10 years (2007~2016) ranges from 1,269mm to 1,443mm locally representing decrease trend gradually since 2007 year. As the results of SS reduction efficiency for 6 settling basins in nonpoint source management areas, the efficiency showed a big difference (9.9~89.7%) locally according to location, baffle structure, weir type, management method. Particularly, the reduction efficiency increased considerably after dredging. Based on the particle size analysis, the sediment inflow into settling basin was mostly composed of silt. However, the reduction efficiency of fine particles was low because the deposited sediment was sand over 100㎛ of particle size.

GIS-based Soil Erosion Modeling on Territories with Gaps in Soil Survey

Vasyl Cherlinka*, Yuriy Dmytruk
Yuriy Fedkovych Chernivtsi National University, Institute of Biology, Chemistry and Bioresources, str.Ukrainka, 25, Chernivtsi, 58012, Ukraine
*Correspond author: Vasyl Cherlinka, v.cherlinka@chnu.edu.ua

An analysis of the current state of cartographic information about soil cover of Ukraine shows that there are a number of significant problems. This relates to three basic points: their availability and accessibility, relevance and accuracy. In particular, large areas of the territory have not yet created large-scale soilmaps, especially in the mountainous part of the Carpathians and the Crimea, for plain-covered areas, areas of most settlements, etc., that is, there are large gaps in which no surveys were conducted at all. So, from total 60.5 million hectares of land of Ukraine is currently covered by large-scale inspections only of about 45 million hectares, i.e. about a quarter of the country's territory is still a white spot. In most areas there are various anthropogenic processes including intense water erosion. GIS implementation of erosion models such as model SIMWE, a physically based model designed by Mitas and Mitasova (1998), was developed to modelling linear erosion processes. Integrated in the software Geographic Resources Analysis Support System – Geographic Information System (Grass GIS) supports efficient management of georeferenced data, computation of input parameters for different scenarios, spatial analysis of the modeling results, and effective visualization. But the fight against water erosion and its negative consequences without accurate information on the qualitative composition of soils is impossible. Therefore, we propose a way of constructing predictive soil maps based on modeling, and these results can be used in water erosion models. Therefore, the main objective was to modelling water erosion on territories with gaps in soil survey. For this aim, we create of simulative soil maps, which are obtained through simulation using a typical set of materials that can be potentially available for soil scientist in modern Ukrainian realities. Achievement of this goal has been accomplished by solving a number of the following tasks: a) digitization and attribution of cartographic materials; b) construction of a DEM; c) analysis of digital elevation models and generation on this base a set of maps of morphometric and other derivatives characteristics in the GIS GRASS; d) the creation simulation models of soil cover (maps-versions or maps-models) using 14 basic types of predictive algorithms for areas with available soil information and for those where it is absent.

As an object was selected a fragment of the territory of Ukraine (4200x4200 m) within the limits of Glybotsky district of the Chernivtsi region, confined to the Prut-Siret interfluve (North Bukovina)with contrast geomorphological conditions. This area has different administrative subordination and economic use but is covered with soil cartographic materials only by 49.43%. For data processing were used instrumental possibilities of free software: geo-rectifications of maps material – GIS Quantum, digitalization – Easy Trace, preparation of maps morphometric parameters – GRASS GIS and building simulative soil maps – R, a language and environment for statistical computing. Digital elevation models was constructed using by regularized splines with tension in GIS GRASS. DEM served as the basis for the selection of a number of morphometric characteristics of the relief: slope and aspect of the slopes, curvature of the surface (profile, plan, longitudinal, minimal and maximal), calculations of data on the amount of solar radiation and forms of relief. Additional maps of hydrological indicators were also generated: the topographic wetness index, flow accumulation and direction, length of water flows and distance to them. To create simulation models of soil cover, a R-statistic script was written that includes a number of adapta-tions for solving set tasks and implements the types of predicative algorithms such as: Multinomial Logistic Regression, Decision Trees, Neural Networks, Random Forests, Naive Bayes, K-Nearest Neighbors, Flexible Discriminant Analysis, Nonlinear Discriminant Analysis, Support Vector Machines, Linear Discriminant Analysis, Partial Least Squares Discriminant Analysis, Penalized Logistic Regression, Nearest Shrunken Centroids and Bagged Trees. To assess the quality of the obtained models, the Cohen's Kappa Index (k) was used. A significant beneficial effect of this kind of modeling is the ability to fill gaps on existing cartographic materials with data from predicative map-versions and, thus, obtaining composite soil maps. This composite soil maps will be a good base for assessment, modeling and management processes of water erosion.

A Study of Rainfall Kinetic Energy Equations based on Climate Classification

Joon-Hak Lee *
Dept. of Civil Engineering and Environmental Sciences, Korea Military Academy, Seoul, Republic of Korea, 01805
*Correspond author: Joon-Hak Lee, cetera@kma.ac.kr

Rainfall Erosivity, which is required to estimate the long-term annual average amount of soil loss in the arable land, is calculated as the total rainfall energy and a maximum 30 min rainfall intensity. Rainfall energy is defined as the rainfall kinetic energy formula multiplied by rainfall amount, and is used to calculate the rainfall erosivity. Rainfall kinetic energy equation is an empirical formula based on rainfall intensity and is derived from the regression analysis between rainfall intensity and rainfall kinetic energy. Rainfall kinetic energy equation in USLE, which has been widely used in the worldwide, was derived from Washington, D.C. in the U.S. Over the past 50 years, many researchers have proposed new rainfall kinetic energy equations derived from each region of the world, and have conducted the comparative study between their new equations and the USLE's equation. This study was focused on investigate the characteristics of the rainfall kinetic equations derived from various regions around the world. This study collected 43 rainfall kinetic energy equations and boundary conditions of each equation. The finding was that 43 rainfall kinetic equations were classified into 8 climate regions according to Köppen-Geiger Climate Classification Map. This study presented that the widely used equations in (R)USLE were derived from Cfa (humid subtropical climate) regions in the U.S. In South Korea, the climate could be divided into five climatic zones such as Dwb, Dwa, Dfa, Cwa, and Cfa. The result showed that the characteristics of rainfall kinetic energy were related with climate conditions in each region. Thus, the application of a (R)USLE's kinetic energy equation for all climatic regions could not be appropriate except for Cfa and have the limitation to be underestimated or overestimated depending on climate conditions.

Developing a Guidance for Top-Soil Conservation in Development Projects

Tae Heum Kim *
Yooshin Engineering Corporation, Seoul, Republic of Korea, 06252
*Correspond author: Tae Heum Kim, taemmy13@hanmail.net

Damage and erosion of soil resources resulted by the development project are divided into the damage caused by the cutting and filling at the early stage of the construction and the soil erosion with stormwater runoff during the construction period or after completion of the construction according to the construction plan. Therefore, in order to propose a soil conservation guideline for development project, it is necessary to establish a plan to minimize the damage of soil resources caused during development project by grasping conservation of topsoil-related standards and management plan of overseas guidelines of topsoil-related standards. Collection, storage and recycling regulations are being applied for the conservation of topsoil in various development projects in order to recycle fertile soil. Ministry of Land, Infrastructure, and Transport of Korea choose collecting area of fertile soil from forest area according to the construction standard specification of environmental management and the environment-friendly guideline of railway construction. On the other hand, Korea Land & Housing Corporation, which is a government-affiliated organization, has wider range of choices – fields, forest, and miscellaneous land. In addition, collecting depth is regulated to be 40~60cm, 20~50cm, 50cm (forest area) and 30cm (other area) respectively for construction standard specification of environmental management, landscape design standard, environment-friendly standard of railway construction, and Korea Land & Housing Corporation, ultimately leading to a conclusion of establishment for same, unified standard. The Guideline for Conservation of Topsoil for Development Project (draft) is prepared not for government agencies or environmental impact assessment agents but for actual development companies, so that it should help the development companies and engineers environmentally to implement the environmental protection and erosion mitigation measures at the site. Therefore, the development plan should be composed on the basis of contents that should be reflected for topsoil conservation by dividing into planning stage, design stage, construction stage, and operation stage so as to be helpful to the development company.

Sediment Yield from Ungauged Watersheds in South Korea

Pierre Y. Julien[1], and Woochul Kang[1], Chunyao Yang[1], Jai Hong Lee[1], Joonhak Lee[1,2], and Seongjoon Byeon[1,3*]
[1]Colorado State University, Fort Collins, Colorado, USA;
[2]Korea Military Academy, Seoul, South Korea; and
[3] International Center for Urban Water Hydroinformatics Research & Innovation, Incheon, South Korea.
*Correspond author: Seongjoon Byeon, seongjoon.byeon@gmail.com

The objective of this project is to develop a multiple regression model for the estimation of the sediment yield from ungauged watersheds in South Korea. Thirty-five watersheds were investigated and 5 regression equations are proposed to estimate the mean annual sediment yield as functions of river basin characteristics. The meaningful river basin characteristics are: watershed area in square kilometers, mean annual precipitation in millimeters, percentage of urban area, percentage of sand in the soil, and average watershed slope. The proposed models were tested and validated with nine river stations. The results of the proposed regression equations are reasonable. The reservoir data are separated from the river data. The average specific degradation of reservoirs is 896 tons/km2·year. Using MEP, the annual sediment yield of 29 river stations were calculated and then used for multiple regression. Five regression models were proposed based on the structure of the USLE. As more variables were used, theaccuracy of the prediction should increase. The models were validated with 9 river stations in South Korea. All the validation results are within the 95% prediction intervals, except station N6. The result of validation is satisfactory.

Soil Erosion of Shihmen Reservoir Watershed in Taiwan

Walter Chen*Dept. of Civil Engineering, National Taipei University of Technology, Taipei, Taiwan ROC
*Correspond author: Walter Chen, waltchen@ntut.edu.tw

Soil loss due to surficial erosion is a critical problem in watersheds of Taiwan. Not only does it create environmental hazards, but it also threatens the ability of downstream reservoirs to supply water to major cities. In this study, we conducted a new analysis using the most recent available data and the Universal Soil Loss Equation (USLE) to compute the amount of sheet and rill erosion of the Shihmen reservoir watershed in northern Taiwan. The results are close to the measured reservoir siltation rates,which are 71.20 t/ha/yr (15-year average) and 48.50 t/ha/yr (53-year average). These amounts are much higher than the average erosion of 2.46 t/ha/yr in the European Union (Panagos et al. 2015). There is at least one order-of-magnitude difference between Europe and Asia, which indicates that soil erosion is a much more serious issue in Asia, especially in areas with highly erodible soils and steep terrains. In addition, we found that topography has the most influence on the amount of soil erosion than any other factors. The soil loss is highly concentrated, and a small proportion of the areas contributes to a large proportion of the total erosion (approximately 2% of the areas account for 30% of the erosion). The implication of this finding is that a restoration prioritization strategy can be developed to focus on areas with high Soil Erosion Risk (SER). To visualize the high SER sites, we exported the high SER cells to KML format and displayed them on Google Earth. Many of the cells are found to be close toactual eroded zones. The spatial proximity of the high SER sites to the actual eroded zones is an indication that our approach is a good first estimate and worth of consideration and further investigation.

SSORii Erosion Model: Development and Applications

Giha Lee *
Dept. of Construction & Disaster Prevention Eng,, Kyungpook National Univ., Korea
*Correspond author: Giha Lee, leegiha@knu.ac.kr

Empirical erosion models such as Universal Soil Loss Equation (USLE) family models have been widely used to produce spatially distributed soil erosion vulnerability maps. Even if the models describe relatively well vulnerable sites using big data related with climate, geography, geology, land use, etc within studydomains, they do not describe the physical process of soil erosion on the ground surface due to rainfall or overland flow. In other words, such models are still quite powerful tools to distinguish the erosion-prone areas at large scale but physics-based models are necessary to be developed for analysis of soil erosion and deposition as well as eroded particle transport simulation. This study aims to develop the SSORii erosion model (a physics-based soil erosion modeling system) to produce both runoff and sediment yield time series at watershed scale and represent the spatiotemporal map for erosion and deposition. The developed modeling system consists of 3 sub-systems: rainfall pre-processor, geography pre-processor and main modeling processor. For modelingsystem test and validation, we applied the system for various erosion researches, in particular, rainfall-runoff-sediment yield simulation and estimation of probable maximum sediment(PMS) due to probable maximum rainfall(PMP). The system provided acceptable performances of both applications.

Soil Change Detection using Aerial Photographs

Junku Park[1], Jungsub Kim[1], Gi-ha Lee[2]
[1]Dept. of Civil Engineering, Inha University, Incheon, Republic of Korea, 22212
[2]Dept. of Construction and Disaster Prevention Engineering, Kyungpook National University, Daegu, 41566,
*Corresponding author: Junku Park, vanadius@naver.com

Based on the Administrative rule(Public notices) on the Investigation of Soil Erosion Status, soil loss is estimated using USLE(Universal Soil Loss Equation) model, and if the soil loss exceeds 50 tonnes per hectare per year, it needs to conduct field survey. But the major dissatisfaction in field survey is not consistent with the results of the USLE model. USLE model consist with various factors such as the rainfall erosivity factor(R), soil erodibility factor(K) and the cover-management factor(C) etc. andthis model predicts relatively soil loss under the influence of corresponding factors. The cause of the soil erosion can be classified into two factors as natural and artificial. But USLE model can only estimate natural factors. Soil erosion is not actually lost or disappeared but it meant soil fractions are moving. However, the USLE model only predicts loss in unit cell, so this contains uncertainty because it could not reflect the mechanism of erosion and deposition. The best way for the determining reliable soil loss is field survey, but it is too difficult to conduct field survey periodically over a wide area of watershed. Aerial photograph contains all the information of the actual geographic feature at the time of image acquisition. Therefore, if 3D terrain can extract accurately, the same effect can be achieved as field survey. And the multi temporal photographs can also be used to monitoring erosion and deposition. For this purpose, soil loss was estimated by multi-image matching using aerial photographs, terrain/non-terrain filtering and coregistration method. Watershed in Naeseong-cheon, natural factors is the main cause of the soil loss. The soil loss was 2.7 tonnes per hectare per year from 2010 to 2015. In addition, amount of soil erosion and deposition appeared to be similar. Soil loss of the Anbandegi region is caused by natural factors such as rainfall erosion, wind erosion and by artificial factors such as cultivation. The soil loss of Anbandegi region was 0.5 tonnes per hectare per month, this means that more effective management plan is required.

Discontinuous Gullies in Ethiopia: Typology, Morphology and Evolution

Paolo Billi*
International Platform for dryland Research and Education, University of Tottori, 1390 Hamasaka, Tottori, 680-0001 Japan
*Corresponding author: Paolo Billi, bli@unife.it

Gully erosion is very common in Ethiopia affecting large areas with different geomorphological, pedological and climatic characteristics. The amount of soil loss due to gullying has become a very serious problem in the recent decades leading to remarkable depletion of cultivated land. Discontinuous gullies are defined as individual gullies that develop entirely within a slope and do not have any direct connection with the fluvial network. Three different types of discontinuous gullies were identified on the basis of their morphological characteristics: 1) short (meters) and very steep (65 %) gullies; 2) short (meters), low gradient (5-10%) gullies and 3) very long (kilometers) and deep (10-20 m) box gullies. Field investigations on gully morphological features and development were carried out on three gullies, each representative of the three main types of discontinuous gullies in two study areas of Ethiopia, the Lakes Region in the Main Ethiopian Rift Valley and the central highlands, i.e. the main gross physiographic regions of Ethiopia, characterized by different geo-morphological and environmental conditions. In order to investigate the main factors originating the different types of gullies, geomorphic parameters data were collected in the field. From their analysis no correlation was found between top width and depth as instead reported by other authors. The box and short, low gradient gullies have similar geomorphic characteristics in terms of cross-section shape factor and longitudinal variation of depth, whereas the short, steep gully has distinctive features. The long term (nine years) monitoring of the small, low gradient gully morphology indicates that gullies in their early stage of development can be very dynamic. The average rate of expansion of this gully is 4.8 m^3per year, which corresponds to 26% of the initial gully and to 476 t $ha^{-1}yr^{-1}$, i.e. a value much higher than that of 48 t $ha^{-1}yr^{-1}$ calculated for gullies in the northern Ethiopia highlands by Nyssen et al. (2006) from interviews and measurements. Hypotheses on the mechanisms responsible for gully development in the study areas are investigated and the short- and mid-term gully expansion rate and the main processes involved are discussed as well.

Sediment Yield Variability: A Case Study from Paired Watersheds in the Upper Blue Nile Basin, Ethiopia

Kindiye Ebabu[1,2*], Atsushi Tsnekawa[3], Nigussie Haregeweyn[4], Enyew Adgo[2], Derege Tsegaye Meshesha[2,3], Dagnachew Aklog[5], Tsugiyuki Masunaga[6], Mitsuru Tsubo[7], Dagnenet Sultan[1,8], Ayele Almaw Fenta[1], Mesenbet Yibeltal[1,8]

[1]The United Graduate School of Agricultural Sciences, Tottori University, 1390 Hamasaka, Tottori 680-8553, Japan

[2]College of Agriculture and Environmental Sciences, Bahir Dar University, P.O. Box 1289, Bahir Dar, Ethiopia

[3]Arid Land Research Center, Tottori University, Tottori, Japan

[4]International Platform for Dryland Research and Education, Tottori University, Tottori Japan

[5]Center for International Affairs, Tottori University, Tottori, Japan

[6]Faculty of Life and Environmental Science, Shimane University, Shimane, Japan

[7]Institute for Soil, Climate and Water, Agricultural Research Council, Pretoria, South Africa [8]Faculty of Civil and Water Resource Engineering, Bahir Dar Institute of Technology, Bahir Dar University, Bahir Dar, Ethiopia

*Corresponding author: Kindiye Ebabu, kebabu2@gmail.com

Improved knowledge of spatial and temporal variability of sediment yield (*SY*) is needed to design erosion control strategies, particularly in the most severely eroded areas. This study was conducted to provide this knowledge for the humid tropical highlands of Ethiopia using the Akusity and Kasiry paired watersheds in the Upper Blue Nile basin. The main objective was to examine controls on spatial and temporal variations of *SY* in these tropical humid highlands. Discharge and suspended sediment concentration (SSC) data were monitored during the rainy season of 2014 and 2015 using automatic flow stage sensors, manual staff gauges and a depth-integrated sediment sampler. The *SY* was calculated using empirical discharge–sediment rating curves for different parts of each rainy season. The measured mean daily SSC varied greatly between years and watersheds (0.51 g L^{-1} in 2014 and 0.92 g L^{-1} in 2015 for Kasiry, and 1.04 g L^{-1} in 2014 and 2.20 g L^{-1}in 2015 for Akusity). At both sites, SSC decreased as the rainy season progressed, regardless of the rainfall and discharge patterns, owing to depletion of the sediment supply and limited transport capacity of the flows caused by increased vegetation cover. Seasonal *SYs* for Kasiry were 7.6 t ha^{-1} in 2014 and 27.2 t ha^{-1} in 2015, while in Akusity *SYs* were 25.7 t ha^{-1} in 2014

and 71.2 t ha^{-1} in 2015. The much larger values in 2015 can be partly explained by increased rainfall and larger peak flow events. The magnitude and timing of peak flow events are major determinants of the variability of *SYs*. Thus, site-specific assessment of such events is crucial to reveal *SY* dynamics of small watersheds in tropical highland environments.

Watershed Runoff Response to Soil and Water Management Interventions in a Tropical Humid Highland of Ethiopia

Dagnenet Sultan Alemu[1,2,*], Atsushi Tsunekawa[3], Nigussie Haregeweyn[4], Enyew Adgo[5], Mitsuru Tsubo[6], Derege Tsegaye Meshesha[5], Tsugiyuki Masunaga[7], Dagnachew Aklog[8], Ayele Almaw Fenta[1], and Kindiye Ebabu[1,5]

[1]The United Graduate School of Agricultural Sciences, Tottori University, Tottori 680-8553, Japan

[2]School of Civil and Water Resource Engineering, Institute of Technology, P.O. Box 26, Bahir Dar University, Bahir Dar, Ethiopia

[3]Arid Land Research Center, Tottori University, 1390 Hamasaka, Tottori 680-0001, Japan

[4]International Platform for Dryland Research and Education, Tottori University, 1390 Hamasaka, Tottori 680-0001, Japan

[5]Department of Natural Resources Management, Bahir Dar University, P.O. Box 1289, Bahir Dar, Ethiopia

[6]Institute for Soil, Climate and Water, Agricultural Research Council, Pretoria 0083, South Africa

[7]Faculty of Life and Environmental Science, Shimane University, Shimane Matsue 690-0823, Japan

[8]Center for International Affairs, Tottori University, 680-8550, Tottori, Japan

*Correspondence: Dagnenet Sultan, dags120@yahoo.com

Various soil and water conservation measures (SWC) have been widely implemented to reduce surface runoff in degraded and drought-prone watersheds. But little quantitative study has been done on to what extent such measures can reduce watershed-scale runoff, particularly from typical humid tropical highlands of Ethiopia. Firstly, a paired-watershed approach was employed to quantify the relative difference in runoff response for the Kasiry (treated) and Akusty (untreated) watersheds. Secondly, a calibrated curve number hydrological modelling was applied to investigate the effect of various SWC management scenarios for the Kasiry watershed alone. The paired-watershed approach showed a distinct runoff response between the two watersheds however the effect of SWC measures was not clearly discerned being masked by other factors. On the other hand, the model predicts that, under the current SWC coverage at Kasiry, the seasonal runoff yield is being reduced by 5.2%. However, runoff yields from Kasiry watershed could be decreased by as much as 34%

if soil bunds were installed on cultivated land and trenches were installed on grazing and plantation lands. In contrast, implementation of SWC measures on bush land and natural forest would have little effect on reducing runoff. We conclude that integrated field measurements and modelling applied in the current study can improve our understanding of the effects of land management interventions on watershed-scale hydrology. This in turn helps planners choose appropriate management scenarios and enable identification of appropriate conservation measures that are suited to particular biophysical niches.