





# Abstract Book 3<sup>rd</sup> International Youth Forum

## on

# **Soil and Water Conservation**

Tarbiat Modares University, Noor, I.R. IRAN

16-21 October 2021

كتابچه چكيده مقالات









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**Editors:** 

- Dr. A. Khaledi Darvishan - Prof. SHR. Sadeghi - Dr. V. Moosavi

## **Conference Main Theme:**

Soil and Water Conservation (SWC) under Changing Environments

## • Sub-Themes:

- Smart SWC
- Adaptive SWC
- Youth Roles in SWC
- Climate Change and SWC
- SWC in Developing Countries
- Performance Evaluation of SWC Projects
- Impacts and Possible Solutions of COVID-19 Pandemic on SWC Practices

www.IYFSWC.modares.ac.ir Email: IYFSWC@modares.ac.ir





# *Faculty of Natural Resources and Marine Sciences,* Tarbiat Modares University, Noor, I.R. IRAN

16-21 October, 2021

# **Abstract Book**

**Editors:** 

- Dr. A. Khaledi Darvishan - Prof. SHR. Sadeghi - Dr. V. Moosavi



Professor Dr. Seyed Hamidreza Sadeghi, Scientific Secretary

# Respected excellences, senior scientists, colleagues, audience, organizers, and distinguished guests:

Greetings,

I, as a member and Deputy President for the World Association of Soil and Water Conservation (http://www.waswac.org.cn/waswac/index.htm), Honorary President, Watershed Management Society of Iran (http://www.wmsi.ir/), and a professor in the Department of Watershed Management Engineering at Tarbiat Modares University TMU (Iran) am very privileged to welcome to all participants of the 3rd International Youth Forum on Soil and Water Conservation jointly organized by WASWAC and TMU. The application for the forum was received the precious WASWAC consent during the last board meeting of WASWAC at Delhi in Nov. 2019. Since then, many efforts were made to publicize the meeting and receive the maximum contribution to the main theme, Soil and Water Conservation (SWC) under Changing Environments. However, the COVID-19 Pandemic paralyzed all activities worldwide. Nonetheless, the attempts were persistently continued through different ways and aspects. Consequently, the call for papers was dispatched, more than 70 weekly meetings were held, some 106 papers were received, the YOPA contest was held, and top ten papers were selected among nominated contributors, the forum was postponed by five months, hoping to get better conditions, and finally the semi-virtual type was decided for holding 3rdIYFSWC during October 16-21, 2021. Afterward, the forum received valuable supports from different international and national bodies. The UNESCO branch in Tehran, the Iranian National Commission for UNESCO, Agrohydrology Research Group (TMU) and Kalleh Dairy Company also financially supported the forum, whose valuable cooperation is greatly appreciated. Incontestably, thinking about the simultaneous fulfillment of watershed balance and human needs is vital for decision-makers, politicians, and experts to properly govern declining situations of the biotic and abiotic resources at different scales. In this direction, scientific gatherings on managing two crucial commodities of soil and water while considering global and livelihood security facilitate an appropriate platform to propose new ideas and exchange valuable experiences among peoples with various backgrounds, living standards, and even governmental situations. Such issues need more consideration in developing countries due to the ever-increasing population and uncontrolled developmental activities to balance all contradictory sectors in the ecosystems. It is therefore needed to overcome existing myopia in the management of soil and water resources through propagating applied, and scientific outcomes resulted from promising and fruitful gatherings to bring as many as scientists around a table to elucidate scientifically based practical solutions for the existing issues in the world to convince politicians, decision-makers, planners, practitioners, and even end-users. It is ultimately hoped that all stakeholders proportionate their needs and expectations to conserve all resources as a precious heritage for future generations holistically. I hope the outcomes of the forum not only fulfill human demands and welfare but also guarantee the sustainable production of the system for present and future generations economically efficient and ecologically friend as it strives in the forthcoming gathering. On this occasion, I profoundly extend my thanks and greetings to all those who collaborated with the forum and wishing them all the best.



Dr. Abdulvahed Khaledi Darvishan (Associate Professor) Executive Secretary

# Respected excellences, senior scientists, colleagues, audience, organizers, and distinguished guests:

Greetings,

As the executive secretary, it is my great pleasure to welcome you all to the 3<sup>rd</sup> International Youth Forum on Soil and Water Conservation jointly organized by World Association of Soil and Water Conservation (WASWAC) and Tarbiat Mosares University (TMU). Despite the negative effects of COVID-19 pandemic on all the scientific activities and conferences worldwide, we received valuable contributions from nine countries of Iran, China, India, Serbia, Russia, Turkey, Italy, Montenegro and Germany. A total of 107 abstract/full papers were received, of which 51 full papers were evaluated for WASWAC Youth Outstanding Paper Award (YOPA)-2021 by an international valuable group of senior scientists. The other 56 abstract/full papers received for participation in the conference were also evaluated by valuable group of international referees. I would like to thank all the organizers including the President and Deputy of Research and Technology of Tarbiat Modares University, the Dean and Vice Chancellor for Research of the Faculty of Natural Resources and Marine Sciences of Tarbiat Modares University and the President and Secretariat of World Association of Soil and Water Conservation. The valuable contributions of all the scientific and executive committees and reviewers are also appreciated. Because of COVID-19 pandemic conditions, the forum was basically organized and held online and I would like also to thank my colleagues, student branch and the experts of IT center and open course office of Tarbiat Modares University. I do really hope this event has created a good opportunity in scientific sessions for senior and young scientists to bring and share their knowledge and to learn more on the most up-to-date aspects of soil and water conservation.

I wish all of you success, health, happiness and prosperity!



Dr. Vahid Moosavi (Assistant Professor) Organizing Secretary

#### Respected scientists, colleagues and distinguished guests:

Greetings,

I am very delighted and honored to have this opportunity to welcome you all to the 3<sup>rd</sup> International Youth Forum on Soil and Water Conservation. The major goal and feature of this forum is to bring academic scientists, engineers and researchers together to exchange and share their experiences and research results about different aspects of soil and water conservation and discuss the practical challenges encountered and the solutions adopted. A sustainable soil and water resource is a utopia in different societies. It could be achieved by a proper balance between socio-economic development and environmental protection. The forum provides a setting for discussing recent developments in soil and water conservation specially under changing environments. I hope all participants will have a technically rewarding experience. I would like to extend my sincere gratitude to all of you who kindly helped us make this event come together to become a success.

## **Key Organizers**

- Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, IRAN
- World Association of Soil and Water Conservation (WASWAC)





## **Sponsors and Partners**



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World Association of Soil and Water Conservation (WASWAC)



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(Professor) Scientific Secretary



Vahid Moosavi

(Assistant Professor) Organizing Secretary



Abdulvahed Khaledi Darvishan

(Associate Professor) Executive Secretary



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Secretary



Forum Main Theme:

## > Soil and Water Conservation (SWC) under Changing Environments

### Sub-Themes:

- ➢ Smart SWC
- > Adaptive SWC
- > Youth Roles in **SWC**
- Climate Change and SWC
- **SWC** in Developing Countries
- > Performance Evaluation of *SWC* Projects
- > Impacts and Possible Solutions of COVID-19 Pandemic on SWC Practices

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## Rare Earth Elements Tracing Interrill Erosion Processes as Affected by Near-Surface Hydraulic Gradients

B. Wang<sup>1\*</sup>, Ch. Wang<sup>1,2</sup>

<sup>1</sup> School of Soil and Water Conservation, Beijing Forestry University, Beijing 100083, China.
<sup>2</sup> State Key Laboratory of Hydroscience and Engineering, Tsinghua University, Beijing 100084, China.
\*Corresponding author Email: wangbin1836@bjfu.edu.cn

#### Abstract

Understanding the mechanism of the interrill erosion process is important to develop a processbased interrill erosion model. Six rare earth elements (REEs) were applied in different slope segments and soil layers to track sediment movement and deposition in order to gain insights into the near-surface hydraulic gradient-affected (drainage, saturation, and seepage conditions) interrill erosion processes under three rainfall intensities of 30-, 60-, and 90-mm.h<sup>-1</sup>, respectively. The results showed that the contribution of interrill soil loss from each tracer segment along the slope was increased firstly and then decreased in drainage-saturation conditions, while that was increased in seepage conditions. The transport by raindrop-induced and overland flow-driven rolling, creeping, and/or sliding was dominant transport mode. The dominant process of interrill erosion was transport-limited in drainage-saturation conditions and detachment-limited in seepage conditions, respectively. In transport-limited process, raindrop-induced transport was more efficient than raindrop impact overland flow-driven transport. However, the raindrop impact overland flowdriven transport was more efficient than raindrop-induced transport in detachment-limited process. The response relationships of sediment transport capacity and soil detachment rate which separated from the interrill erosion rate to near-surface hydraulic gradient, rainfall intensity, slope gradient, and slope length could be better described by power equation respectively ( $R^2 > 0.81$ , NSE > 0.81). The values of  $R^2$  and Nash-Sutcliffe simulation efficiency (NSE) increased by 2.53% to 1840.00% and the average absolute values of the relative error (RME) derived from in this study decreased by 38.03% to 87.21% compared with the existing interrill erosion empirical equations. In addition, the so called interrill erodibility should be further divided into interrill sediment transportability in transport-limited process and interrill detachability in detachment-limited process.

**Keywords:** Interrill Erosion Process, Near-Surface Hydraulic Gradient, Ree Tracing, Transport Mode, Soil Erosion Mechanism.





## Soil Physical Quality in Relation to Soil Erosion

M. Singh

Regional Research Station, Punjab Agricultural University, Ballowal Saunkhri, Balachaur, SBS Nagar, Punjab, India. Email: <u>mmjsingh@pau.edu</u>

#### Abstract

Soil quality is the capacity of a soil to function within ecosystem and land use boundaries to sustain biological productivity, maintain environmental quality and promote plant and animal health. The usefulness of the soil quality concept can be enhanced greatly by making it objective, quantitative and precise through development of appropriate soil quality indices. Key soil properties can be used as indicators of sustainable soil management. The standard or reference values should be established for specific kind of soils or group of soils that function similarly and for specific land uses based on best management practices. Then assessment of soil quality can be made by comparing the measured value of an indicator with its reference value. Soil erosion affects soil quality through its effects on inherent soil properties like rooting / topsoil depth, available nutrient content and soil clay content and on efficiency of use of external inputs like fertilizer, irrigation and tillage energy. Determinants of soil physical quality are adversely affected by soil erosion. The most reactive portion of the soil are the organic and clay fractions. Accelerated erosion is a selectively destructive process because it removes one of these key reactive fractions of soil which leads to degradation in soil physical properties. Soil structure is an important attribute of soil physical quality, and its maintenance and improvement are essential for reducing soil erosion risks. Soil erosion rate is determined by the quality of soil aggregates to withstand the forces of raindrop impact and surface flow. Soil aggregation decreases with increasing severity of erosion. Soil organic carbon level needs to be maintained or increased because of its strong impact on aggregation and soil quality. The magnitude of erosion and, therefore, its effect on soil quality vary with land use. As the intensity of land use increases, the amount of ground cover and associated root contribution decreases, the quantity and quality of soil organic carbon decreases, and soil quality is reduced. So, it can be concluded that soil quality and soil erosion are tightly interrelated phenomenon. Soil quality affects the rate of soil erosion and is in turn affected by it.

Keywords: Erosion process, Land degradation, Soil depletion, Soil productivity.



## Application of 'Smart Irrigation Scheduling' to Improve Water Use Efficiency for Sustainable Agriculture in the Pacific Island of Guam

M.H. Golabi<sup>\*1</sup>, F.P. Galsim<sup>1</sup>, S. Bateni<sup>2</sup>

<sup>1</sup>University of Guam, Mangilao, Guam. <sup>2</sup>University of Hawaii at Manoa, Honolulu, Hawaii. \*Corresponding author Email: mgolabi@triton.uog.edu, m\_golabi@hotmail.com

#### Abstract:

As Guam pushes toward a sustainable agriculture, farmers are still facing challenges with the high costs of water and fertilizer. An irrigation system optimized in tandem with technological components can provide maximum water savings with minimal impact on soil health and water quality. Thus, to improve farmers' overall confidence in the agriculture economy, a web-based irrigation scheduling tool known as 'CropManage' (CM) is currently being evaluated in Guam to help farmers with irrigation decision making. 'CropManage' is a smart advising tool that is expected to significantly reduce irrigation costs as well as meet the plant water requirement for optimum water-use efficiency. Factors such as soil type and crop coefficients are entered into CM. which generates a profile for a specific crop growing in a given farm/field. 'CropManage' then considers past rainfall data (via on-site weather station) together with proximal evapotranspiration (ET) data to generate recommendations for irrigation rates that meet the plant water requirement. The tool uses information specific to an individual farm like geographic location, crop type, basic soil parameters, and atmospheric data via on-site weather station. During 2020 monitoring, data were collected from two farms: 1) Island View Farm in the northern Guam, and 2) University of Guam (UOG) Research farm also in northern Guam. At the UOG Research Farm, where eggplants were irrigated with using 'CropManage' recommendation had greater canopy cover and higher crop yield (although not statistically different), compared to the traditional irrigation system practiced by farmers (control). Preliminary data from a cropping season (2020) showed over 13,500 gallons of water saved (approximately 85% water saving) when CropManage was used compared to a traditionally practiced irrigation system by farmers (control). In addition, there were noticeable improvements in crop yield for CropManage study plots. However, damages to crops by insects, diseases, and weather conditions were encountered during the cropping season. Therefore, more data collection is recommended to confer the efficacy of a weather-based irrigation scheduling tool in Guam's farmlands. As Guam and other islands in the Marianas move from subsistence agriculture toward cash-crop economy, the integration of such technology in agriculture can help enhance environmentally sound and sustainable cropping system while increasing farmers' overall confidence in agricultural economy.

**Keywords:** Vegetable crop, Plant canopy cover, CropManage, Smart irrigation, Water use efficiency, Sustainable agriculture.





## **Conservation of Monsoonal Rainwater Behind Indian Dams**

P.R. Rakhecha

Former Dy. Director: at Indian Institute of Tropical Meteorology, Pune, India. Independent researcher at: D-82, Shastrinagar, Jodhpur-342003, India. Email: rakhechapukhraj@gmail.com

#### Abstract

India with a total area of 3,287,263 km<sup>2</sup> is situated in the monsoon climate zone of south Asia. The country is divided into 28 states and 9 union territories. Rainfall from the southwest monsoon is the main source of fresh water in India. The country receives almost 80-90% of its annual rainfall during the southwest monsoon season from June to September. Since most of the fresh water in India occurs during 4 months in a year, whereas the country needs water throughout the year for domestic use (including drinking water), irrigation, industry, production of hydro electricity and a host of other purposes. Therefore, there is a need for the conservation of the monsoonal rainwater through the construction of dams across the Indian rivers for its use throughout the year. The main principle guiding the water conservation has been to ensure adequate supply of water for various uses as described above. The average annual flow in India's river systems is 1869 km<sup>3</sup> (BCM) which gives per capita water availability of 1902 m<sup>3</sup>.yr<sup>-1</sup>. Today world per capita use of water is 710 m<sup>3</sup>.yr<sup>-1</sup>. According to the ford foundation team India has one of the largest supplies of water in the world. It is estimated that out of 1869 km<sup>3</sup> water only about 690 km<sup>3</sup> water can actually be stored because of the geographical factors, especially the location of proper sites, climate and soil conditions. There were only 250 storage dams in the country at the time of India's independence in 1947 with total water storage of about 12 km<sup>3</sup> (BCM). The need for increasing dams for more water conservation was felt after 1947. As a result India exhibited great engineering feats in the construction of a large number of dams in the different states of the country for the conservation of the monsoonal rainwater to meeting water needs of the growing population. Consequently, there has been a rise in the number of dams and up to the end of the year 1990 there were about 3634 dams in India (CWC, 1990). Out of these about 2154 dams are large each having storage of more than 60 million m<sup>3</sup> water. These dams provide water supply for domestic use, agriculture, industry, power generation also for flood control works. The storage build up in the completed dams was about 254 km<sup>3</sup> (BCM). This indicates that about 36% of the estimated usable water resource or 14% of average annual flow in the rivers was being stored up to the end of the year 1990. While the situation has improved from 250 dams in 1947 but there is a great scope for more rainwater conservation through dams. India proposes to continue with its program of dam construction to create additional storage of 200 km<sup>3</sup> to ensure continued sufficiency in food grain production and to meet the energy and drinking water needs of a growing population. In this paper, we review realistic situation as to what proportion of the available rainwater in each state of India is presently being conserved through their dams.

Keywords: Runoff management, Reservior management, Water harvesting, Water management.



## Review and Enlightenments of Soil and Water Conservation in Past 70 Years on Loess Plateau, China

L. Rui

Institute of Soil and Water Conservation,CAS/MWR, NWUA, China. Email: lirui@ms.iswc.ac.cn

#### Abstract

To summarize the experiences of soil and water conservation on Loess Plateau, China in the past 70 years (1949-2019), and to provide reference for the ecological environment protection and highquality development in this region. Based on long-term and extensive field investigation experiences and scientific research achievements, a large number of documents and literature related to soil and water conservation work on the Loess Plateau were analyzed. In term of the main objectives and measures of soil and water conservation, the history of soil and water conservation on the Loess Plateau in the past 70 was divided into three stages: No.1 is the stage of response to urgent (1949-1980), No.2 is the stage of comprehensive control (1980-2000), and No.3 is the stage of ecological restoration (after 2000). It is suggested that water and soil conservation in the new period should pay attention to the following aspects.(1) Scientific and rational understanding of the overall reality of soil and water loss conservation status in the Loess Plateau;2) Raising the socioeconomic and production level of the areas and improving people's living conditions.(3) assessing the environmental impacts of large-scale projects for soil and water conservation.(4) having more scientific research projects focused on the new problems and challenges under higher-level control conditions. After soil and water conservation of 70 year, remarkable achievements on the loess plateau has been achieved, including vegetation restoration and reconstruction, soil and water conservation infrastructure construction, slope soil erosion control, and sediment reduction in yellow river. But it is very important to realize clearly that Loess Plateau still faces many severe challenges caused by natural conditions and human activities. Many connatural factors causing soil and water loss still exist, as well as many new factors may arise. Therefore the task of soil erosion prevention and control is still arduous. It is necessary to improve the speed and quality of soil erosion control and social/economic development on Loess Plateau for making great contribute to the national strategic goals of Yellow River basin ecological protection and high-quality development.

**Keywords:** Loess Plateau, Soil And Water Conservation, Review and Enlightenment Ecological Protection, High Quality Development, Yellow River Basin.



## Soil and Land Degradation in Central European Condition during the Last Century and Possible Measures for Sustainable Land Use

B. Sarapatka

Department of Ecology and Environmental Sciences, Palacky University, Slechtitelu 27, 783 71 Olomouc, Czech Republic. Email: borivoj.sarapatka@upol.cz, borivoj.sarapatka@seznam.cz

#### Abstract

The presentation focuses on the processes influencing soil and landscape degradation, on evaluation of the problem and on possible remedial measures. Landscape degradation is a global problem caused by a number of factors, often in combination, including inappropriate management, unsustainable farming procedures, pollution, deforestation, etc. Protection of land against degradation is one of the 21<sup>st</sup> century global problems which currently has a negative influence on roughly a third of the Earth's land surface. The quality of agricultural land is declining, and there is a consequent impact on the land's non-productive functions, and the environment itself. These processes are intensifying, not only due to actual farm management, but also due to changes in the agricultural landscape. A typical example can be seen in the development of landscape in the post-war period in Central and Eastern Europe, with the collectivization of agriculture. On a global scale, one of the most serious types of degradation is that of water erosion. It is therefore given greater attention in this presentation. According to research reports, European farm land is subject to an average annual loss of more than 2 ton.ha<sup>-1</sup> due to water erosion. In these erosion areas, significant changes are evident in a number of studied soil characteristics. A very sensitive reaction is noted especially in characteristics relating to soil organic matter, or biological and biochemical properties. Similar changes are apparent in production characteristics relating to crop yield and economic indicators. A smaller area of land, roughly a third in comparison with water erosion, is threatened by wind erosion. A problem with intensively farmed arable land is its relatively low content of organic matter as a result of farm management with low quantities of crop residue. This is compounded by other problems, such as a considerable compaction of soil due to changes in water and air regimes, loss of biodiversity or contamination due to heavy industrialisation. Some of these degradation factors act in unison, leading to intensification of e.g. soil erosion, reduced retention capability, resulting in degradation of landscape and disturbance of its structure and ecosystem services. In other parts of the world, other problems of degradation factors are on the increase, such as soil salination, which may even become a greater problem within Europe due to climatic changes. In order to comprehend the extent and intensity of soil and landscape degradation, numerous models have been developed and used in recent decades which are applicable from global to local level. Many of these relate to soil erosion. An essential factor in the creation of these models is the availability of data relating to soil erosion. In the Czech Republic there is a long tradition of gathering such data. It was, therefore, possible to use this data on our worksite as the basis for a degradation model for the Czech Republic. This enables the evaluation of individual degradation influences, on a cadastral level, including the combined effect of their incidence. This means the model is of particular use in identifying the most problematic areas, which can then be worked on with the proposal of measures to improve the state of both soil and landscape. Of course, apart from land management, soil degradation also relates to physical-geographic factors of the land. Knowledge of these can help in the proposal of measures against the increasing degradation of landscape. A demonstration of this practical proposal, on which we are working (e.g. project QK1810233 Ministry of Agriculture, or Technology Agency CZ Centre for landscape and biodiversity – DivLand) will also be part of the presentation.

Keywords: Climate change, Land Degradation, Soil loss, Soil productivity, Sustaiability goals.





## Watershed Development: Congenial Sustainable Asset

V. Rama Krishna

Department of Studies and Research in Political Science, Tumkur University, Tumakuru, India. Email: rahul\_rk2004@yahoo.co.in

#### Abstract

In India more than 70 percent population are depending on major agricultural activities and Indian agriculture is dependent on monsoon which is not uniform. The productivity of any crop in India mainly depends on land and water as a two natural resources. Since the concept of watershed development is gaining importance over the years, projects have been taken up under different programmes by Government of India. Watershed Development or watershed and development concept which means a consist drainage basin or catchment area, all water flowing into it goes to a common outlet. Watershed Development is conservation, regeneration and the judicious use of all the natural resources, particularly land, water, vegetation and animals and human development within the watershed. John Wesley Powell explains "that area of Land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where as humans settled, simple logic demanded that they became part of a community". Watershed development requires multidisciplinary skills, integration of technology and competences. The present paper concentrates on strategies and key interventions of watershed development programmes in India and in Karnataka Particularly which are congenial sustainable asset for the development of livelihoods focusing on management of water resources, transforming agriculture sector, climate change and management of water resources. Drought Prone Areas, Poor Soils, Lack of access to Information and Technology, Inadequate Infrastructure, Inability to get credit from formal channels keep the farmers trapped in poverty and other livelihood opportunities in the context of Watershed Development identifying the socio economic impact of the programmes on improving the productivity of crops and sustenance of the Watershed Development Programmes.

Key Words: Drought, Productivity of Crops, Programmes, Watershed Development.



## On the Role of Geospatial Modeling for Sustainable Soil and Water Management

R. Duttmann

Department of Landscape Ecology and Geoinformation Sciences, Kiel University - CAU Kiel Email: duttmann@geographie.uni-kiel.de

#### Abstract

Over the last few decades the availability of geodata data provided by state, national and supranational authorities increased exponentially. Modern earth observation technology enables continuous mapping and monitoring of environmental states and changes and supports to the build-up of environmental data bases of high quality and increasing spatial and temporal resolution, while to-date geodata infrastructures serves to to identify and disseminate existing data for the different application purposes, such as the modeling of environmental processes and related impacts. The lecture aims at giving an overview on the recent technological developments in the provisioning and usage of readily available geodata for the modelling of soil degradation processes at different spatial scales. It further shows how the modeling results can be used to assist sustainable land management. The regional focus will be laid on central Europe at the example of soil erosion and soil compaction the data processing chain, starting with the provision of geodata via official geodata infrastructures and ending with the modelling of the recent state and related impacts of both degradation processes will be demonstrated. Finally the lecture discusses how geospatial predition results can be integrated into a vehicle mounted on-the-fly assistance system as developed in the soil assist project (https://www.bonares.de/soilassist) to contribute to sustainable agriculture.

Keywords: Geo-Spatial Study, Land Degradation, Monitoring Tools, Spatial Modeling.





## **Precious Soil - The Need for Sustainable Soil Resources Management**

M. Zlatic

Department of Ecological Engineering in Soil and Water Resources Protection, Faculty of Forestry, University of Belgrade, Belgrade, Serbia. Email: miodrag.zlatic@sfb.bg.ac.rs

#### Abstract

According to the natural characteristics, Serbia is predisposed to erosion processes. However, both worldwide and in Serbia, a large percentage of erosion processes are contributed by anthropogenic factors. The activity of man can be both negative and positive, depending on the degree of awareness of the importance of using natural resources on the principles of sustainability. Preventing the degradation of torrential floods and erosion processes contained in the sustainable management of land resources, which includes the use of participatory methods. The paper presents the participation of the community in the management of natural resources (CBNRM - Community Based Natural Resources Management), according to which the community becomes the primary implementer, with the assistance and under the supervision of professional services. In the case of public participation in the sustainable management of land resources of Grdelica Gorge (South Serbia), shows the socio-economic and ecological approach of the local population. One of the significant participatory approach programme is WOCAT (World Overview of Conservation Approaches and Technologies) which was also implemented in Serbia. Within the WOCAT program in Serbia, the best conservation technologies and approaches were recorded, which were derived not only from experts but also from local farmers/villagers. These technologies and approaches have entered the world database, whose use can certainly act in the prevention of torrential floods. This paper also presents a model of sustainable management of land resources, adapted to the conditions of hilly areas of Serbia, which includes the planning of production on sloping terrain from the aspect of land resources, then the needs of the population for certain localities particular production, and profitability of planned production. Regarding ecological effects of the model of SLM, soil loss is reduced under the level of tolerance in the researched area. Economic effects of the established model of SLM, proved by Benefit-Cost Analysis, are on the satisfactory to significant level. These reasons are enabling people to stay and survive in these regions.

**Key words:** Economic Effects, Environmental Effects, Land Degradation, Sustainable Management.



## Soil Erosion in Montenegro, South-East Europe: Processes, Prediction, Modeling, and Measurements

V. Spalevic

Department of Geography, University of Montenegro, Montenegro. Email: velibor.spalevic@gmail.com

#### Abstract

Soil erosion by water is one of the major threats not only to soils but also to ecosystem services, crop production, drinking water and carbon stocks in Europe, but also within the Balkan Countries. The Mediterranean region, where Montenegro belongs, is particularly prone to erosion. This is because it is subject to long dry periods followed by heavy bursts of erosive rainfall, falling on steep slopes with fragile soils, resulting in considerable amounts of erosion. In most of the European countries monitoring of soil erosion is one of the mandatory policy matters. The application of a modified version of the Revised Universal Soil Loss Equation (RUSLE) model (RUSLE2015) to estimate soil loss in Europe, within which the input factors (Rainfall erosivity, Soil erodibility, Cover-Management, Topography, Support practices) are modeled with the most recently available pan-European datasets. 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 ton. $ha^{-1}$ .yr<sup>-1</sup>, resulting in a total soil loss of 970 Mt annually. In parts of the Mediterranean region, erosion has reached a stage of irreversibility and in some places erosion has practically ceased because there is no more soil left. With a very slow rate of soil formation, any soil loss of more than 1 ton.ha<sup>-1</sup>.yr<sup>-1</sup> can be considered as irreversible within a time span of 50-100 years. Losses of 20 to 40 ton. $ha^{-1}$  in individual storms, that may happen once every two or three years, are measured regularly with losses of more than 100 ton.ha<sup>-1</sup> in extreme events. The elite's resolve to accumulate ever more wealth and to maintain, consolidate, or expand their sociopolitical power and the necessity of the poor to fulfill their requirements of food. Unless the vast masses of poor people are integrated into the national mainstream through the implementation of equitable and redistributive development policies, it is impossible to control within the South-East European Countries the accelerating rate of soil erosion and thus to achieve the objective of sustainable development. The main causes of soil erosion are still inappropriate agricultural practices, deforestation, overgrazing and construction activities. For assessing soil erosion risk, various approaches can be adopted. A distinction can be made here between expert-based and model-based approaches. One may make a subdivision based on the time scale for which a model can be used: some models are designed to predict long-term annual soil losses, while others predict single storm losses (event-based). Alternatively, a distinction can be made between lumped models that predict erosion at a single point, and spatially distributed models. Another useful division is the one between empirical and physically-based models. The choice for a particular model largely depends on the purpose for which it is intended and the available data, time and funds. In Montenegro we grounded analysis on soil erosion intensity using the local IntErO model developed by Spalevic, based on the Erosion Potential model of Gavrilovic. New initiatives are now based on the development of Web based IntErO that will be open dynamic map for calculation of soil erosion intensity, available for all the researchers from the South-East Europe and the other interested parties all over the World.

Keywords: Soil Erosion Modeling, Processes, Prediction, Modeling, Montenegro, South-East Europe.



## Strategizing Integrated Management of Water Resources in Northwest Indo-Gangetic Plains

S.S. Kukal

Member, Punjab Water Regulation & Development Authority, Chandigarh, India. Email: sskukal@rediffmail.com

#### Abstract

Water is expected to become an issue of concern in very near future keeping in mind the fast depleting and/or degrading water resources. The increasing scarcity of water is clearly reflected in the current negative water balance in the northwest region of Indo-Gangetic Plains (IGP). With the present annual demand of about 66 billion m<sup>3</sup> (BCM) of water in agricultural most productive region (Punjab) in IGP, the available water in the state including annual replenishable water is 53 BCM, leading to a deficit of 13 BCM, which is being met by overexploiting the already exploited ground waters. This has led to a fall in groundwater level to the extent of 65 cm every year. With climate becoming harsher due to rising temperatures and ill-distributed rains, the demand for water in agricultural sector may rise further. On the other hand, industrial growth and improved living standards of general public are expected to raise water demand in these sectors at the cost of agricultural sector, thereby threatening the food security of the region. Apart from depleting water resources, the water quality degradation is another issue adding to its scarcity. The increasing salinity, sodicity and heavy metal concentration in the ground waters is being witnessed. The untreated sewage water in all the cities and towns of the state is finding its way in the streams and rivers thereby not only polluting the surface waters but also the ground waters especially in the vicinity of these streams and rivers. The water resources, be it river water, ground water, rainfall, re-circulated water, are inter-connected and cannot be seen in isolation for their management. There is a dire need to manage these resources in an integrated way. To sustain the water resources for the coming generations, it is important to manage these across different sectors (inter-sectoral) instead of doing it in piecemeal within a particular sector (intra-sectoral), as per the prevailing practice. This paper highlights a multi-pronged strategy to be formulated based on the concepts of (i) increasing the quantum of existing water, (ii) improving the groundwater recharge and (iii) conservation of water through its judicious use in all the sectors.

Keywords: Reservior Management, Water Desalinization, Water Management, Water Pollution.



## Erosion, Sediments and Pollutants Transport in the Largest European Megapolis Catchment

S. Chalov<sup>1\*</sup>, Oxana Erina<sup>1</sup>, Dmitriy Sokolov<sup>1</sup>

<sup>1</sup> Department of Land Hydrology, Lomonosov Moscow State University, Moscow, Russia. \*Corresponding author Email: srchalov@geogr.msu.ru

#### Abstract

Moscow city is the largest metropolitan area in Europe. Due to inefficient infrastructure of water supply and treatment systems, it pose a huge impact on the downstream reaches of Moskva-Oka-Volga river system. Rather limited availability of sediment and water quality information impedes detection of specific pollution sources and control over them: low spatial coverage, scarcity and poor accessibility of its environmental monitoring data hinders comprehensive research. Since 2019, integrated study on the Moskva River and its tributaries was conducted, complete with determination of the with a focus on sediment and water quality regime and pollutants spreading. The study is based on the network of autonomous monitoring station which capture water discharges and suspended load on regular basis (each 30 minutes) and are used as a proxy of urban (artificial) regime of the area. Water and sediment sampling at 38 locations on the main river and at 17 of its tributaries is done on monthly basis. The ADCP discharge measurements are linked to water sampling along depth profiles to assess metals variability with depth in suspended and dissolved modes. For each sample analyses were made for trace metals (68 elements), nutrients and dissolved and suspended organic carbon matter content both in dissolved and particulate (suspended and bed loads) forms. These samples can determine annual and seasonal distribution to 70% of the chemical elements and substances. Additionally RUSLE-based erosion model was developed for case study catchments to assess impact of catchment processes on sediment and pollutants spreading over metropolitan area. The results revealed a formation of specific anthropogenic sediment and chemical regime over river system which is characterized by frequent extreme loads of organic sediments. Manifold increase in sediment transport and nutrients as the river crosses the Moscow metropolitan area, which can be attributed to both direct discharge of poorly treated sewage and nonpoint urban pollution. Within the city borders, organic matter concentration increased by a factor of 1.5 due to an inflow from the Volga River via the Moskva-Volga Canal, whereas the release of treated sewage from the Moscow City wastewater treatment facilities did not have a significant effect. Below the city, the nutrients content grew increased again by a factor of 1.5 due to the inflow of urban and industrial wastewater and polluted tributaries. Even at the Moskva's lower reaches, where the anthropogenic pressure on the river and its tributaries is less pronounced, the inorganic nitrogen and phosphorus content remains consistently high and exceeds the environmental guidelines by up to almost 10 times. This indicates increased vulnerability of the Moskva River ecosystem during periods of low flow, which can be a major factor of eutrophication in the entire Moskva-Oka-Volga system. Comparison of our data with some archive records shows no significant improve in the nutrient pollution of the river since the 1990s, which raises further concern about the effectiveness of water quality management in Moscow urban region.

Keywords: Environmental Monitoring, Megacity, Moskva River, Urban Pollution.




## GLOSEM Application for the Impact Assessment of Climate and Land Use Changes on Soil Erosion in Iran; a Large Watershed Scale Evaluation

H. Memarian

Department of Rangeland and Watershed Management, Faculty of Natural Resources and Environment, University of Birjand, Birjand, Iran. Email: hadi memarian@birjand.ac.ir

### Abstract

Soil erosion is a complex process with adverse environmental impacts. Today, on a global scale, by modeling the effects of natural and human factors on the severity of soil erosion, it is possible to determine the main drivers of ecosystems, for effective policy-making in optimal soil management. Therefore to assess the severity of soil erosion in Iran watersheds, the validated data set of the Global Soil Erosion Modeling project (GloSEM database) were used. Our project includes baseline scenario (2015) and future forecasts (2070) of soil erosion with the effects of climate change in three scenarios RCP2.6, RCP4.5 and RCP8.5 on rainfall erosivity factor (R) and the effects of land use change in three combined scenarios SSP1-RCP2.6, SSP2-RCP4.5 and SSP5-RCP8.5 on vegetation (C) and soil protection (P) factors. The outcomes showed that the vulnerability of central, southern, and eastern watersheds due to climate change and land use change was higher than other watersheds. In these areas, even without considering the effects of climate change, the trend of soil erosion changes in the baseline scenario (2015) in comparison with SSP2-RCP4.5 and SSP5-RCP8.5 scenarios has been increasing, but declining in humid or semi-humid areas in northern and western watersheds. Considering the combined effects of land use and climate change, the trend of soil erosion changes between the baseline scenario (2015) compared with the scenarios of SSP1-RCP2.6 (with an average increase of 184%), SSP2-RCP4.5 (with an average increase of 243%) and SSP5- RCP8.5 (with an average increase of 341%) has been increasing in all watersheds except Aras watershed. The results indicate a vulnerability of more than 10 times in the central watersheds of Iran due to climate and land use changes by 2070.

**Keywords:** Prediction of Soil Erosion, Land Degradation, Climate Models, Global Model of Soil Erosion, Watershed Management.





# **To Improve the Universal Soil Loss Equation (USLE) for Complex Hillslopes**

A. Talebi

Faculty of Natural Resources, Yazd University, Yazd, Iran. Email: talebisf@yazd.ac.ir

### Abstract

Catchment hillslopes in nature have different plans and profile curvatures. They are divided into convergent, parallel and divergent in terms of the plan form and concave, straight and convex in terms of profile curvature. The universal soil loss equation (USLE) was offered and completed by Wischmeier and Smith (1978). This model estimates the soil loss of slopes based on information such as rainfall, type of soil, vegetation and topography. In the present study, the erosion rates of the nine complex hillslopes were investigated using the universal soil loss equation (USLE). The most important objectives of this study are Development of the USLE model in a way that allows the geometry of complex hillslopes to be considered and comparison of erosion rates over the nine type of complex hillslopes. The topography factor (including slope length and slope steepness) in the USLE (LS function) was developed as a function of plan shape and profile curvature. The hillslopes studied were divided into sets of complex pixels and the erosion over the pixels was calculated. Total erosion was regarded as the sum of erosion of all pixels. Furthermore, to calculate the sediment delivery ratio of each pixel, a new travel time equation for complex hillslopes was employed. Our results also revealed that a hillslope's degree of convexity is more effective than the hillslope's convergency in the soil erosion process. This means that the highest erosion belonged to convex divergent slopes and the least erosion were related to concave divergent slopes. The laboratory results intended for validation of the numerical model also show that in hillslopes with fixed plan, the erosion rate in the convex hillslopes exceeds that of concave and straight hillslopes. According to the model results, the erosion rate of convex hillslopes was greater than that of straight and concave hillslopes. On average, the erosion rate of convex the hillslope was 1.43 times that of the concave hillslope and 1.19 times that of the straight hillslope. Furthermore, the highest amount of erosion was related to the convex-divergent hillslope and the lowest was related to the concave-divergent hillslope.

Keywords: Erosion Modelling, Hillslope Scale, Slope Shape, Soil Erosion.





# Challenges of the Iranian Legal System Related to Soil and Water Conservation

E. Rouhi<sup>1\*</sup>, Y. Karimi Hajipamoq<sup>2</sup>

<sup>1</sup> Department of Law, Sanandaj Branch, Islamic Azad University, Sanandaj, Iran.
<sup>2</sup> Member of Judiciary Bar Association, Sanandaj, Iran. Corresponding author Email: ebadrouhi@iausdj.ac.ir

### Abstract

The right to development and healthy environment has emerged as a fundamental human right in the third generation of human rights. Since the concept of development at the national level is realized by policymaking in order to exercise the right of permanent sovereignty of nations over the resources under their rule, a balance must be made between the right to utilize the natural resources and the environment and their conservation and restoration. Therefore it should be noted that the realization of fundamental human rights to enjoy the clean environment and development with criteria of sustainability requires effective conservation of soil and water. Despite the fact that Iranian legal system encompass several codes in the field of environmental law and natural resources, there are many challenges in the content of the laws, implementation and monitoring of rules in both theoretical and practical dimensions. Conflict between public and private rights, absolute and unlimited ownership and the right of benefit, as well as incompatibility between legal and managerial principles are some of these problems. These conflicts become more controversial when they are particularly related to soil and water conservation. For example, one of these problems is the conflicts between ownership rights over the water and soil with public rights and common good. Based on the ownership right, the owners consider themselves entitled to any encroachment on their property and the legislature usually recognizes this right and privilege for them. Along with the changes in Iran's social relations and also as a result of changes in production relations, the manner of ownership and methods of utilization of natural resources, especially water and soil intensified with the implementation of land reform rules. Over-exploitation of soil capacity and renewable groundwater and surface water has caused a sharp decline in the level of these resources which have led to environmental risks such as soil erosion and salinization, land subsidence, creating gaps in the surface, causes damage to infrastructure and so on. What is more important is the direct impact of these aggressions on extracting as much profit as possible from water and soil resources. Changes in land ownership and water exploitation have led to increased utilization of these resources. The right to use is a concept that is different from ownership, but in most cases, such a distinction is not found in law. This research through a descriptive-analytical method has examined the challenges of the Iranian legal system related to water and soil conservation, while reviewing applicable laws and introducing its shortcomings and gaps, to provide legal and managerial solutions to address inefficiencies. It has been concluded that the method of exploiting water and soil resources, as well as the ease of violating laws and regulations and also the lack of up-to-date laws in this field, have caused water resources to be plundered and consequently soil resources undergoes undesirable changes too.

Keywords: Ownership, Sovereignty, Natural Resources, Environmental Law, Water and Soil Conservation.





# **Rain City Initiative to Mitigate Local Climate Crisis Effects**

M. Han

Department of Civil and Environmental Engineering, Seoul National University, Seoul, Republic of Korea. Email: myhan@snu.ac.kr

### Abstract

The recent IPCC report highlights the effects the world is facing due to the climate crisis. Torrential rainfall in city areas causes floods and infrastructure damage, heatwaves in built-up areas makes life unbearable, extended droughts lead to water shortage and uncontrolled fires disrupt society. These challenges are expected to be intensified. Both global thinking and local action is urgently required to overcome these catastrophes. These phenomena are all related to rainwater. There are many proven cases throughout time and space that these challenges can be mitigated by proper and wise rainwater management. Site specific solutions for site specific water problems have been found most effective and they are well reflected in their own nature-based traditions and cultures. Some may have been forgotten in favour of technology and energy intensive solutions. It is necessary to share the knowledge and experiences to benefit the mankind. In today's world, with reducing economic volumes of water per person, we can not afford to waste rainwater. There should be a revolutionary change of thinking about the rainwater management. Instead of draining rainwater away as has been the practice in our cities, rainwater should be buffered, collecting and storing it for effective use later, as drinking water source, for agriculture, for ecosystems, for society at large. The Rain City is defined as a city where all the citizens understand the importance of rainwater for the functioning of society (now and in the future), where government makes city-wide plans and regulations for the collection of rainwater. Municipalities may offer financial incentives for promoting the initiative. It is heartening to see that more and more cities are gradually taking up the rain city concept. The Rain City concept should be applied in all cities and villages. Experiences that have shown cities or areas to become rain-resilient can be shared. The technology, policy and culture of rainwater management to make it work, we will debate in an inclusive process that aims to benefit and protect all. We strongly recommend the following to the relevant stakeholders. A) A paradigm shift should be adopted for rainwater to be collected, buffered and utilized rather than be drained away. B) Citizens should understand the importance and role of rainwater in their living environment and its link to water resources. They should be encouraged to find wise ways to utilize rainwater. Rain cools the city, it makes trees and shrubs grow, it augments the aquifer and enhances local biodiversity, thus contributing to managing the effects of the climate crisis. C) Water experts and business can further develop rainwater management technology for easy access and application in a variety of ways. D) Each central and local government should integrate the rainwater management (at domestic, city or district level) in its policies, strategies and operations and provide financial incentives for taking such measures. E) International organizations, programs and initiatives related to climate crisis should support this Rain City Initiative, taking a long term view and support the initiative through traditional and innovative rainwater resilience enhancing measures. F) International Rainwater Youth Network should be launched to raise youth's awareness on rainwater and to share the traditions and cultures of rainwater management from all over the world.

**Keywords:** Adaptive Water Management, Green Cities, Low Impact Development, Water Harvesting.



# A Framework for Participatory Watershed Governance and Management

A. Sadoddin<sup>1\*</sup>, V. Sheikh<sup>1</sup>, A. Najafinejad<sup>1</sup>, S.H.R. Sadeghi<sup>2</sup>, A. Zare<sup>1</sup>

<sup>1</sup> Department of Watershed Management, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan-Iran.

<sup>2</sup> Department of Watershed Management, Tarbiat Modares University, Noor, Iran. \*Corresponding author Email: amir.sadoddin@gau.ac.ir

## Abstract

This paper discusses the concepts of watershed governance versus water governance, given different aspects being compared. The principles and steps required for participatory watershed governance (PWG) purposes are described. A particular focus is on action plan development and its constituents, including watershed authorities formation, watershed health, and sustainability assessment, quantifying objectives and thresholds, identifying solutions, cost allocation, identifying administrative arrangements and time schedules. As a complementary section, a conceptual framework for integrated watershed assessment and management is described. A pilot application is suggested to get the conceptual framework into practice in an adaptive learning atmosphere. Expanding the theoretical concept and real feedback can assist policymakers and academia in further developing the concept of watershed governance and formulating a strategic framework to implement the idea country-wide. The successes in this domain can be extended to other countries, particularly countries with similar socio-economic and institutional settings.

**Keywords:** Ecosystem Restoration, Integrated Watershed Management, Watershed Adaptive Management, Watershed Health.



سومین همایش بینالمللی جوانان انجمن جهانی حفاظت خاک و آب

Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, NOOR, IRAN





## Controlling Enhanced Surface Runoff Components Resulted from a Freezing-Thawing Cycle Through Inoculating of Soil Microorganisms

S. Gharemahmudli<sup>1\*</sup>, S.H.R. Sadeghi<sup>2</sup>, A. Najafinejad<sup>1</sup>, B. Zarei Darki<sup>3</sup>, A. Mohammadian Behbahani<sup>4</sup>, H. Kheirfam<sup>5</sup>

<sup>1</sup>Department of Watershed Management, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran.

<sup>2</sup> Department of Watershed Management Engineering, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran.

<sup>3</sup> Department of Marine Biology, Faculty of Marine Science, Tarbiat Modares University, Iran.

<sup>4</sup> Department of Arid Zone Management, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan,

Iran.

<sup>5</sup> Department of Environmental Science, Urmia Lake Research Institute, Urmia University, Iran. \*Corresponding author Email: gharemahmudlisudabe@yahoo.com

## Abstract

Extreme climatic characteristics including freezing-thawing cycle affect soil erosion processes and facilitate exaggerated damages to natural-human coupled ecosystems. Further efficient and comprehensive efforts are therefore required to turn towards sustainable development. This involves alternative approaches by focusing on the protection of natural resources and ecosystems, leading to soil and water conservation and economic profitability. Recent studies have focused on natural based approaches among which the formation of soil biological crusts through inoculation of bacteria and cyanobacteria for soil stabilization can be exemplified. However, modification of hydrologic behaviours of the soil due to inoculation of endemic microorganisms has received less attention. The present study was accordingly designed to determine the role of inoculation of native bacteria and cyanobacteria on the inhibition of surface runoff under physical simulation of a freezing-thawing cycle at the laboratorial scale. In this regards, the study soil was primarily collected from the dry land of Badranlou Area in North Khorasan Province and transferred to the small erosion plots  $(0.5 \times 0.5 \text{ m})$  with constant slope of 20% placed in the Rain and Erosion Simulation Laboratory of Tarbiat Modares University, Iran. The dominant and non-pathogenic bacteria and cyanobacteria and available in the micro-bank of study soil were identified, selected, purificated and proliferated. The selected bacteria and cyanobacteria were then inoculated to the study soil before subjecting to a freezing-thawing cycle in six replications. The treated and control plots were ultimately subjected to a simulated study rain with intensity of about 70 mm.h<sup>-1</sup> lasted for 30 min whose hydrologic outputs were compared. Comparison of the control and inoculated treatments with individual and combined inoculation of bacteria and cyanobacteria under a freezing and thawing cycle in 60 days after inoculation showed significant (p < 0.001) improvement in the surface runoff components. So that, bacteria, cyanobacteria and the combined treatments increased the start time by 102, 228 and 266% and time to peak by 26, 49 and 56%; whilst they decreased the runoff peak by 22, 48 and 55% and runoff volume by 33, 65 and 73%, respectively. The results of the present study disclosed that soil microorganism inoculation including bacteria and cyanobacteria is an efficient, an economic and a bio-sustainable tool for improving runoff components in areas influenced by freezing-thawing phenomena.

Keywords: Soil Bio-Amendment, Soil Bio-Engineer, Soil Biocrust, Soil Conservation, Soil Erosion.



## Evolution of Historical Sediment Yield by Taking Check–Dam Systems as Carrier: a Case Study in a Restored Agricultural Catchment on the Loess Plateau, China

Y. Wei<sup>1,2</sup>, J. Jiao<sup>2,3\*</sup>, Y. Li<sup>3</sup>

<sup>1</sup> Key Laboratory of Desert and Desertification, Northwest Institute of Eco–Environment and Resources, Chinese Academy of Sciences, Lanzhou 730000, Gansu Province, China.

<sup>2</sup> State Key Laboratory of Soil Erosion and Dryland Farming on Loess Plateau, Institute of Soil and Water

Conservation, Chinese Academy of Sciences and Ministry of Water Resources, 26 Xinong Road, Yangling 712100, Shaanxi Province, China, Tel.: +86 134 7437 5827, Fax: +86 29 87012210.

<sup>3</sup> Institute of Soil and Water Conservation, Northwest A&F University, 26 Xinong Road, Yangling, 712100, Shaanxi Province, China.

\*Corresponding author Email: jyjiao@ms.iswc.ac.cn

### Abstract

It is critical to determine soil erosion rates and sediment yields under the condition of ecological restoration on the Loess Plateau, and the sediments retained by check-dams document the soil erosion history in a small watershed. We selected a check-dam system to reconstruct the long-term sediment yield in the Fangta catchment on the middle of the Loess Plateau. Storage capacity curve method was applied to estimate the total sediment deposition of check-dam systems, a total of 725.82 thousand tons sediment was trapped by the check-dams in the Fangta catchment from 1975 to 2013. Two abrupt-change points of 1987 and 2003 were detected by the double mass curve method, the average catchment sediment yields were 5273.63 t/( $km^2 \cdot a$ ) in Stage-1 (1975–1987),  $1734.09 \text{ t/(km^2 \cdot a)}$  in Stage-2 (1988–2003) and 2653.10 t/(km<sup>2</sup> \cdot a) in Stage-3 (2004–2013), represented intense erosion, mild erosion and moderate erosion, respectively. Since in Stage-2, the sediment yield variation in the Fangta dam-controlled catchment was mainly affected by human activities and its contribution reached 97%. When the average annual erosive rainfall reached about 300 mm, 350mm and 400 mm in the Fangta catchment of the loess hilly-gully region, the soil erosion intensity changed gradually from mild erosion to moderate erosion and then to intense erosion. Approximately 6.1%~42.6% of the sediment was deposited along the way since 2003 when the sediments generated by erosion in small watersheds were transported to the downstream river network gradually. Therefore, check-dam systems were important carriers to reconstruct the historical sediment yield in small and ungauged watersheds. The results of this study not only serve as a basis for obtaining the reliable information on erosion and sediment yield in the small damcontrolled catchments, but also provide a useful reference for implementing sustainable ecological restoration in the future on the Loess Plateau.

**Keywords:** Soil Erosion, Check–Dam Systems, Flood Couplets, Erosive Stage, Cluster Analysis, Yanhe River Basin



## Study and Evaluation of Soil and Water Conservation Functioninkarst Small Watershed

Y. Li<sup>1</sup>, Y. Wei<sup>2</sup>, Sh. Qi<sup>3\*</sup>, J. Li<sup>1</sup>

<sup>1</sup> College of Public Administration, Guizhou University of Finance and Economics, Guizhou, 550025, PR China.

<sup>2</sup> School of Management science, Guizhou University of Finance and Economics, Guizhou, 550025, PR China.

<sup>3</sup> Key Laboratory of State Forestry Administration on Soil and Water Conservation, Beijing Forestry University,

Beijing 100083, PR China.

\*Corresponding author Email: luoshen 1125@126.com

## Abstract

On the basis of "the national plan for developing functional zones" and "the soil and water conservation program (2015-2030)" and based on the national strategy and local needs, China has put forward new requirements for soil and water conservation work, requiring that control measures of soil and water conservation should serve the overall goal of the national soil andwater conservation plan. Comprehensive management of small watersheds is the most effective means to control soil erosion in China. In consideration of different types of areas, studies should determine the feasibility of soil and water conservation function of control measures, and whether the effect of control measures complies with the requirements of the overall national goals. In this study, a typical small watershed in karst rocky desertification in Guizhou province was selected as the research object, and the dominant soil and water conservation function of watershedmanagement was quantitatively evaluated by constructing a distributed hydrological model. The results show the following: (1) Under plan A of soil and water conservation measures, the total amount of evaporation in the basin increased by 1.55% from 2015 to 2017, the runoff in the basindecreased significantly compared with that before the implementation of the measures, water storage in the basin increased, and the improvement rate after the implementation of measures reached 17.84%. (2) After the implementation of plan A of soil and water conservation measure, compared with that before implementation, the evaporation capacity of the watershed in the wet year increased by about 1.00%, runoff the reduced by about 10.00%, and the total amount of soil water storage increased by about 5%. Compared with pre-implementation measures, evaporationin the dry year increased by 1.78%, runoff decreased by 16.81%, and water storage increased by 12.70%. In the normal year, the evaporation and water storage in the watershed increased by 1.28% and 5.73%, respectively, whereas runoff decreased by 7.10%, soil water consumption andwater storage of the watershed increased, and reducing flow exhibited a significant effect.

Keywords: Karst Area, Small Watershed Management, Soil And Water Conservation Function



# Unpaved Road Erosion After Heavy Storm in Mountain Area of Northern China

Ch. Wang<sup>1,2</sup>, B. Liu<sup>3\*</sup>, Q. Yang<sup>1,2</sup>, G. Pang<sup>1,2</sup>, Y. Long<sup>1,2</sup>, L. Wang<sup>1,2</sup>, RM. Cruse<sup>4</sup>, W. Dang<sup>5</sup>, X. Liu<sup>1</sup>, E. Wang<sup>6</sup>

<sup>1</sup> Shaanxi Key Laboratory of Earth Surface System and Environmental Carrying Capacity, College of Urban and Environmental Sciences, Northwest University, Xi'an, 710127, PR China.

<sup>2</sup> Key Laboratory of National Forestry Administration on Ecological Hydrology and Disaster Prevention in Arid Regions, Northwest University, Xi'an, 710127, PR China.

<sup>3</sup> State Key Laboratory of Soil Erosion and Dryland Farming on the Loess Plateau, Institute of Soil and Water

Conservation, Northwest A&F University, Yangling, Shaanxi, 712100, PR China.

<sup>4</sup>Department of Agronomy, Iowa State University, Ames, IA 50011, USA.

<sup>5</sup> Suide Experimental Station for Soil and Water Conservation, the Yellow River Conservancy Commission, Yulin, Shaanxi, 719000, PR China.

<sup>6</sup> Key Laboratory of Sustainable Forest Ecosystem Management-Ministry of Education, Northeast Forestry University,

Harbin, Heilongjiang, 150040, PR China.

\*Corresponding author Email: <u>baoyuan@bnu.edu.cn</u>

### Abstract

More frequent extreme rainfall events associated with global climate change causes greater challenges for soil conservation. Severe erosion occurs on unpaved roads since these structures create important water flow paths during heavy storms. However, research on this topic is still lacking and erosion severity associated with unpaved roads is overlooked. This research aimed to investigate the intensity and influencing factors of unpaved road erosion under varied land use and management conditions (sloping agriculture, terrace, forest & grass) in the watersheds contributing water to the roads after the greatest rainfall event ever recorded in the mountain area of northern China caused by Typhon Lekima. The research was conducted in an agricultural-forest-dominated watershed based on field investigation and UAV-based image analysis. A road erosion level classification standard was given according to the occurrence of rills, ephemeral gullies, and gullies. Significant erosion happens on 67.5% of the unpaved roads; 42.8% of them suffered moderate to severe erosion which had ephemeral gullies or gullies developed. The average erosion amount from these roads was 2283.83 ton.ha<sup>-1</sup> and was significantly influenced by the watershed land use type and management. The dominant factor of unpaved road erosion in terraced areas was vegetation coverage on roads, and in sloping agriculture areas was slope gradient. Slope gradient and drainage area were both critical factors in forest & grass dominated areas. Terraces, forest & grass in drainage areas significantly reduced unpaved road erosion by 84.75%, 45.97%, respectively, compared to sloping agriculture. More integrated measures should be used to prevent unpaved road erosion. The results of this research could be applied to road protection against erosion in heavy storms.

Keywords: Unpaved Road Erosion, Heavy Storm, Gully, Land Management, Climate Change



## Is the Runoff Coefficient Increasing or Decreasing After Ecological Restoration on China's Loess Plateau

H. Zheng<sup>1</sup>, Ch. Miao<sup>1\*</sup>, G. Zhang<sup>1</sup>, X. Li<sup>1</sup>, S. Wang<sup>1</sup>, J. Wu<sup>1</sup>, J. Gou<sup>1</sup>

<sup>1</sup>State Key Laboratory of Earth Surface Processes and Resource Ecology, Faculty of Geographical Science, Beijing Normal University, Beijing 100875, China, Corresponding author. Chiyuan Miao Corresponding author Email: <u>miaocy@vip.sina.com</u>

## Abstract

The "Grain for Green" project (GGP) was launched in 1999 on China's Loess Plateau to reduce soil erosion, which had far-reaching impacts on ecological hydrology of watersheds. In this study, we use monthly runoff depth and precipitation datasets spanning 1961 to 2015 for 16 primary basins of the plateau to reveal changes in runoff generation capacity before and after the GGP. We use a Budyko-based elasticity method to calculate the runoff depth  $(R_1)$  and runoff coefficient  $(C_1)$ exclusively attributable to land use/cover change. Results indicate that the mean annual runoff coefficients (C<sub>0</sub>) decline by 26%–76% from the period 1961–1999 to 2000–2015. The annual observed runoff depth ( $R_0$ ) and  $C_0$  for 75% of basins show significant downward trends during 1961–1999; after the GGP, both annual  $R_0$  and  $C_0$  for over 50% of basins show upward trends. The study further finds that the increase of erosive rainfall (daily precipitation > 12 mm), reaching 4.6 mm.yr<sup>-1</sup>, is the main reason for upward trends of  $R_0$  / $C_0$  during 2000–2015. After removing the effect of precipitation variation, we find that in this period, 11 out of 16 basins show decreased trends for  $C_1$ , with the downward rate between 2.4% and 6.0% yr<sup>-1</sup>. The rate in semi-arid areas is about four times the rate in semi-humid areas. The results remind us that we need to consider the carrying capacity of local water resources when implementing the soil and water conservation measures across the Loess Plateau in the future.

**Keywords:** Loess Plateau, Precipitation, Runoff Coefficient, Budyko-Based Elasticity Method, Land Use/Cover Change



## Development Characteristics of Preferential Flow Affected by Rock Boundary in the Karst Rocky Desertification Area

T. Liu<sup>1,2</sup>, X. Peng<sup>1,2\*</sup>, Q. Dai<sup>1,2,3</sup>

<sup>1</sup> College of Forestry, Guizhou University, Guiyang, 550025, China.

<sup>2</sup> Institute of Soil Erosion and Ecological Restoration, Guizhou University, Guiyang, 550025, China.

<sup>3</sup> The Key laboratory of Plant Resource Conservation and Germplasm Innovation in Mountainous Region (Ministry of Education), Collaborative Innovation Center for Mountain Ecology & Agro-Bioengineering (CICMEAB), Guizhou

University, Guiyang, 550025, China.

\*Corresponding author Email: yuj157@126.com

### Abstract

Soil preferential flow, as one of the most common forms about the movement of soil water, is an important process of water downward leakage. The rock and soil is in mosaic pattern in the Karst Rocky Desertification Area. The development of preferential flow in soil affected by rock boundary of outcrop rock may be different from that in the non karst area. The aims of this study are to: 1) analyze the distribution characteristics of soil preferential flow pathways under the influence of different types of rock boundaries; 2) the dyeing area characteristics of soil preferential flow affected by rock boundaries with different types; 3) the effect of rock boundaries on the development of preferential flow in soils. To achieve the above goals, several text sites with five typical rock boundary types were selected in an area with severe rocky desertification in the Guizhou Province, China. A dye tracing method, one of the most commonly used methods to research preferential flow, combined with digital image processing technique were applied in this study. Results indicated that: the rock-soil interface flow is the most important form of soil preferential flow in the karst area. The dyeing area ratio of preferential flow changed from 0.12 to 0.48 in rock-soil profiles, from 0.06 to 0.37 in soil profiles, while between 0.02 and 0.16 in rock profiles. The rock profiles are the smallest in both dyeing area ratio and variation ranges of preferential flow compared with soil and rock-soil profiles. The soil preferential flow mainly occurs at the soil depth of 0-20 cm under different rock boundaries. The pathway of preferential flow is mainly the rock interface on both sides, which can pass through the yellow clay soil with poor permeability. However, the dyed part of rock interface can reach the soil depth of more than 50 cm. The flow in rock-soil interface affected by different rock boundaries is the main form of preferential flow in the karst rocky desertification area. It can flow to the bottom of soil layer by passing through the layer with poor permeability, which is an important inner-factor of water leakage in the karst rocky desertification area.

Keywords: Rock Boundary, Preferential Flow, Dye Tracing, Rocky Desertification



## Direct Observation of Characteristics of Precipitation Redistribution After Vegetation Reconstruction in Semi-Arid Regions of China

Y. Cheng<sup>1,4\*</sup>, H. Zhan<sup>2</sup>, Y. Wang,<sup>1,4</sup>, B. Wang<sup>1,4</sup>, M. Shi<sup>1</sup>, X. Bai<sup>1</sup>

<sup>1</sup>School of soil and water conservation, Beijing Forestry University, Beijing, China.
 <sup>2</sup>Department of Geology and Geophysics, Texas A&M University, College Station, Texas, USA.
 <sup>3</sup>Institute of Desertification Control, Chinese Academy of Forestry, Beijing, China.
 <sup>4</sup> Jinyun Forest Ecosystem Research Station, School of Soil and Water Conservation, Beijing Forestry University, Beijing 100083, PR China.
 Corresponding author Email: chengyiben@bjfu.edu.cn

## Abstract

Precipitation is the most important water resource in arid and semi-arid regions of China. The redistribution of precipitation among atmospheric water, soil water and groundwater are related to the ecological security of semi-arid regions. The study took widely replanted Pinus sylvestris var. mongolica (PSM) in Mu Us Sandy Land (MUSL) as research object and monitored precipitation, soil moisture, sap flow, deep soil recharge (DSR). Results show that the reconstruction process of PSM in MUSL has changed the distribution of precipitation. Precipitation is intercepted in shallow soil, then evapotranspiration increases, DSR significantly decrease, up to 466.94 mm of precipitation return to the atmosphere through evapotranspiration in 2016. Vegetation increases SWS capacity, with maximum water storages in PSM plot and bare sandy land (BSL) being 260 mm and 197 mm per unit horizontal area, respectively. DSR has decreased from 54% of precipitation to 0.2% of precipitation. Infiltration rate is affected by PSM and soil temperature, infiltration rate in the BSL plot was 11 times of that in the PSM plot from August to September in an annual base. The SWS in shallow soil decreases 16 mm and 7.58 mm per unit horizontal area in 2017 and 2019, respectively. PSM annual sap flow is maintained at a relatively constant level of 153.98 mm.yr<sup>-1</sup>. This study helps understand the role of precipitation-induced groundwater recharge in the process of vegetation reconstruction in semi-arid regions and why PSM forest degradation. It is necessary to reduce PSM density to allow adaptation to extreme drought in the future.

**Keywords:** Three North Shelterbelt Project, Mu Us Sandy Land, Pinus sylvestris var. mongolica, Precipitation Redistribution, Deep Soil Recharge



## Use of Flash Flood Potential Index (FFPI) Method for Assessing the Risk of Roads to the Occurrence of Torrential Floods - Danube Basin

M. Marković<sup>1,2\*</sup>, S. Lukić<sup>1</sup>, A. Baumgertel<sup>1</sup>, M. Jeličić<sup>2</sup>, I. Kostić<sup>2</sup>, Đ. Mitrović<sup>2</sup>

<sup>1</sup>Department of Ecological Engineering for Soil and Water Resources Protection, University of Belgrade Faculty of Forestry, Belgrade 11000, Serbia.

<sup>2</sup> Public Enterprise "Roads of Serbia", Belgrade 11000, Serbia. \*Corresponding author Email: mladenmarkovic88@gmail.com

## Abstract

Torrential floods are the one of the most frequent natural hazards in the Republic of Serbia, which cause severe damage to a road network, change a traffic regime and endanger a traffic safety. The occurrence, extent and duration of the torrential floods, can be predicted based on experience, statistics and modeling methods. By managing the risks of torrential floods, which include integrated short-term and long-term measures and defence strategies, it could be provided the state roads' manager implements the protection of public roads and ensures the uninterrupted traffic flow in the torrent endangered places. A method of Flash Flood Potential Index (FFPI) was used to determine the terrain proneness to the torrential floods in the places related to the state road network. The method includes analysis of factors which define susceptibility to torrential floods in the certain area that are terrain slope, land use, soil type and vegetation density. Taking into account that physiographic parameters of a catchment have a large influence on time to peak and flood magnitude, we may assume that analysis of those parameters may be a valuable tool for the assessment of predisposition to torrent flood formation. The spatial analysis is performed using the remote sensing data on Digital Elevation Model (DEM), Bare Soil Index (BSI), CORINE and FAO Soil Database within GIS surrounding in order to analyse the relationship between torrential factors and spatial characteristics of the research area. The FFPI index is calculated using raster data, so that the research area is completely divided into cells, which are analyzed, reclassified and calculated using GIS technology. Based on the obtained FFPI values, the torrent endangered locations were classified into four classes, according to the susceptibility to torrential floods. The results show a total of 75 endangered locations, were classified as the medium endangerment class (68%), followed by low endangerment (16%), high endangerment (10.66%) and very high endangerment (5.33%) classes of road locations endangered by torrential floods. The spatial distribution of FFPI values provides a good starting point for flood risk management and the possibility for implementation of road prevention and protection measures.

Keywords: Torrential Floods, Roads Management, Remote Sensing, Environmental Modeling



## Predicting Shift in Soil Erosion Vulnerability Status Based on Water Quality in Lesser Himalayan Watershed

S. Pandey<sup>1\*</sup>, R. Nautiyal<sup>2</sup>, P. Kumar<sup>3</sup>, VP. Panwar<sup>3</sup>

<sup>1</sup> Forest Ecology and Climate Change Division, Forest Research Institute, Dehradun, India.

<sup>2</sup> Division of Forestry Statistics, Indian Council of Forestry Research and Education, India.

<sup>3</sup> Forest Ecology and Climate Change Division, Forest Research Institute, Dehradun, India.

\*Corresponding author Email: <a href="mailto:shachi0213@gmail.com">shachi0213@gmail.com</a>

## Abstract

Watersheds are important for stabilizing ecosystems and micro climates. To conserve and maintain soil integrity in a watershed through strategic planning and applying best management practices, it becomes necessary to identify the degree of vulnerability of watersheds to soil erosion. There are various factors like land use, slope, morphology, topology, and rainfall which determine the vulnerability of watershed. Soil erosion vulnerability of a watershed can be determined quantitatively as well as qualitatively by using existing models. Sometimes, lack of data required for assessing vulnerability becomes a constraint to understand the status of soil erosion vulnerability. In such a scenario water quality can be an indicator of soil erosion in the upper reaches, and can therefore be used for rapid assessment of vulnerability of watershed to soil erosion. This paper provides an understanding of how changes in water quality can be used to determine the status of soil erosion vulnerability of watersheds. The study was conducted in a watershed which lies in the fragile ecosystem of lesser Himalayas. Based on availability of the water streams, ten sub watersheds were selected and were classified into low, medium, high and very high vulnerability class using Multi-Criteria Analysis, based on compound value using hydrology tool in ArcGIS10.3, with sixteen parameters belonging to morphology, land use and slope. 154 water samples were collected in three different seasons from outlet of each sub watershed and water quality parameters were estimated. Multinomial Logistic Regression was then performed to predict the shift of vulnerability status of watershed, taking very high vulnerability as the reference. The results showed that Electrical conductivity (EC), Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) are the main water quality parameters that can predict the transition of soil erosion vulnerability from low, medium and high to very high category. The results indicated that per unit change in TSS will lead to 43 percent chance of shifting vulnerability status of the sub watershed from low to very high. Also, 83 percent and 94 percent chance of shift was predicted from medium and high to very high vulnerability status respectively in sub watersheds. Similarly, the chances of shifting of the vulnerability to Very High from each of the other three by observing the water quality have been determined. The study highlights the importance of water quality in predicting the shift in soil vulnerability of watershed as an auxiliary group of variables.

**Keywords:** Soil Erosion Vulnerability, Water Quality, Multinomial Logistic Regression, Himalayas, Multi Criteria Analysis



# Modeling Hydrologic Responses Using Multi-Site and Single-Site Rainfall Generators in a Semi-Arid Watershed

Z. Ying<sup>1\*</sup>, MA. Nearing<sup>2</sup>, DP. Guertin<sup>3</sup>

<sup>1</sup> China Institute of Water Resources and Hydropower Research, Beijing, 100038, China.
<sup>2</sup> USDA-Agricultural Research Service, Southwest Watershed Research Center, Tucson, AZ 85719, USA.
<sup>3</sup> School of Natural Resources and the Environment, University of Arizona, Tucson, AZ 85719, USA. Corresponding author Email: <u>zhaoying@iwhr.com</u>

## Abstract

Hydrologic response in a watershed is driven by precipitation. Multi-site rainfall generators can be used to model watersheds using spatially varied rainfall inputs to better analyze how the rainfall variability affects runoff generation. This study adopted both a single-site rainfall generator (CLIGEN) and a multi-site rainfall generator to generate two rainfall data sequences, which were then used to drive the Soil and Water Assessment Tool (SWAT) for runoff simulation. Three different sized watersheds in the 148 km<sup>2</sup> Walnut Gulch Experimental Watershed were selected to evaluate the hydrologic response. Runoff calibration was done against measured runoff in the watershed. Statistics showed that the single-site and multi-site rainfall generators gave similar results regarding annual precipitation. However, the multi-site generator performed much better than the single-site generator in both mean summer flow and for different return period flows. The runoff derived from the single-site generator was significantly over-estimated in all three watersheds, whereas the multi-site generator performed satisfactorily in the smaller watersheds and overestimated in the largest watershed. This indicated that in small to medium sized watersheds, the spatial variability of rainfall could play an important role for hydrologic response because of the heterogeneity of convective rainfall in this semi-arid region, which makes the application of multisite rainfall generator a better option then the single-site generator.

Keywords: Rainfall Generator, Hydrologic Response, Watershed Modeling, Semi-Arid, Spatial Variability, Runoff





# **Transport Characteristics and Morphology of Wind Eroded Sediment**

X. Lin<sup>1</sup>, J. Niu<sup>1\*</sup>, R. Berndtsson<sup>2</sup>, X. Yu<sup>1</sup>, L. Zhang<sup>2</sup>, S. Wu<sup>1</sup>, H. Zhang<sup>3</sup>

<sup>1</sup>Key Laboratory of State Forestry Administration on Soil and Water Conservation, Beijing Engineering Research Center of Soil and Water Conservation, Engineering Research Centre of Forestry Ecological Engineering, Ministry of Education, School of Soil and Water Conservation, Beijing Forestry University, Beijng, China.

<sup>2</sup> Division of Water Resources Engineering & Centre for Advanced Middle Eastern Studies, Lund University, Lund, Sweden.

> <sup>3</sup> Qingdao Municipal Bureau of Human Resource and Social Security, Qingdao, China. \*Corresponding author Email: <u>niujianzhi111@163.com</u>

## Abstract

Sediment caused by wind erosion worsens air quality and visibility, and its morphology is important in transport processes affecting adsorption equilibrium and the combined-state distribution of particles by influencing surface characteristics and interfacial interactions. In spite of intensified research during the last decades on wind erosion, there is knowledge gaps regarding the transport characteristics and morphology of wind erosion sediment. In view of this, we used passive collector and electron microscope tape to trap windblown sediment from of 0 to 60 cm height above ground for wind speeds of 8, 12, and 16 ms<sup>-1</sup> in a wind tunnel test. Field emission scanning electron microscope (SU8010) was used to observe the morphology of wind erosion sediment from a Luvic cinnamon soil with a high erosion risk. The clay fraction is dominated by Vermiculite and Hydromica. The results show that (1) increasing wind speed leads to increase of soil loss, horizontal sediment flux, and particle size of wind eroded sediment; 2) the horizontal flux of wind eroded sediment decreases with increasing height, except for a wind speed of 8 ms<sup>-1</sup>; 3) the volume fraction of sediments with diameter less than 20 µm tends to increase with height. However, particles larger than 20 µm tend to decrease with height; 4) the shape of wind eroded sediment tends to have lower circularity, higher fractal dimension, and higher heterogeneity with the increase of particle size, which depends on the mineral composition. It can be concluded that the shape of wind eroded sediments at different wind speed depends on the particle size and abrasion by air flow, and the shape of wind erosion sediment at different transport height depends on particle size.

Keywords: Wind Eroded Sediment, Transport Characteristics, Morphology, Wind Speed



## The Spatiotemporal Analysis of the Future Sensitivity to Wind Erosion in the Republic of Serbia Using Ensemble of the Regional Climate Models

A. Baumgertel<sup>1\*</sup>, S. Lukić<sup>1</sup>, M. Caković<sup>1</sup>, P. Miljković<sup>1</sup>, M. Tošić<sup>2</sup>, I. Lazić<sup>2</sup>, M. Marković<sup>1,3</sup>, V. Đưrđević<sup>2</sup>

<sup>1</sup> Department of Ecological Engineering for Soil and Water Resources Protection, University of Belgrade Faculty of Forestry, Kneza Višeslava 1, Belgrade 11000, Serbia.

<sup>2</sup> Institute of Meteorology, Faculty of Physics, Belgrade University, Dobračina 16, Belgrade 11 000, Serbia.

<sup>3</sup> Public Enterprise "Roads of Serbia", Belgrade 11000, Serbia.

\*Corresponding author Email: <u>aleksandar.baumgertel@sfb.bg.ac.rs</u>

### Abstract

Wind erosion is a dominant type of degradation on agricultural land. The wind acts as the main driving forces behind the land's susceptibility to wind erosion, whereas factors that contribute to resistance from wind erosion are the presence of vegetation and soil erodibility. Climate indicators, such as air temperature and precipitation, are particularly important in the times of global climate changes because they create the preconditions for the development of wind erosion. The research was conducted in the autonomous province (AP) of Vojvodina, an important economic region of the Republic of Serbia, characterized by flat relief, low forest cover, and intensive agricultural production. The main goal of this research is to analyse the land's susceptibility to wind erosion in the future, using the fuzzy logic for the non-growing season (March and November) as well as for the growing season (July). The factors that were used for this analysis are: Climate Factor (CF), vegetation cover and soil erodibility (EF). The Climate Factor (CF) has been calculated for four different time periods: historical (1971-2000), near future (2011-2040), mid-twenty-first century (2041-2070), and late twenty-first century (2071-2100). The research data were extracted for eleven different combinations of regional climate models (RCMs) and Global Climate Models (GCMs) using the EURO-CORDEX database. The considered emission scenario was RCP8.5. Due to the models' systematic error over the historical period, we bias-adjusted multi-model ensemble results using the gridded climatological dataset CARPATCLIM (Climate of the Carpathian Region). Vegetation coverage map was retrieved using the Landsat 7 scenes based on the Google Earth Engine (GEE) platform, while the soil erodibility map was generated based on the soil samples' network using the Empirical Bayesian Kriging method. The land susceptibility to wind erosion is generally higher during the months of the non-growing season due to a higher wind speed and the absence of protective vegetation cover in the large parts of the study area. The climate sensitivity to wind erosion is bound to be significantly higher in the growing season (late 21st century) due to the increase in the average monthly air temperature and the decrease in the precipitation. On the other hand, in the late 21<sup>st</sup> century the non-growing season will be characterized by an increase of temperature as well as by an increase in precipitation. The land susceptibility to wind erosion for nongrowing season is likely decrease. However, as result of climate change in future, the hot-spot zones for the non-growing period will shift towards the central part of the research area as the 21<sup>st</sup> century draws to a conclusion. The land susceptibility to wind erosion (considering climate conditions, but also the factors of vegetation and soil erodibility) during the growing season will slightly increase despite significant negative changes of the climate factor in the late 21st century. The vegetation cover plays a significant protective role during the growing season in shielding the soil from the wind erosion, thus mitigating the effects of the increased climate factor. The future changes of the climate indicators will point out at possible changes in land susceptibility to wind erosion in the area of research. This knowledge has the potential to help the regional decision-makers to determine and develop management patterns aimed at mitigation and adaption to climate changes.

**Keywords:** Wind Erosion, Fuzzy Logic, Environmental Modelling, EURO-CORDEX, Regional Climate Change.



# Prediction Model for Shallow Slide Erosion of Subalpine Meadow Soil on Eastern Tibetan Plateau

J. Guo<sup>1</sup>, M. Xu<sup>1\*</sup>, Y. Deng<sup>1</sup>, P. Yi<sup>2</sup>, J. Zhao<sup>1</sup>, H. Shi<sup>1</sup>

<sup>1</sup> State Key Laboratory of Geohazard Prevention and Geoenvironment Protection, Chengdu University of Technology, Chengdu 610059, China.

<sup>2</sup> Sichuan Institute of Geological Engineering Investigation Group Co.,Ltd., Chengdu 610072, China. \*Corresponding author Email: xm@cdut.edu.cn

## Abstract

Subalpine meadow soil is widely distributed on the slope within the deep-cut valley area of eastern Tibetan plateau. Due to the specific structure of meadow soil and climatic conditions, rainfall amount effect can cause a large area of subalpine meadow soil erosion behaved with disintegration and shallow slide. This can cause terribly soil erosion and meadow degeneration, and is regarded as the typical ecologically vulnerable phenomena in eastern Tibetan plateau. Field prototype investigation revealed that the shallow slide erosion is principally driven by seepage pressure of the infiltrated rainwater and gravity pressure of saturated meadow soil. Based on the erosion mechanism, an Ad-TSMS model was established by coupling the hydrological model of TOPMODEL to the modified limit equilibrium slope stability model of TRIGRS. By comparison of the prediction result of the models and the catalog data of the erosion event investigated, Ad-TSMS predicted 60,085 more erosion spots than TRIGRS do with the same input parameters and computing time, and the Ad-TSMS model was proved 32.5% higher of the prediction accuracy than the TRIGRS model in the erosion area. Accurate prediction of shallow slide erosion of subalpine meadow soil can help establishing ecological management regulations, and has great theoretical and practical significance to conservation of soil and water on eastern Tibetan plateau.

**Keywords:** Erosion Mechanism, Subalpine Meadow Soil, Shallow Slide, Prediction Model, Rainfall.



## Farmers Perspectives on Determinants of-and for Adoption Conservation Agriculture Practices in Western versus Eastern Indo-Gangetic Plains of India

AK. Mishra<sup>1\*</sup>, H. Shinjo<sup>1</sup>, HS. Jat<sup>2</sup>, ML. Jat<sup>2</sup>, RK. Jat<sup>3</sup>, S. Funakawa<sup>1</sup>, JM. Sutaliya<sup>2</sup>

<sup>1</sup> Terrestrial Ecosystem Management Laboratory, Graduate School of Global Environmental Studies, Kyoto University, Japan.

<sup>2</sup> International Maize and Wheat Improvement Centre (CIMMYT), NASC Complex, Pusa New Delhi, India.

<sup>3</sup>Borlaug Institute of South Asia (BISA), International Maize and Wheat Improvement Center, Pusa, Bihar, India.

\*Correspongding author Email: <u>akm8cest@gmail.com</u>

## Abstract

Determinants of conservation agriculture (CA) for adoption and ways head for amplifying the extension are of utmost significance in the Indian Indo-Gangetic plains (IGP) to conserve resources and counteract the negative effects of climate change. Understanding the farmer's perspective has traditionally been seen as critical to influencing the adoption and out-scaling of CA-based climateresilient practices. This study evaluated the farmer's attitude and experiences with CA adoption. This study's objective was to investigate the biophysical, socio-economic, and technical constraints in the adoption of CA by the farmers in the Western- and Eastern-IGP i.e. Karnal, Harvana, and Samastipur, Bihar, respectively. A pre-tested structured questionnaire was administered to 50 households practicing CA in Western and Eastern-IGP. Results show that 10% and 66% of the households were categorized as smallholder farmers (<2 ha of landholding) in Karnal and Samastipur. About 46 and 8% of households inspect soil periodically in Karnal and Samastipur, respectively. PCA results suggest economic profitability (r=0.843) and soil health (r=0.806) as core components from the farmer's motivational perspective in Karnal and Samastipur, respectively. Low return, expensiveness and poor germination were common constraints by PCA analysis for the study area. Besides, lack of irrigation is significant in the case of Samastipur. Promotion and scaling up of CA technologies should be targeted as per site-specific requirements, emphasizing biophysical resource availability, socio-economic constraints and future impacts of such technology.

**Keywords:** Conservation Agriculture, Social Structure, Extension, Agent Of Change, Indo-Gangetic Plains, Technology Diffusion



# **Smart Monitoring Tools for Effective Soil and Water Conservation**

Z. Hazbavi<sup>1\*</sup>, M. Arabkhedri<sup>2</sup>, E. Ghabelnezam<sup>3</sup>

<sup>1</sup> Department of Natural Resources, Faculty of Agriculture and Natural Resources, Member of Water Management Research Center, University of Mohaghegh Ardabili, Ardabili, Iran.

<sup>2</sup> Soil Conservation and Watershed Management Research Institute, Tehran, Iran.

<sup>3</sup> Department of Natural Resources, Faculty of Agriculture and Natural Resources, University of Mohaghegh Ardabili,

Ardabil, Iran.

\*Correspongding author Email: z.hazbavi@uma.ac.ir

## Abstract

In the age of technology, effective conservation of soil and water needs smart monitoring tools adoption. Smart monitoring deals with the advent and development of modern sensors/actuators. These new tools can costly share a lot of valuable data with scientists, managers, and the public to build, conserve, and progress best management practices, inform policies, and establish good watershed governance. In this paper, we have discussed several smart tools that were recently introduced in the natural resource contexts, particularly in the watershed scale. The modern tools have processors that automatically measure critical hydrological variables and processes. In this regard, it could be referring to the US U-95 passive samplers, ISCOTM automatic pump sampler, radio telemetry of VHF (Very High Frequency) and UHF (Ultra High Frequency), and automated electronic samplers, smart pebbles, UbeTube 7, SMARTBoat 7, smart water turbidity monitoring system, image processing, automatic runoff samplers, automatic bucket prototype, smart IoT flood monitoring system, microcontroller-based automatic rain sampler, and. The results emphasize the widespread need to address smart management in the hydrological processes. The information of the present study strongly supports the appropriate selection of the most suitable tools for the different aspects of soil and water conservation systems.

**Keywords:** Hydrological Monitoring, Remote Sensing Devices, Portable, Smart Data, Technology Development, Wireless Networks.



# Spatial Distribution of Water Erosion Using Stochastic Modeling in the Southern Isfahan Province, Iran

R. Zakerinejad<sup>1\*</sup>, Ch. Sommer<sup>2,4</sup>, V. Hochschild<sup>3</sup> M. Maerker<sup>4</sup>

<sup>1</sup> Faculty of Geographical Sciences and Planning, University of Isfahan, Isfahan, Iran.
 <sup>2</sup> Department of Physical Geography, University of Tuebingen, Ruemelinstr. 19-23, 72070 Tuebingen, Germany.
 <sup>3</sup> Department of Earth and Environmental Sciences, Pavia University, Via Ferrata 1, 27100 Pavia, Italy.
 <sup>4</sup> Heidelberg Academy of Sciences and Humanities c/o University of Tuebingen, Germany.
 \*Correspongding author Email: <u>r.zakerinejad@geo.ui.ac.ir</u>

## Abstract

Soil erosion by water is a significant problem in arid and semi-arid areas of large parts of Iran. Water erosion is one of the most effective phenomena that leads to decreasing soil productivity and pollution of water resources. Our case study is located in the Southern Isfahan province, in central of Iran. The area is severely affected by different type water erosion such as gullies, rills and badlands. The intention of this research is to predict the spatial distribution of the different water related erosion type susceptibilities using a probabilistic Maximum Entropy Model (MEM) approach based on the following environmental layers: lithology, soil textures, land use, precipitation, Normalized Difference Vegetation Index (NDVI) and topographic indices derived from a SRTM DEM with 30 m spatial resolution. In order to validate the stochastic modelling approach we divided the entire sample in a train (70%) and test (30%) dataset. We validated the model performance using the Area Under Curve (AUC) value. The model yield good (rill and gully erosion) to excellent (badland) results for both train and test data. The spatialized prediction of susceptibilities for rill, gully and badland erosion show that in total more than 40% of the study area affected by water erosion processes (4.8% rill erosion; 23.4% gully erosion and 17.9% badland erosion). The knowledge of susceptible areas is crucial for a proper land management and related soil conservation measures to guarantee a sustainable land use.

Keywords: Gully Erosion, Badlands, Rill Erosion, Maximum Entropy Model.





## Application of Thiourea Modified Biochar Derived from Potato Peel for Enhanced Adsorption of Pb and Ni in Contaminated Acidic Soil

L. Gholami $^{1*}$  and Gh. Rahimi $^{1}$ 

<sup>1</sup> Department of Soil Science, University of Bu-Ali Sina, Hamedan, Iran. \*Correspongding author Email: l.gholami6163@gmail.com

## Abstract

In this study, the effect of biochar produced via pyrolysis of potato peel before and after modification by thiourea (CH4N2S) at three rates (0, 4%, and 8%) on the adsorption of lead (Pb), and nickel (Ni) in contaminated acidic soil was investigated. The results showed that the thioureamodified potato peel biochar (TMPB) has a higher pH, cation exchange capacity (CEC), surface functional groups, O/C, and H/C ratios than the potato peel biochar (PB). The addition of thioureamodified biochar to soil, especially at the application rate of 8%, increased soil pH, CEC, and organic carbon (OC). The pseudo-second-order kinetic model with lower SE and higher  $R^2$  was introduced as the best model of adsorption kinetics. The adsorption of Pb, and Ni by soil amended with TMPB reached equilibrium at 16, and 12 h, respectively. The results of fitting the obtained data with the adsorption isothermal models showed that the adsorption of heavy metals in the control soil and the soil amended with TMPB is consistent with the Langmuir isothermal model. The maximum adsorption capacity values of Pb increased from 846.71 mg.kg<sup>-1</sup> in control soil to 5561.23 and 6249.75 mg.kg<sup>-1</sup> in soil amended with 4% TMPB and 8% TMPB, respectively. Similarly, the maximum adsorption capacity values of Ni increased from 591.63 mg.kg<sup>-1</sup> in control soil to 3972.15 and 4311.98 mg.kg<sup>-1</sup> in soil amended with 4% TMPB and 8% TMPB, respectively. The results of this study showed that thiourea-modified potato peel biochar can be used as a lowcost and eco-friendly amendment to the adsorption of heavy metals in contaminated acidic soils.

Keywords: Potato Peel Biochar; Thiourea-Modified Biochar; Adsorption; Heavy Metals



## Effect of Vermicompost, Nano-Manure and Various Moisture Levels on Changing Runoff and Sedimentgraph

L. Gholami<sup>1\*</sup>, A. Khaledi Darvishan<sup>2</sup>, N. Karimi<sup>1</sup>

<sup>1</sup> Department of Watershed Management, Faculty of Natural Resources, Sari University of Agricultural Sciences and Natural Resources, Sari, Iran.

<sup>2</sup>Department of Watershed Management, Faculty of Natural Resources, Trbiat Modares University, Noor, Iran. \*Corresponding author Email: l.gholami@sanru.ac.ir

## Abstract

Land surface cover affects on runoff production. Due to the time variation of sediment concentration and runoff volume during storms, and on the other hand, the lack of control and study of storms in field conditions for analyzing hydrographs and sedimentgraphs changes in different soil moistures, the investigation of these variables has special importance in laboratory conditions. Nowadays, miscellaneous conditioners are being applied to conservation of water and soil at worldwide. Therefore, the use of soil conditioners is essential for soil and water conservation. Then, the present study conducted with study aim of effect of soil conditioners of vermicompost and nano-manure with rates of 24 and 6 g.m<sup>-2</sup>, respectively, on variables changing runoff and sedimentgraph at moistures of air-dried, 15 and 30% and rainfall intensities of 50 and 90 mm.h<sup>-1</sup>. The obtained results in addition to confirmation of the significant effect of each conservation treatment at the level of 99 percent on runoff components showed that the conservation treatment of vermicompost compared to nano-manure treatment had the more effect on measured variables. Vermicompost treatment could increase the time to runoff at soil moisture air-dried, 15 and 30 percent with rates of 33.69, 104.22 and 135.52 percent (rainfall intensity of 50 mm.h<sup>-1</sup>), respectively, and 92.78, 111.63 and 406.66 percent (rainfall intensity of 90 mm.h<sup>-1</sup>), respectively. The treatments effect on changing runoff volume were decrease, the runoff volume reduced with rates of 44.84, 50.00 and 49.55 percent (rainfall intensity of 50 mm.h<sup>-1</sup>), respectively, and 42.31, 32.73 and 35.23 percent (rainfall intensity of 90 mm.h<sup>-1</sup>), respectively. Also the results showed that the vermicompost and nano-manure conditioners toward control treatments had significant effect on hydrograph and sedimentograph changes. Therefore, due to the widespread use of different types of conditioners, today need to move the application feasibility of conditioners for example vermicompost and nano-manure that these have not the adverse effects of environmental.

Keywords: Erosion Plots, Hydrograph, Soil Amendments, Time to Runoff, Soil Antecedent Moisture.



# Rainfed Agriculture and Slope Gradient Interactions in Soil Erosion and Redistribution Using <sup>137</sup>Cs

F. Sedighi<sup>1\*</sup>, A. Khaledi Darvishan<sup>1</sup>, V. Golosov<sup>2</sup>, MR. Zare<sup>3</sup>

<sup>1</sup> Department of Watershed Management, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran.
<sup>2</sup> Faculty of Geography, Lomonosov Moscow State University, Moscow, Russia.
<sup>3</sup> Faculty of Sciences, University of Isfahan, Isfahan, Iran.
\*Corresponding author Email: <a href="mailto:sadight.fatemeh@yahoo.com">sadight.fatemeh@yahoo.com</a>

## Abstract

Understanding the processes of displacement and redistribution of soil particles caused by different erosion types is considered as an efficient sediment management tool in various scales from the field plot to the watershed. Due to the effective role of plowing on surface roughness, soil structure, the rainfed agriculture on high gradient slopes is one of the main sources of accelerated soil erosion. Therefore, the present study aimed to investigate the synergistic effect of rainfed agriculture and slope gradient on soil erosion using 137Cs in Khamsan experimental watershed, western Iran. The distribution map of soil erosion and deposition of the watershed was prepared using 137Cs method and the interactions between rainfed agriculture and slope gradient (as the most effective geomorphological factor) on erosion rate and sediment redistribution were evaluated. The results indicated that the highest rates of soil erosion in rainfed agriculture (11.46 ton.ha<sup>-1</sup>yr<sup>-1</sup>) and rangeland (1.27 ton.ha<sup>-1</sup>yr<sup>-1</sup>) was recorded in the slope classes of 20-30% and >60%, respectively. In addition, the maximum sedimentation in rainfed agriculture (5.78 ton. ha<sup>-1</sup>yr<sup>-1</sup>) and rangeland (0.89 ton. ha<sup>-1</sup>yr<sup>-1</sup>) occurred in the slope classes of 30-60% and in >60%, respectively.

**Keywords:** Accelerated Soil Erosion, Fingerprinting, Cultivated Fields, Sediment Redistribution, Sediment Source.



## **Construction and Calibration of a Portable Rain Simulator Designed for In Situ Researches of Soil Resistance to Erosion**

N. Živanović<sup>1\*</sup>, V. Rončević<sup>1</sup>, M. Spasić<sup>2</sup>, G. Gajić<sup>1</sup>

<sup>1</sup> Faculty of Forestry, University of Belgrade, Belgrade, Republic of Serbia. <sup>2</sup> Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Prague, Czech Republic.

\*Correspongding author Email: nikola.zivanovic@sfb.bg.ac.rs

## Abstract

Land degradation caused by erosion processes is a widespread global problem. A rain simulator is one of the tools often used to determine the resistance of soils to erosion processes. The aim of this publication is to present the process of construction and calibration of a small, portable field simulator which would be implemented in researches designed to determine the changes of soils' shear strength parameters in forested areas (in situ) caused by the change of soil moisture content achieved by rain simulation. The constructed simulator consists of a metal frame, sprayers (with specific nozzles), a sediment funnel/tray made of metal, water and sediment collector unit, a water tank and pump, and a set of rubber hoses, manometer, valves, reducers, adapters and other supplementary equipment. The calibration was carried out by using the pluviometer method. The choice of nozzles was based on the criteria of low water consumption (losses), high uniformity coefficient (CU) and the possibility of achieving the intensity of downpour rains specific for the investigated area. Further calibration of the device consisted of determining the raindrop diameter and the distribution of rainfall when the simulator is positioned on slopes ( $7^{\circ}$  and  $15^{\circ}$ ). The achieved rain intensity was 1.7-1.9 mm.min<sup>-1</sup>, with a uniformity coefficient (CU) of 92.23-93.70% for raindrop diameters (D50) equal to 1.2 mm. The kinetic energy of simulated rain (Ke) was 2.82.10-6 J. The constructed simulator proved itself to be in accordance with all of the criteria given, and it can successfully be implemented in researches aimed to determine the resistance of forest soils to erosion processes, infiltration, and sediment yield.

Keywords: Field Rain Simulator, Portable Rain Simulator, Erosion, Raindrop Distribution, Raindrop Diameter.



# The Use of Accuracy Data in Soil Loss Assessment: Biased and Unbiased Estimation

P. Miljković<sup>1\*</sup>, A. Baumgertel<sup>1</sup>, J. Beloica<sup>1</sup>, SB. Simić<sup>1</sup>, S. Lukić<sup>1</sup>, R. Kadović<sup>1</sup>

<sup>1</sup> Department of Ecological Engineering for Soil and Water Resources Protection, University of Belgrade Faculty of Forestry, Kneza Višeslava 1, Belgrade 11000, Serbia.
\*Corresponding author Email: predrag.miljkovic@sfb.bg.ac.rs

## Abstract

Remote sensing is referred to as a process of observing, monitoring and collecting information about the physical characteristics of a specific area, mostly obtained by satellites or special aircrafts. Such information has found application in environmental sciences, and their availability in recent years has increased, regarding spatial resolution. Due to their use, remote sensing products have become essential in the process known as image classification, i.e. mapping the land use/land cover. Depending on classification technique and using geographic information system (GIS), it is possible to create thematic maps for further spatial and statistical analyses, based on multi-channel mono or multitemporal satellite images. Land use information, obtained from maps may differ significantly, and later use of generated layers may lead to significant differences in further assessments in environmental sciences, as well as in decision making and measure application. The accuracy of the classified data (classes) depends primarily on the quality of satellite images, the appropriate method and technique for classification, as well as the user's expertise in choosing reference data, whereby the error in the process of classification is a common factor. In this paper, the results of soil erosion assessment were analyzed, in the Zagrža river catchment in central Serbia, which is characterized by different land use classes. Important segment of the paper is given through C factor, obtained by three different methodologies: supervised pixel based and object-based classification of a monotemporal multi-channel Sentinel 2A satellite images (10 m resolution) and by using CORINE Land Cover database. Generated layers were transformed to C factor maps, which were used in soil erosion assessment by USLE model. After classification, an accuracy assessment was performed. with estimated errors of omission and commission. This process involves evaluation and comparison of the image classification to reference data that are assumed to be true. In addition, stratified estimation was applied, in order to determine the unbiased accuracy assessment. Supervised pixel-based classification and object-based classification gave the accuracy of 76.62 % and 52.54 %, respectively. On the other hand, unbiased accuracy gave the results of 74.93 % and 63.59 %, respectively. These estimations showed the difference in soil loss between 6.61 and 8.5 ton.ha<sup>-1</sup>yr<sup>-1</sup>. These results suggest that land use maps should be accompanied by the assessment of land use classification accuracy, which would include sample size, an error matrix, details of stratified estimator, and errors of omission and commission. Accuracy assessment represents an important uncertainty parameter of applied technique and a key point in decision making for further data processing and analysis.

Keywords: Accuracy Assessment, C Factor, Remote Sensing, Stratified Estimation, USLE



## Changes in the Erosion Transportation Processes in Highly Managed Small Watersheds Caused by Gully Land Consolidation Projects in the Loess Hilly-Gully Region, China

Q. Ji<sup>1,4,6</sup>, J. Gao<sup>1,2,4\*</sup>, G. Liu<sup>1,2,3</sup>, Z. Gao<sup>5</sup>, Y. Zhang<sup>2,4</sup>, W. Li<sup>1,4</sup>, F. Zhou<sup>1,4</sup>, S. Liu<sup>1,4</sup>

<sup>1</sup> Institute of Soil and Water Conservation, Northwest A&F University, 712100, Yangling, Shaanxi, China.

<sup>2</sup> Institute of Soil and Water Conservation, Chinese Academy of Sciences and Ministry of Water Resources, 712100, Yangling, Shaanxi, China.

<sup>3</sup> State Key Laboratory of Soil Erosion and Dryland Farming on the Loess Plateau, Institute of Soil and Water Conservation, Northwest A&F University, 712100, Yangling, Shaanxi, China.

<sup>4</sup> Research Center on Soil & Water Conservation, Ministry of Water Resources, 712100, Yangling, Shaanxi, China.

<sup>5</sup> College of Water Resources and Architectural Engineering, Northwest A&F University, 712100, Yangling, Shaanxi,

China.

<sup>6</sup> Yangling Vocational & Technical College, 712100, Yangling, Shaanxi, China. \*Correspongding author Email: Jqq029@163.com

### Abstract

The Loess Hilly-Gully Region contains area showing the most severe soil and water loss in the world, however, gully land consolidation projects have been established in this region since 2010. Therefore, quantifying how these projects influence the erosional processes in the highly managed small watersheds remains an issue of general concern. For this reason, a scale mode was developed based on erosional dynamics and similarity theory for the purposes of simulating the evolution of erosional environment. Similarity scales were provided to include the similarities of geometry, rainfall, runoff, eroded sediment and pollutant transportation, which have rarely been addressed before. These scales were tested on the Kangjia watershed scale model, which has a 90% management coverage. Compared with the unmanaged conditions, significant influences on the production and confluence mechanisms were found. Not only was the amount of sediment and the discharge peak greatly reduced by 50%~90% but the peak propagation time order was also reversed. Further research showed that the critical land consolidation proportion value ranged between  $0.85\% \sim 1\%$  for the highly managed small watersheds. These results indicate not only that the production and confluence mechanisms of small watersheds under high-level management had changed greatly but also that a critical value exists at the scale of gully land consolidation projects. When the critical value was exceeded, erosion and sediment production obviously increased, which led to a decrease in the governing benefits. These findings are highly significant for land consolidation projects in highly managed watersheds under the condition of ensuring ecological security.

**Keywords:** Gully Land Consolidation, Erosion Transport, Highly Managed Small Watershed, Loess Hilly-Gully Region



# Development and Application of Spatially Distributed Runoff and Sediment Yield Model

A. Yousuf<sup>1\*</sup>, A. Bhardwaj<sup>1</sup>

<sup>1</sup>Department of Soil and Water Engineering, Punjab Agricultural University, Ludhiana, India. \*Corresponding author Email: <u>er.aywani@pau.edu</u>

## Abstract

The present study proposes a distributed digital elevation model (DEM) based runoff and sediment yield model. The model takes DEM as a primary input and determines flow direction, flow accumulation, channel extraction and flow routing sequence for each cell of the DEM. The model calculates the runoff (using the NRCS curve number method) and sediment yield (using MUSLE) on each cell (pixel) of the DEM and routes these hydrological parameters over the overland flow cells into the drainage channels to the watershed outlet using Muskingum routing method. The model develops the runoff hydrograph and sediment graph at the watershed outlet. The backend and frontend of the model is developed in Python and HTML+JavaScript code, respectively. The performance of the developed model (in terms of runoff, sediment yield, peak runoff rate and time to peak) has been evaluated by comparing the model output with the observed runoff and sediment yield measured at the outlet of forest micro-watershed located in Shivalik foot-hills of North-West India. The statistical analysis reveals the reasonably accurate performance of the developed model in simulating runoff and sediment yield as is corroborated by low values of PBIAS, MAPE, MBE and RMSE and high values of correlation coefficient and model efficiency.

Keywords: DEM, Model Efficiency, Muskingum Method, NRCS Curve Number Method, Shivaliks, Python



# Indirect Estimation of Suspended Sediment Concentration Using Image Processing

M. Moradi Dashtpagerdi

Natural Resources and Watershed Management Office, Shahrekord, Iran. \*Correspongding author Email: <u>moradi20000@gmail.com</u>

## Abstract

Suspended sediment concentration (SSC) is one of the most important factors in association with estimation and monitoring of flood characteristics. SSC represent water pollution and sediment characteristics in upstream of a river and reservoirs and dams characteristics in downstream of a river. In this study, deposited suspended sediments in the bottom of the stream were collected and dried. The dried suspended sediments were then dissolved in the measured volume of water. Then, 332 images were taken based on suspended sediment different concentrations in the range of 0.0005 to 200 mgr.l<sup>-1</sup> using a mobile camera. Finally, the average Red, Green and Blue (RGB) bands values and also, Hue, Saturation, and Brightness (HSV) were extracted for each image based on image processing technique using the Matlab 2020 software and Python programming language in Google Colab environment. In this matter, Artificial Neural Networks (ANN) models based on training algorithms viz., Bayesian Regularization backpropagation (BR), Conjugate Gradient backpropagation (CG) and Levenberg-Marquardt backpropagation (LM) were applied to evaluate SSC observation values as dependent variables and images Red, Green and Blue (RGB color model) and Hue, Saturation and Value (HSV color model) as independent variables. The results showed that the coefficient of determination (R2) value for training phase was obtained 0.67 based on Levenberg-Marquardt algorithm (LM) related to RGB. However, these were 0.56 for HSV. It was concluded that of image processing technique and ANN models could be acceptable method to indirect estimate SSC in the streams in association with reduction of costs and time.

**Keywords:** Artificial Neural Networks, Suspended Sediment Concentration, Image Processing, Python.



# Acid Footprint in Burozems of the Middle Ural

P.Sh. Sayranova<sup>1\*</sup>, I.A. Samofalova<sup>2</sup>

<sup>1</sup> Perm State National Research University, Perm, Russia.
 <sup>2</sup> Department of Soil Science, Perm State Agro-Technological University, Perm, Russia.
 \*Correspongding author Email: <u>s7p51996@yandex.ru</u>

### Abstract

Brown forest soils (Cambisols, WRB) have been of great interest to researchers for many years, causing a lot of controversy about their distribution and origin. Scientists have come to the conclusion that brown forest soils are formed where mixed and coniferous forests grow in a temperate and humid climate on a variety of soil-forming rocks. The provincial features of any mountainous country are reflected in the morphological, genetic and analytical diagnostics of soils. Soil acidity indicators are the main parameters that determine the direction and dynamics of soil processes. Currently, a new methodological basis for the interpretation of these acid-base properties is the use of an acid footprint. Soil studies were carried out in the Middle Urals in the Basegi State Reserve. Burozems (Cambisols, WRB) are conventionally divided into 3 groups in height: 800-700 m (meadows of herbs and grasses), 700-600 m (tall-grass meadows), 600-500 m (park forest). The acid-base properties of burozems of the subalpine belt were assessed by the acid trace. Analysis of the acid footprint made it possible to reveal the altitudinal features of the formation of burozems in the Middle Urals, which is reflected in the displacement of horizonograms from the upper left part of the acidity field (in the upper steep part of the slope in the subalpine belt) to the lower right part (in the gentle and saddle part of the slope). More sinuous lines of the horizonograms indicate a complex profile with horizons of different ages, that is, soils at an altitude of more than 700 m have a longer period of their formation, and, accordingly, a greater age. V-diagrams of the acidic properties of soils reflect the individual characteristics of soils, which are manifested in the corresponding genetic characteristics: evolution, gleviness, ferruginization, raw-humus content. Understanding the nature of soil acidity (undisturbed and inaccessible territories) is possible if we know the relationships between individual indicators in soils. We can use the found relationships as diagnostic features for quantitative assessment of the ecological state of soils, the degree of its stability (acid-base buffering capacity).

**Keywords:** Burozems (Cambisols, WRB), Ural, Altitudinal Belt (Landscape), Acidity, Acidity Field, Acid Footprint, Exchangeable Cations.



## Evaluation of Wetting Front Detector (WFD) to Estimate the Dimensions of Wetting Front in the Drip Irrigation

M. Valiyari<sup>1</sup>, A. Bahrami<sup>1\*</sup>, Z. Bahrami<sup>2</sup>, R. Fatahi<sup>1</sup>

<sup>1</sup> Department of Water Engineering, Shahrekord University, Shahrekod, Iran.
<sup>2</sup> Shahid Beheshti University, Tehran, Iran.
\*Correspongding author Email: abbas\_bahrami94@yahoo.com

## Abstract

Investigating the pattern of moisture distribution and proper estimation of wetting front dimensions in different soils in drip irrigation are important in order to provide solutions to improve water use efficiency in the field, especially in arid and semi-arid areas. In order to achieve the proper water use efficiency in micro-irrigation systems, the space and flow of the Emitters should be match with the hydraulic characteristics of the soil and the time and amount of irrigation water for plant. As a result, having proper information about the width and soaked soil depth is essential for the design and management of the drip irrigation systems. The shape of wetted soil volume is one of the important parameters in selecting the emitters and it influences the irrigation scheduling, and the emitters spacing. The purpose of this study was to achieve a set of semi-experimental relations for more accurate and easier estimation of the diameter and depth of wetting front. The field data of trickle irrigation systems were gathered by Wetting Front Detector (WFD) installed in three different conditions in terms of soil texture and flow rates of 4 and 8 l.hr<sup>-1</sup>. Due to technical difficulties and errors in the measurement of saturated hydraulic conductivity that is the main representative of soil characteristics, the presented relations here, estimate the dimensions of the wetted soil volume based on the time of penetration and the volume of water stored in the reservoir, without need to the soil hydraulic conductivity. The obtained equations in this study predicts the diameter and depth of wetted soil volume with correlation coefficient of 89 and 98%, respectively. Using these relations to estimate the dimensions of the wetted soil volume, it is possible to design and plan the drip irrigation system more correctly.

Keywords: Drip Irrigation, Wetting Front Detector (WFD), Advance Front.



## Introduction and Application of Soil-Water-Energy-Food Nexus Approach for Designating Sustainable Agricultural Management Pattern at Watershed Scale

E. Sharifi Moghadam<sup>1\*</sup>, S.H.R. Sadeghi<sup>2</sup>, M. Zarghami<sup>3</sup>, M. Delavar<sup>4</sup>

<sup>1</sup> Former Ph.D. Student, Department of Watershed Management Engineering, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran. At present, Expert at Natural Resources and Watershed Management Office, Firoozkooh, Tehran Province, Iran.

<sup>2</sup> Department of Watershed Management Engineering, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran.

<sup>3</sup> Faculty of Civil Engineering and Institute of Environment, University of Tabriz, Tabriz, Iran.

<sup>4</sup> Faculty of Agriculture, Tarbiat Modares University, Tehran, Iran.

\*Correspongding author Email: e.sharifi67@yahoo.com

## Abstract

The soil is essential to humans and all living things on the earth and the foundation of any waterenergy-food nexus system. Besides many services provided by soil, it importantly stores water and made it available to agricultural crops which play a vital task in food security. However, the importance of soil in exiting nexuses still has not been indoctrinated by planner, decision maker and even experts, worldwide. Owing to this, soil as a basic commodity needs to be considered and managed across other elements of any nexus. In this regard, the balancement among various main components of the ecosystem based on the Soil-Water-Energy-Food (SWEF) nexus approach is introduced as one of the important parts of integrated and adaptive watershed management approaches. To best our knowledge, this is the first application of integrated watershed management at the watershed scale. Therefore, the present endeavour has been formulated to designate and apply the SWEF approach in order to develop a conceptual model for the adaptive management of proper land use/cover allocation at the watersheds scale. The approach was consequently applied to the Shazand Watershed, Markazi Province, Iran. Towards that, different indicators viz., soil erosion, soil organic carbon (SOC), water and energy consumption, mass productivity, and economic productivity were considered. Eventually, the soil-water-energy-food nexus index (SWEFNI) for different land uses/crops was calculated using a compound indicator for the node year of 2014. The results showed that SWFENI varied from 0.19 (the worst) for rangeland to 0.78 (the best) for almond plantation. The current approach developed in the study can be examined in any watershed across the world.

**Keywords:** Energy Security, Integrated Watershed Management, Resources Security, Sustainable Development, Water Security



## Toward Linking Landscape Metrics and Environmental Variables for Runoff Modelling and Assessment

V. Moosavi<sup>1\*</sup>, A. Karami<sup>2</sup>, N. Behnia<sup>3</sup>

<sup>1</sup> Department of Watershed Management Engineering, Tarbiat Modares University, Tehran, Iran.
<sup>2</sup> Pooyeshgaran Forogh Fardad Co., Science and Technology Park, Yazd, Iran.
<sup>3</sup> Department of Arid Lands Management, Yazd University, Yazd, Iran.
\*Corresponding author Email: <u>v.moosavi@modares.ac.ir</u>

## Abstract

Runoff modelling and forecasting is one of the main issues in flood control and water resources management. The most important runoff triggering/controlling variables are climatic, physiographic and land use/cover variables. Landscape metrics which can be defined as quantitative spatial characteristics of patches, classes, or entire landscape, play an important role in rainfall-runoff process. In this study the effect of different landscape metrics and climatic and physiographic variables on runoff generation were investigated for 42 sub-basins of the Urmia Lake basin. To this end, land use/cover maps were produced for 2000 and 2019. Several important landscape metrics were calculated in class and landscape levels. Important climatic variables such as rainfall and temperature were also considered as well as important physiographic variables i.e. elevation, area and slope. Three different models namely partial least square (PLS) regression, random forest (RF) and group method of data handling (GMDH) were used for stream flow modelling in two different paradigms i.e. global and local modelling. Particle swarm optimization (PSO) and genetic algorithm (GA) were used to cluster sub-basins into two homogenous groups. The most important variables were selected by principal component analysis (PCA) for GMDH and RF. Results showed that streamflow modelling in homogenous clusters (local modelling) can significantly enhance the performance of modelling methods. It was also shown that GMDH outperformed PLS and RF.

Keywords: Clustering, Landscape Metrics, Particle Swarm Optimization, Runoff Modelling, Artificial Intelligence.



## Predicting Land Subsidence Based on Groundwater Level changes and Using Radar Interferometry (InSAR) Technique and Regression Statistical Equations (Case Study: Varamin Plain)

M. Ali Athari<sup>1</sup>, S.Sh. Hashemi<sup>2</sup>, H.R. Azizi<sup>2\*</sup>

<sup>1</sup> Faculty of Civil, Water and Environmental Engineering, Shahid Beheshti University, Tehran, Iran.
<sup>2</sup> Department of Civil engineering, Shahr-e-Qods Branch, Islamic Azad University, Tehran, Iran.
\*Corresponding author Email: <u>azizi.hamidr@gmail.com</u>

## Abstract

Vertical movement of the earth's crust is one of the most important geological phenomena that appears in the form of subsidence and uplift. Numerous reports of land subsidence, especially in arid and low rainfall areas, have been presented, and Iran is no exception due to its location in the arid and low rainfall belt of the world. One of the most important factors influencing the subsidence phenomenon, which has been studied by many researchers around the world, is the changes in water levels in different aquifers. For this purpose, Varamin plain was selected as one of the strategic plains of the Iran in Tehran province. According to the approach of this research, in order to evaluate the changes in ground elevation from 2014 to 2019, the radar interference technique (InSAR) was used and satellite images were analyzed by SNAP software .Finally, by evaluating changes in aquifer level through observation wells and land surface changes in the study area and comparing statistical models, it was found that the linear regression model has a more favorable predictive power than the parabolic regression model And is grade 3. In continuation, the changes of water level changes in the next 4 years (2019-2023) according to the regression model were predicted in linear ways and based on that, the rate of land surface changes was evaluated. The results showed that according to the current trend of aquifer decline, the maximum amount of subsidence in the linear model is equal to -266/74 cm in the center of Varamin in the coming period.

Keywords: Subsidence Prediction, Radar Interferometry, Aquifer Level Changes, Regression Model.



# Changes in Hydrologic Components from a Mid-Sized Plots due to Cyanobacterization

A. Jafarpoor<sup>1\*</sup>, S.H.R. Sadeghi<sup>1</sup>, B. Zarei Darki<sup>2</sup>, M. Homaee<sup>3</sup>

<sup>1</sup> Department of Watershed Management, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran.
 <sup>3</sup> Department of Marine Biology, Faculty of Marine Science, Tarbiat Modares University, Noor, Iran.
 <sup>4</sup> Department of Soil Science, Faculty of Agriculture, Tarbiat Modares University, Tehran, Iran.
 \*Correspongding author Email: atefeh.jafarpoor@modares.ac.ir

### Abstract

Runoff components are the most important factors in explaining hydrological behaviour of a system. So that the proper understanding of the runoff processes may effectively help managers and decision makers adopt appropriate measures. In this regard, controlling different factors of runoff processes may consequently allow efficient management of other processes like soil erosion and nutrient loss. Although, there are many ways to handle runoff generation, but the application of environmentally bio-based economic approaches has been rarely reported. The present study has therefore tried to investigate the role of inoculation of cyanobacteria on runoff components under rain simulation conditions at the mid-sized (i.e.,  $6 \times 1$ m) plots installed at  $\approx 30$  % slope steepness. Accordingly, cyanobacteria was inoculated on 6-m<sup>2</sup> plots in three replications and filled by erosionprone marl soil collected from Marzanabad Region, Northern Iran. The treated plots were subjected to a simulated rainfall with intensity of 50 mm h<sup>-1</sup> and initial duration of 30 min. A simulated runoff of 2.18±0.32 L was also performed simultaneously on the onset of starting surface runoff. A regular measurement of runoff from the plots was also made with 2-min intervals. The results showed significant differences (P<0.010) in hydrological behaviours in control and treated plots. So that no surface runoff was produced in treated plots up the end of initial duration of 30 min of simulated rainfall. Whilst, the runoff was commenced in control plots just after 2.34±1.09 min. The rainfall simulation was then prolonged for further 30 min to facilitate comparative study of the runoff elements. The volume of runoff, time to peak and runoff coefficient, infiltrated water and seepage in control plots were found 109.10±21.91 L, 14.21±4.69 min, 42.61±8.55 %, 130.90±21.91 L and 0.00 L, respectively. While the similar study variables of volume of runoff, time to peak and runoff coefficient, infiltrated water and seepage in cyanobacteria inoculated plots after commencing runoff at 32.07±3.63 min of rainfall simulation were 63.09±14.11 L, 52.74±3.61 min, 15.17±4.15 %, 228.15±12.38 L and 98.75±5.65 L, respectively. The results of the study clearly revealed that cyanobacterization not only postponed runoff generation but also effectively inhibited runoff components even if the rainfall incident extends for longer periods. The positive effect of cyanobacterization on increasing infiltration and potential storage of water in the beneath of the soil was also verified in the present study, which obviously suggests the profitable application of cyanobacteria for regulating hydrologic components.

Keywords: Soil Bio-Crust, Soil Infiltration, Water Balance, Water Management


# Land Cover Classification Using Landsat Images and Pixel-Based Methods

A. Eslami<sup>1</sup>, S. Anvari<sup>2\*</sup>, N. Karimi<sup>3</sup>, S. Mohammadi<sup>4</sup>

<sup>1</sup> Department of Water Resources Management, Graduate University of Advanced Technology, Kerman, Iran.

<sup>2,4</sup> Department of Ecology, Institute of Science and High Technology and Environmental Science, Graduate University of Advanced Technology, Kerman, Iran.

<sup>3</sup> Water Research Institute of Ministry of Energy, Tehran, Iran.

\*Corresponding author Email: s.anvari@kgut.ac.ir

#### Abstract

Jiroft Dam constructed on Halil River is the fifth concrete dam in Iran. Its reservoir was planned to irrigate more than 14200 ha of downstream agricultural lands including Jiroft case study. Due to population growth and increasing demand for agricultural products, this tropical region has experienced rapid landscape changes. This study aims to determine the land cover (LC) of Jiroft area using some supervised and unsupervised classification techniques, satellite images and geographic information system (GIS). In this regard, some pixel-based classification methods like mahalanobis distance (MD), maximum likelihood (ML), neural network algorithm (NN) and support vector machine (SVM) have been employed. Landsat 8 imagery data of OLI sensor for September, 2020 was acquired and its land cover was classified into five classes of orchard, agriculture, water body, rock and Barren lands. Finally, using ground control points (GCPs), derived by global positioning system (GPS), the performance of these classification methods were evaluated. Results showed kappa coefficient as well as overall accuracy for MD, ML, NN and SVM methods were equalling to (81%, 86%), (88%, 91%), (90%, 93%) and (88% and 92%), respectively. Comparison of results reveals a superior capability of NN method for land cover classification.

**Keywords:** Land Cover, Mahalanobis Distance, Maximum Likelihood, Neural Network, Support Vector Machine, Jiroft.





# Splash Measurement Tools: A Statistical Comparison

H. Mohammadamini<sup>1\*</sup>, Kh. Haji<sup>1</sup>, A. Katebikord<sup>1</sup>, A. Khaledi Darvishan<sup>1</sup>

<sup>1</sup> Department of Watershed Management, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran. \*Correspongding author Email: herom1369@yahoo.com

### Abstract

Splash erosion is the first stage in the formation of other types of water erosion and plays a very important role in starting and continuing the soil degradation processes. Therefore, awareness of rainfall characteristics, as well as the accurate measurement of soil splash particles, is necessary to study its role on soil erosion processes by water. There are different methods and tools to measure splash erosion, each of which may have different results. Therefore, the aim of this study is to compare the statistical indices of the data obtained by different soil splash measurement tools. To achieve the study purposes, the soil splash components were measured by using four known tools including splash cups and splash trays with splashing inwards and outwards, each at three replications on a sandy clay loam soil under rainfall simulated with constant intensity and duration of 60 mm. hr<sup>-1</sup> and 15 min, respectively. The results showed that the highest total and net splash rates (26.03 and 12.61 g. m<sup>-2</sup> min<sup>-1</sup>) were observed using inwards splash cups, while the lowest rates (1.62 and 0.67 g. m<sup>-2</sup> min<sup>-1</sup>) were observed using inwards splash trays, respectively. The results of one-way ANOVA showed significant differences between total and net splash components in four different studied tools at 95% level of confidence.

Keywords: Aggregate Stability, Net Splash, Splash Cup, Splash Tray, Soil Detachment.



### Investigation of Sand Content Using Laboratory Diffuse Reflectance Spectroscopy

M. Danesh<sup>1\*</sup>, H.A. Bahrami<sup>2</sup>, R. Darvishzadeh<sup>3</sup>, A.A. Noroozi<sup>4</sup>

<sup>1</sup> Department of Soil Science, Sari Agricultural Sciences and Natural Resources University (SANRU), Sari, Iran
<sup>2</sup> Department of Soil Science, Tarbiat Modares University (TMU), Tehran, Iran.

<sup>3</sup> Faculty of Geo-Information Science and Earth Observation (ITC), Department of Natural Resources (NRS), University of Twente, Enschede, Netherlands.

> <sup>4</sup> Institute of Soil conservation and watershed management research, Tehran, Iran. \*Correspongding author Email: <u>m.danesh@sanru.ac.ir</u>

### Abstract

Sand content is closely related to soil quality and plant growth. As well, sand fraction is one of the most important soil textural segments which should be highlighted for environmental modeling operations and digital soil mapping projects. On one hand; identification, mapping and monitoring of sand content over wide scales using traditional sampling and common lab analysis procedures is time-consuming and costly, probably due to its vast spatial variability. With the advent of Lab. Diffuse reflectance Spectroscopy (LDRS) which exploits the fundamental vibration, overtones and combination of functional groups for soil investigation, and so, that became a promising tool related. The present research intends to predict sand content utilizing the mentioned proximal soil sensing tech. Thus, in accord with supplementary data layers (geology, pedology, landuse and etc.) and stratified randomized sampling method, eventually, 128 samples from 20cm of soil surface of Mazandaran province (scattered parts), were gathered. First of all, sample-set subdivided into two subsets: calibration subset with 96 and validation subset with 32 samples. Afterwards, using the multivariate regression analysis-PLSR method with leave-one-out cross-validation technique and some preprocessing algorithms such as: spectral averaging (spectra reduction method), smoothing and 1<sup>st</sup> derivative (Savitzky-Golay derivation algorithm), the definitive calibration model with two & four latent vectors and R<sub>P</sub>,  $R^{2}_{P}$ , RMSE<sub>P</sub>, RPD<sub>P</sub> and RPIQ<sub>P</sub> respectively: 0.83 and 0.82, 0.68 and 0.67, 8.68 and 8.83%, 1.78 and 1.75, 2.45 and 2.41, were validated(using standalone validation subset) and spotted as the most appropriate model for the sand content prediction in the study region. Lastly, the VNIR-DRS potentiality for sand content estimation in Mazandaran soils has proven. Also it is feasible to upscaling the sand prediction process utilizing the principal resulted model and key spectral domains(recognized) via airborne/satellite hyperspectral data, which emphatically shows the LDRS importance as a commencement point for characterizing the informative optical wavelengths, likewise, that will be the infrastructure for spaceborne data modeling (upscaling process).

Keywords: PLSR, Proximal Soil Sensing, Sand, Spectroscopy, Textural Segment.



## Identification of Erosion Critical Areas Based on Soil Erodibility and Terrain Influence Factors in the Iranian Part of the Caspian Sea Basin

Kh. Haji<sup>1\*</sup>, A. Khaledi Darvishan<sup>1</sup>, R. Mostafazadeh<sup>2</sup>

<sup>1</sup> Department of Watershed Management, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran. <sup>2</sup> Department of Watershed Management and Member of Water Management Research Institute, University of Mohaghegh Ardabili, Ardabil, Iran.

\*Correspongding author email: <u>khadijehaji95@gmail.com</u>

### Abstract

Understanding the contribution of different land uses in soil erosion leads to optimal management and conservation practices to reduce the severity of erosion and consequently, the sustainable management. Changeability of the most effective factors on soil erosion especially soil erodibility and topography in different land uses is a first step to have a general view of soil erosion in the watersheds. Therefore, the present research was carried out to study the soil erodibility and terrain influence factors in different land uses in the Iranian part of the Caspian Sea Basin and identification of erosion critical areas based on topography and soil erodibility factors. In order to prepare land use, soil erodibility (S) and terrain influence (T) maps for the study area, were prepared by using satellite data of moderate resolution imaging spectroradiometer (MODIS), shuttle radar topography mission (SRTM 90m) and harmonized world soil database (HWSD) and the use of geographic information system (GIS) and remote sensing (RS), respectively. The results showed that the mean soil erodibility in the Iranian part of the Caspian Sea Basin varied from zero (soilless areas) to 0.044 (ton ha hr. ha<sup>-1</sup> MJ<sup>-1</sup> mm<sup>-1</sup>). While, among eight studied land use, the highest and lowest mean values of soil erodibility were obtained in the rangeland and permanent snow-water body equal to 0.040 and zero (ton ha hr. ha<sup>-1</sup> MJ<sup>-1</sup> mm<sup>-1</sup>), respectively. Also, the mean terrain influence (T) factor varied from 0.01 to 35.83 and shows more changeability in the study basin. As a result, by considering the high soil erodibility and terrain influence, the maximum erosion potential in the study area are located in the middle parts of the basin, where the highest slope gradients have high soil erodibility values. These areas are mainly located in the south slopes of the Alborz mountains. In this regard, defined critical regions based on topography and soil erodibility factors along with natural and anthropogenic factors can be considered in the planning of soil erosion control in watersheds and soil and water conservation programs.

Keywords: Land Use, Management Practices, Satellite Data, Soil Erodibility, Topography.





## Simulating the Effect of Land Use/Land Cover Changes on Soil Erosion Using RUSLE model and Google Earth Engine in Karkheh Basin, Iran

K. Rangzan<sup>1</sup>, M. Kabolizadeh<sup>1</sup>, Sh. Mohammadi<sup>1\*</sup>

<sup>1</sup>Department of RS and GIS, Faculty of Earth Sciences, Shahin Chamran University of Ahvaz, Ahvaz, Iran \*Correspongding author Email: <u>shahin\_mohammadi70@yahoo.com</u>

#### Abstract

Soil erosion by water is a natural process in which particles are separated from the land surface and transported. In terms of managing and planning soil conservation in the revised universal soil loss equation (RUSLE), factors C and P are the most important and dynamic components at different time scales. This study aims to simulate the effect of land use/land cover changes on soil erosion using the RUSLE model in the Karkheh basin using remotely sensed data and geographic information systems. Time series of MODIS products, MCD12Q1 and MOD13Q1, 10-minute rainfall intensity data, soil properties, and digital elevation model were used. The results indicated that the average long-term soil erosion of the whole basin was 14.7 ton. ha<sup>-1</sup> yr<sup>-1</sup>, and the average amount of soil erosion in its sub-basins was varied between 0.1 (Azadegan plain sub-basin) to 34.2 ton. ha<sup>-1</sup> yr<sup>-1</sup> (Cheghlvandi sub-basin). The results also revealed that the average trend of soil loss in this basin in the last two decades has been decreasing and in 2018 has reached its minimum level of 14.2 ton. ha<sup>-1</sup> yr<sup>-1</sup>. The general results of this study showed that by dynamically considering the LULC from 2001 to 2018, the average annual rate of soil erosion changed by about 5%.

Keywords: Watershed Management, Soil Conservation, Time Series Analysis, Google Earth Engine, Geospatial Data.



### Modelling Multi-Temporal Overland Flow Dynamics in a Terraced Landscape Characterized By Road Induced Shallow Landslides

L. Mauri<sup>1\*</sup>, E. Straffelini<sup>1</sup>, P. Tarolli<sup>1</sup>

<sup>1</sup> Department of Land, Environment, Agriculture and Forestry, University of Padova, Agripolis, viale 8 dell'Università 16, 35020 Legnaro (PD), Italy. \*Correspongding author Email: luca.mauri.2@phd.unipd.it

#### Abstract

The presence of roads in high steep agricultural systems is often linked with landslides occurrence. This research aims to model multi-temporal overland flow dynamics in a shallow landslides-prone terraced landscape (northern Italy) characterized by the presence of a rural road network. The combined use of Remotely Piloted Aircraft Systems (RPAS) and photogrammetric techniques (e.g. Structure from Motion; SfM) allowed to elaborate multi- temporal high-resolution Digital Elevation Models (DEMs). Hydrological analyses of water flow's depth alterations due to the road presence were carried out through the adoption of the SIMulated Water Erosion model (SIMWE), focusing on different scenarios considering the presence of the road and assuming its absence trough a specific DEM smoothing procedure. The possibility to perform multi-temporal hydrological simulations at hillslope scale, so as to analyse the role played by the road in landslides activation is still a challenge to be investigated. Results proved the role played by the road in water overland flows alterations above the two observed shallow landslides, with respective maximum water depth values equal to 0.18 m and 0.14 m. On the contrary, no-road simulations not revealed significant water flows deviations towards landslides, with water depth values around 0 m, underlining that the absence of the road would avoid relevant changes in water flow paths toward the collapsed surfaces. This work could be a solid starting point for analyse road impact on runoff dynamics at a wider scale, as well as for planning efficient mitigation intervention so as to reduce the occurrence of future risk scenarios.

Keywords: Terraced Landscape, Road, Landslide, Remote Sensing, DEM





# **Delineation of Landslide Clusters Using Depth-Number Fractal Model**

M. Hadian Amri<sup>\*1</sup>, K. Solaimani<sup>2</sup>, A. Kavian<sup>2</sup>, P. Afzal<sup>3</sup>, T. Glade<sup>4</sup>

<sup>1</sup> Department of Soil Conservation and Watershed Management, Mazandaran Agricultural and Natural Resources Research and Education Center, Agricultural Research, Education and Extension Organization (AREEO), Sari, Iran.
<sup>2</sup> Department of Watershed Management Engineering, Faculty of Natural Resources, Sari University of Agricultural Sciences and Natural Resources (SANRU), Sari, Iran.

<sup>3</sup> Department of Petroleum and Mining Engineering, South Tehran Branch, Islamic Azad University, Tehran, Iran. <sup>4</sup> Department of Geography and Regional Research, University of Vienna (UNIVIE), Vienna, Austria. \*Corresponding author Email: m.hadian@areeo.ac.ir

#### Abstract

Landslide classification using the Depth–Number (Dp–N) fractal model at the Tajan river basin in the north of Iran is the aim of this study based on 142 landslide information data set. The obtained results were interpreted using a rather extensive set of information available for each landslide class, consisting of Digital Elevation Model (DEM), landuse, drainage network and fault data. The log–log plot shows the existence of five classes for depth (weakly, moderately, highly, strongly and extremely magnitude) which shows that the extremely magnitude landslides have depths higher than 19.95 m in the NE, central and western parts of the Tajan area. The strongly (5-19.95 m) and highly (2.4-5 m) magnitude landslides happened in the northern, NE, western and NW parts of the area. The results, which were compared with landuse, drainage network, DEM and fault distribution patterns revealed a positive correlation between landslide classes and the particulars in the area. In addition, coefficient of determination, R<sup>2</sup>, for each population shows that the classification has been done correctly using Dp-N fractal model. Results illustrate that the dangerous landslides occurred in the NE, northern, western and NW parts of the area.

Keywords: Log-Log Plot, Dp-N Fractal Model, Classification, Tajan River Basin.



## Investigating the Effects of Irrigation Methods on the Establishment of Fruitful and Drought Tolerant Plants in Arid Region (Case Study: Nimroz City)

M. Jahanthigh<sup>1\*</sup>, A. Najafinejad<sup>1</sup>, M. Jahantigh<sup>2</sup>, M. Hosseinalizadeh<sup>3</sup>

<sup>1</sup> Department of Watershed Management, Faculty of Rangeland & Watershed Management, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran.

<sup>2</sup> Department of Soil Conservation and Water Management, Sistan Agriculture and edition Natural Resources Research Center, AREEO, Zabol, Iran.

<sup>3</sup> Department of Arid Zone Management, Faculty of Rangeland & Watershed Management, Gorgan University of

Agricultural Sciences and Natural Resources, Gorgan, Iran.

# \*Correspongding author Email: moienja23@yahoo.com

#### Abstract

Erosion is one of the most challenging issues around the world, especially in arid and semi-arid regions, which experienced land use change and intense agriculture. The most important problem in this phenomenon is scarce vegetation, which should be managed seriously. So, due to limited water resources, there is a need to manage it efficiently using suitable irrigation methods. Therefore, this research has been done in Nimroz area located in north of Sistan and Baluchestan Province of Iran. The aim of this study was to obtain an efficient irrigation method for growing fruitful plants in order to conserve soil in fragile areas. So, an experiment was carried out to assess the influence of different irrigation methods (subsurface irrigation, buried clay pot and water box) on some growth parameters for two plants species (Citrullus colocynthis and Hibiscus tea). The experiment had been conducted in a randomized complete block design with 6 treatments in 4 replications. Each treatment designed with two factors. First factor is the amount of water consumption of plants species (1= Citrullus colocynthis, 2= Hibiscus tea) and Second factor is amounts of water with different irrigation methods (traditional subsurface irrigation, buried clay pot and waterbox irrigation methods). In each treatment, irrigation was performed, at the level of 70-65% soil moisture depletion during March 2020 to November 2020. Soil temperatures and soil moisture was also measured using Thermometer and TDR during study period. Also plant characteristics such as number of leaves, diameter, canopy, plant height, survival rate were measured. The results indicated that the amounts of water consumption with different irrigation methods were significantly different at the level of five percent (P<0.05). So that the lowest amount of water consumption is related to waterbox (76 and 62% less irrigation compared to buried clay pot and traditional subsurface irrigation, respectively) and the highest amount of water consumption is related to buried clay pot (BC) irrigation method (1.6 and 1.2 times waterbox and traditional subsurface irrigation (TS) method, respectively). The results also show that the highest number of water use efficiency of biomass related to Citrullus colocynthis and Hibiscus tea plants with waterbox irrigation method that equal to 0.522 g.l<sup>-1</sup> and 0.381 g.l<sup>-1</sup> respectively. Results of this study also depicted that the waterbox irrigation method retains soil moisture 31 and 42 percent more than buried clay pot (BC) and traditional subsurface (TS) irrigation methods, respectively. Meanwhile findings indicated that the amount of soil moisture under the influence of temperature changes reaches its lowest value during June to August. Accordingly, due to the maintenance of moisture at various depths of soil using waterbox irrigation, mentioned plant are adapted to harsh climate conditions high temperature. According to the results of this study, waterbox irrigation method through reducing water consumption and maintaining soil moisture is the best method of irrigation among all other methods to establish fruitful and drought tolerant plants such as Citrullus colocynthis and Hibiscus tea plant species in the study area.

Keywords: Citrullus Colocynthis, Clay Irrigation, Subsurface Irrigation, Waterbox.



# Aquatic Monitoring Program Design in No.1 Chah-Nimeh Reservoir of Iran

I. Homayoonnezhad<sup>1\*</sup>, P. Amirian<sup>2</sup>

<sup>1</sup> Department of Agriculture and Natural Resources, Payam Noor University (PNU), Iran.
<sup>2</sup> Waste Management Organization, Shiraz, Iran.
\*Correspongding author Email: <u>homayoonnezhad@gmail.com</u>

#### Abstract

Chah-Nimeh reservoirs are important drinking water resources in Sistan and Baluchistan province in Iran. Their water is widely used to supply drinking water of Zabol and Zahedan cities and for agricultural and recreational purposes in this province. An environmental monitoring program is designed and developed due to the importance of investigating the qualitative water condition of Reservoir No. 1, which only has the main entrance and exit water from the Sistan River. To this end, 23 physical, chemical, and biological parameters are monthly studied in 8 sampling stations. Then multivariate statistical methods, ANOVA, cluster analysis, factor analysis, component analysis were used to determine index parameters, main and secondary stations, and sampling frequency in order to determine and design an appropriate water quality monitoring system. Finally, the findings of our experiments showed that the, Stations 4, 5, and 6 are main sampling stations and temperature, turbidity, dissolved oxygen(DO), chemical oxygen demand(COD), magnesium, sodium, calcium, phosphate, chloride, nitrite, sodium absorption rate (SAR), and pH are indicator parameters between 23 parameters.

**Keywords:** Environmental Monitoring, Chah-Nimeh Reservoires, Water Qualitative Parameters, Indicator Stations, Sampling Frequency





# *Hippophae rhamnoides* spp.: Multipurpose Use for Environmental Value

G. Ilhan<sup>1</sup>, S. Ercisli<sup>2\*</sup>

<sup>1,2</sup> Faculty of Agriculture, Department of Horticulture, 25240 Erzurum, Turkey Corresponding author Email: <u>sercisli@gmail.com</u>

#### Abstract

Urbanization, natural forces and heavy traffic may have destroyed landscape and causing topsoil loss and erosion. Reducing soil erosion is important to preserve nutrient-rich soils and natural or unnatural configuration of the topography. Using deep-rooted native wild edible fruits for erosion control is an excellent biological method to safeguard the landscape and the shape of the land. Throughout world there are erosion control native wild edible fruits, but preventing erosion with native plants complements and accents the natural landscape. Native wild edible fruits also need less specialized care and maintenance. Among native wild edible fruits, sea buckthorn (Hippophae spp.) has special importance. The fruits and leaves of the plant is very important for human nutrition point of view and accepted as 'super foods'. The plant distributed mainly Europe and Asia and in its natural environment, sea buckthorn (Hippophae spp.) plants are found on slopes, riverbanks, and seashores. Soil acidity and alkalinity, except at extreme levels are not limiting factors for sea buckthorn plants. The plant exhibite a wide adaptation capacity, fast growth characteristics with high ratio of suckering, coupled with efficient nitrogen fixation, make sea buckthorn particularly suitable for planting in degraded soils. In most of the sea buckthorn growing countries, sea buckthorn has controlled soil erosion and water loss effectively and increased land reclamation.

Keywords: Sea Buckthorn, Erosion Control, Root Architecture.



# Validation and Correction of TRMM Satellite Rainfall Dataset in Taleghan Watershed

M. Tavosi<sup>1\*</sup>, M. Vafakhah<sup>1</sup>, V. Moosavi<sup>1</sup>

<sup>1</sup> Department of Watershed Management Engineering, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran. \*Corresponding author Email: m tavosi@modares.ac.ir

#### Abstract

Due to the limited number of meteorological stations especially in mountainous areas, the use of satellite data to extract rainfall is very important. On the other hand, the lack of spatial appropriate rainfall data is one of the major challenges in flood or drought prediction and timely warning in this case. One of the available solutions in this case is to measure rainfall from space. The aim of this study was to investigate the accuracy of rainfall data obtained from TRMM satellite images in Taleghan watershed on monthly and annual time scales during the period 2010 to 2015. The adjustment coefficients were also obtained to reduce the error of rainfall data, and finally the accuracy of satellite image data was compared with two common interpolation methods i.e. invers distance weighting and ordinary Kriging. The results of error indices showed that the rainfall of TRMM images is well correlated with the data of ground stations, especially Joestan station, but in some months, there is a problem of under-estimation and over-estimation. For this reason, correction coefficients were applied to solve this problem, which on average in most months; this coefficient was calculated less than one, which indicates the overestimation of TRMM image precipitation data. Examination of the corrected data showed that by applying the estimation coefficients, in addition to solving the overestimation problem, the error rate was also reduced and the Nash-Sutcliffe performance index was somewhat improved. The root mean square error (RMSE) at Garab station also decreased from 88 to 26 mm in annual rainfall time scale by applying the adjustment coefficients, which indicates an increase in data efficiency after the application of adjustment coefficients. The results of comparing the modified data with interpolation methods showed that in all error indices, the modified TRMM data is more efficient in estimating rainfall. Therefore, the correction coefficients obtained in this study are recommended to increase the rainfall accuracy of TRMM images.

Keywords: Error Indices, Ground Station, Interpolation, Remote Sensing, Spatial Distribution, Validation



# **Post-COVID19 Perceptions for Soil and Water Resources Conservation**

S.H.R. Sadeghi<sup>1\*</sup>, P.S. Sadeghi<sup>2</sup>

<sup>1</sup> Department of Watershed Management, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran. \*Corresponding author Email: <u>sadeghi@modares.ac.ir</u>

#### Abstract

Coronavirus disease 2019 (COVID-19) as an infectious disease firstly identified in December 2019 in Wuhan, the capital of China's Hubei Province, and has since spread globally, resulting in the ongoing 2019–21 coronavirus pandemic. Due to the COVID-19 world crisis, we surely face new issues regarding the quantity and quality of resources. To the authors, changes in social behaviors and experiencing a new lifestyle of working, servicing, and provision of needs; mutation in pharmaceutical and health industries and products, Interconnection of international bodies for better servicing to infectious people and countries; Severe reduction in fuel and energy consumption; Showing of empathy and sympathy between the people and the governments; Reducing Co<sub>2</sub> emission and effects of greenhouse gases; Temporary revival of flora and fauna communities and ecosystems restoration can be assumed as unexpected benefits of the pandemic. However, many unwished outcomes such as huge consumption of water for cleaning and pursuing precautionary hygienic instructions; Suspension of almost all navigation services; Limitation in journeys and movement of seasonal workers, family visits and friends, and social activities; Threatening both lives and livelihoods mainly due to border closures, quarantines, and market, supply chain and trade disruptions; Closing academic centers; Millions became unemployed; Redirection of huge investments in pacifying the pandemic; Overburdening and consequent fatigue of hundred thousands of physicians, nurses and staffs of hospitals and health centers; Shortfalls in medicines and medical equipment, with associated increase in black markets and mafia; Irregularities in imports and exports; Discharging and releasing large quantities of detergents and pollutants to soil and water resources; Increasing political games through imposition of some severe sanctions on some governments; Severe psychological trauma of the people throughout the globe; The irreparable damage to and deflationary shock for the global economy; all of these ultimately leading to many other unexpected issues are expected. The following consequences of inadequate and inappropriate food production; High inflation and expenses; More consumption of available water and other resources; overexploitation of biologic and non-organic resources; Social conflicts; Migration, More pollutants, and consequent soil and water pollution are foreseen as the trade-off. To mitigate existing issues, we must start working on all the above-mentioned issues immediately and seek out the most environmentally friendly, economically efficient, and technically sound measures to return the world to a natural situation within a reasonable period. Towards this, all NGOs, Societies, Academicians, and even individuals have to work. This is more serious in developing countries due to the need for faster progress and the fact that often fewer precautions are taken in the utilization of resources. Close monitoring of ecosystem behavior and detailed evaluation of the outcomes; meeting the immediate food needs of the vulnerable populations; boosting social protection plans; increased efficiencies and improved productivity, and reduced trade-related costs are some of the main approaches and solutions for handling the consequences of the COVID19 outbreak. Towards this, close and strong cooperation among data collection centers, executive, education, research, and governance bodies is crucial to develop people-centered strategies and adopt practical measures worldwide.

Keywords: Ecological Restoration; Scientific Perception; Soil and Water Management.





# Use of Remote Sensing Techniques for Estimating Suspended Sediments

M. Parvaneh<sup>1</sup>, A. Talebi<sup>1\*</sup>, Z.A. Hosseini<sup>1</sup>

<sup>1</sup> Department of Watershed Management, Yazd University, Yazd, Iran. \*Corresponding author Email: <u>talebisf@yazd.ac.ir</u>

#### Abstract

Soil is one of the most important elements of nature and the most valuable substrate of production for human beings the most important factor that threatens the existence of soil is erosion. Today, remote sensing application in environmental studies has been widely welcomed worldwide due to its time and cost savings and more accurate results than traditional methods and has been used as a powerful and inexpensive tool to manage the assessment and management of terrestrial phenomena and resources (Xiaoming et al, 2010). Remote sensing according to its advantages and features, including detection of terrestrial phenomena and phenomena without interference and physical contact with the application of electromagnetic radiation to the surface of the terrain and recording the reflected wave by sensors, the possibility of general and partial visibility in the area provide (Alavi Panah, 2003). On the other hand, these images can be converted into digital maps with the help of spatial information system that have different applications in earth sciences. The use of such assets is related to all earth phenomena such as vegetation, soil, rocks, minerals and water (Ahmadi, 2012). In this study, which is located in the geographical area of dez dam, we estimated the sediment concentration using satellite images (such as landsat and sentinel) using appropriate algorithms and calibrated the results obtained from satellite images with the measured field data to estimate the suspended sediment concentration.

Keywords: Dez Dam, Landsat, Satellite Image, Sediment Concentration, Sentinel.



### Suspended Sediment Budget Within Lena and Kolyma Rivers Estuaries Based on the Remote Sensing Approach

K. Prokopeva<sup>1\*</sup>, S. Chalov<sup>1</sup>

<sup>1</sup> Department of Land Hydrology, Lomonosov Moscow State University, Moscow, Russia. \*Corresponding author Email: prokris3@mail.ru

#### Abstract

Massive northern rivers transport huge quantities of water and constituents from the continents to the Arctic Ocean due to catchment and channel erosion. Within the Russian sector of Arctic, they are least studied regarding quantitative characteristics of sediment load, transport mode of sediment grain size and particulate heavy metals. Lena and Kolyma rivers estuaries are among largest deltas in the Arctic. Both are located in the zone of continuous near-surface permafrost. It is an important sedimentation barriers which declines delivery of sediments into the Arctic Ocean. This study aims at assessment of long-term and seasonal changes of sediment budget in Lena and Kolyma deltas based on remote sensing dataset. Landsat images since 1999 were applied during ice-free period, from June to September. The sediment concentration (SC) at the Lena delta topset was compared with SC data at the outlets of: the Main (Tit-Ary island), Olenekskava, Tumatskava, Trofimovskava and Bykovskaya channels to calculate suspended sediment budget in delta. For Kolyma delta SC data between delta topset in the vicinity of Cherskiy and outlets of the two main channels of the delta: Pokhodskaya and Kamennaya. The sediment concentration was calculated based on the archive Landsat images (more than 110 images). The single model with the high accuracy of sediment concentration's detection was used for calculation of sediment suspensions. This model was based on calibration of pixels' reflection power from the satellite images according to measured turbidity data in hydrological studies on the middle Lena River (July 2016/June-July 2020) -21/18 measurements and on the estuary section of the river Kolyma (July-August 2019) – 12 measurements. We adapted the turbidity retrieving technique and data processing algorithm and evaluated the accuracy of turbidity modeling. The study reveals significant effects on sediment budget from seasonal variability of weather conditions. Air temperature influence thermal bank erosion along largest channel and lead to longitudinal increase of sediment loads. The increase of the daily average air temperature plays critical role in the degradation of permafrost and the activation of the processes of thermal erosion and thermal denudation.

**Keywords**: Kolyma River Delta, Landsat, Lena River Delta, Permafrost, Remote Sensing Dataset, Satellite Imagery, Sediment Budget.



### Artificial Recharge into Carbonate Formations as a Main Strategy for Water Resources Management

M. Farzin

Department of Nature Engineering, Yasouj University, Yasouj, Iran. \*Corresponding author Email: m.farzin@yu.ac.ir

### Abstract

Karst groundwater resources have been important for thousands of years. A large part of the urban and rural population is extremely dependent on karst water resources. In general, 20-25% of the world's population is largely or completely dependent on karst aquifers. In some European countries, karst water sources provide 50% of the total drinking water, and in many areas, only fresh water is available. More than 85% of the southern regions of Iran also supply their water needs from karst water sources. Karst springs have been more important than other karst features so that in all karst areas, many of the most primitive villages and towns have been concentrated in their vicinity. Significant expansion of karst formations, especially carbonate formations in the geological zones of Zagros, Kopeh-Dagh, Alborz and a limited extent in the central regions of Iran, create suitable conditions for the formation of karst landforms and significant karst groundwater reservoirs in the country. Famous carbonate formations such as Asmari, Jahrom, Shahbazan, Tarbour and Sarvak in the Zagros geological zone, Mozduran and Tirgan in the Kopeh Dagh, Lar and Elika and Cretaceous limestones in the Alborz zone and significant Cretaceous carbonate outcrops in Central Iran has provided favorable conditions for the formation of important karst groundwater reservoirs, so that now it provides drinking water to many small and large cities of the country. Due to population growth and the importance of providing the required water, karst water resources are discharging highly and water level into the aquifer is dropping extremely. On the other hand, the irregular distribution of rainfall in Iran causes that a significant part of the runoff be removed without any uses and in some cases also cause great damage; this state occurs in the Zagros geological zone more than other regions. One way to deal with this risk is artificial recharge into carbonate formations. Since the carbonate formations of Iran, especially in the Zagros geological zone, have a lot of fractures and cracks and are very permeable as a result, the most of the rainfall infiltrate into the formations. Therefore, these formations can be considered the best place for artificial recharge and forced infiltration of excess surface water; So that by transferring flooding runoff in the rainy season (when the water flow is not much needed) and part of the river flow in the season when there is no rain, the karst aquifer can be fed and improved. For this purpose, criteria and indices should be determined and areas prone to artificial recharge should be identified based on that. The most important effective indices in this regard are the fracturing (faults and lineaments) conditions and the presence of springs in the watershed; So that the areas with the most fractures are very prone to infiltrate the surface flows. Whereas the spring is the point of aquifer discharge so the areas with a large number of springs are not suitable for artificial recharge of carbonate aquifers. Artificial recharge potential mapping on carbonate aquifers, therefore, should be used to determine the exact location of the project to increase the karst water level in the areas affected by the water crisis.

Keywords: Artificial Recharge, Carbonate Formation, Infiltration, Zagros.





## **Vulnerability of Aquifer, the Most Important Challenge in Karstic Watersheds**

M. Farzin

Department of Nature Engineering, Yasouj University, Yasouj, Iran. \*Corresponding author Email: m.farzin@yu.ac.ir

#### Abstract

Groundwater resources in fractures media, unlike porous media aquifers, have very little selfremediation. In other words, any contamination in the karst aquifer spreads rapidly. High hydraulic conductivity, transmissivity and heterogeneity, and extreme anisotropy of karst aquifers increase their vulnerability to contaminants (physical, chemical, and biological) so that in a short time, significant volumes of water resources in such aquifers are at risk of pollution. On the other hand, abstraction of karst aquifers in some areas has led to imbalances in karst aquifers and drying of springs. This issue has now reduced the quality or volume of karst reservoirs in many plains of Iran. In some areas of Iran, the catastrophe has been determined by creating karst collapses; a clear example of this can be seen in the karst sinkholes of Famenin plain and Kaboudar Ahang in Hamadan province. Construction of residential buildings on karst formations has also led to karst water pollution; For example, on the slopes of Babakohi Mountain in Shiraz, a large number of Constructions have been built on the karst formation while Shiraz drinking wells are located downstream. Another example is the abandonment of remains of sheep and other lost animals on high karst formations or in sinkholes. The selection of landfill in karst areas close to carbonate aquifers has also greatly increased the risk of contamination of these aquifers. Since the optimal management and protection of natural resources especially water resources is essential for future generations designating safe areas for drinking water is considered a very important tool. The aquifer sensitivity and vulnerability mapping provides a clear depiction of the potential status of groundwater resources. According to which, any management decision that directly or indirectly affect these important water resources of the country will be made consciously; also the necessity of applying water resources management methods in each region is specified. In other words, the risk of groundwater pollution is highly dependent on the vulnerability map. Vulnerability mapping is done as a tool to assess the sensitivity of the karst aquifers and has been proposed the basis for zoning conservation and land use planning. In fact, vulnerability mapping is one of the methods that is mainly used in complex hydrogeological research; as an augmented method for groundwater protection studies, landscaping programs, or assessment of impact projects and pressure on the aquifer. The most important application of the aquifer vulnerability mapping can be considered as the protective zoning of the aquifer. So that, by determining and explaining each of the protection zones, according to the vulnerability of the aquifer, different levels of the desired area are assigned to special uses. In other words, depending on the environmental, economic, social, political, etc. conditions in each region, the number of specific zones and areas can be determined; so that, special restrictions apply in each zone to prevent any contamination of the aquifer and the movement of pollutants towards valuable water resources

Keywords: Aquifer Vulnerabilities, Karst, Protective Zoning.





# The Sediment Budget of Rivers Ob' and Yenisei

V. Ivanov<sup>1\*</sup>, S. Chalov<sup>1</sup>

<sup>1</sup> Department of Land Hydrology, Lomonosov Moscow State University, Moscow, Russia. \*Corresponding author Email: viktoro.1998@yandex.ru

#### Abstract

This paper presents a comparative analysis of the sediment budgets of the Ob' and the Yenisei, based on the empirical measurements and simulations. The results of the work are numerical ratios accumulation, erosion, and runoff of sediments of the studied basins. The RUSLE model was used to calculate soil erosion by the GMTED 2010 DEM with a resolution of 250 m. The calculation of bank erosion was based on the use of GSWE automatic image decoding data and the calculation of the average height of the eroded bank with the ArcticDEM with a resolution of 2 m, in addition, the mean river depth was estimated by Shesi equation from the global databases of morphometric characteristics HYDROAtlas and GWRL. Sediment runoff was estimated by two methods. The first method was an assessment based on monitoring observations of the SSC of Roshydromet. The second method was based on data from field measurements of sediment runoff by MSU in 2018 and 2019 in the mouths of the Ob (Salekhard) and Yenisei (Igarka). In the second case, to calculate the sediment runoff, a method was developed for measuring the sediment runoff with the backscatter intensity of acoustic rays from the ADCP RiverRay 600 kHz. The transition from instantaneous measurements to average annual values was performed using the Makkaveev model, which is the quadratic dependence of sediment runoff from water discharge with "erosion coefficient". For the Ob, this proportionality coefficient calculated values are from 0.42 to 1.05, and for the Yenisei is 0.68. Thus, the difference between total erosion (1250 Mt.  $yr^{-1}$  + 35 Mt.  $yr^{-1}$  for the Ob and 315 Mt.  $vr^{-1}$  + 21.9 Mt.  $vr^{-1}$  for the Yenisei) and sediment runoff in the mouths (63.5 Mt.  $vr^{-1}$  for the Ob and 32.5 Mt. yr<sup>-1</sup> for the Yenisei) was used to calculate the total deposition of matter in the catchment area during the transport of sediments from sources to sinks, for the Ob total accumulations is 1269 Mt. yr<sup>-1</sup>, for the Yenisei is 334.5 Mt. yr<sup>-1</sup>. For the unregulated part of the Ob' catchment, the accumulation was 56.5 Mt. yr<sup>-1</sup>, and for the unregulated part of the Yenisei catchment was 43 Mt. yr<sup>-1</sup>. The coefficient of reduction of sediment runoff (1/SDR) downstream, based on new samplings of sediment runoff in 2018-2019 in the mouths of rivers, for the Ob and Yenisei both, was 2.3, and for the entire catchment area 20 and 30 respectively, this confirms the hypothesis of the accumulating regime of large rivers.

Keywords: Backscatter Intensity, Hydrology, Large Rivers, Remote Sensing.



## Application of Resilience Concept in the Watershed Management via the Combined BWM and TOPSIS Method, Case Study: Shazand Watershed, Markazi Province

P. Farzi<sup>1\*</sup>, S.H.R. Sadeghi<sup>1</sup>, M. Jomehpour<sup>2</sup>

<sup>1</sup> Department of Watershed Management Engineering, Faculty of Natural Resources Tarbiat Modares University, Noor, Iran.

<sup>2</sup> Department of Urban and Regional Social Planning, Allameh Tabatabei University, Tehran, Iran. \*Corresponding author Email: farzi\_pari@yahoo.com

### Abstract

On a global scale, watersheds are currently severely disrupted by climate change and human disturbances. As a representative of the capacity of a watershed to absorb and recover from disturbances, watershed resilience and related transitions in the watershed system has become a vital issue in the maintenance and management of watersheds. In order to understand watershed resilience to change, numerous studies have attempted to improve knowledge about the relationship between natural variables, drivers of change, ecosystem responses, and feedback in a watershed system or its subwatershed. The present study is planned with the aim of evaluating and ranking the watershed resilience index by considering four key dimensions: ecological (8 criteria), social (13 criteria), economic (8 criteria) and infrastructure (13 criteria). For this purpose, first the dimensions and criteria of each dimension were identified taking into account the prevailing conditions in the Shazand area, then information and data on climate, hydrological, demographic, economic and infrastructure and land use were obtained from relevant authorities. Then the mentioned criteria were standardized and the weight according to their importance was calculated based on BWM method and the data obtained from this stage were performed using TOPSIS technique to rank the resilience of the watershed for different subwatershed in Shazand watershed. Finally, a watershed resilience index map was prepared and presented. According to the results of natural environment criteria (ecological dimension), (education of local people (social dimension), livelihood diversity (economic dimension) and access to medical centers (infrastructure dimension) were the most important resilience criteria and among the studied dimensions ecological dimension according to the comprehensive map of watershed resilience index, sub-basin 1 in Shazand basin is the most resilient sub-basin of the study area.

**Keywords**: Best-Worst Method, Capacity Building, Comprehensive Watershed Management, Multi-Criteria Decision Making.



## Temporal Distribution of Wind Erosion in Different Months of Year in Tal Hamid Railway Station of Tabas, Iran

H. Emami<sup>1\*</sup>, M. Memarzadeh<sup>1</sup>

<sup>1</sup>Department of Soil Science, Ferdowsi University of Mashhad, Mashhad, Iran. \*Corresponding author Email: hemami@um.ac.ir

### Abstract

Wind erosion is a serious problem in many parts of the world. It has been reported that 19.6 million ha (11.95 %) of the land surface are exposed to wind erosion, in Iran. Some parts of the Iranian railway lines were located in windy erosion deserts. In Tabas southern (Tal Hamid railway station-Iran), Surface soil particles are easily transported by wind blowing, due to the lack of moisture and poor vegetation. Therefore, the objective of this study was to determine the amount of windy deposition in different months of year in Tal Hamid rail way station of Tabas (Iran). For this purpose, sediment traps with diameter of 0.5 m were located in three different heights of 0.5, 1 and 1.5 m above the earth surface. The amount of sediments collected from June to January. The highest amount of sediments (5400 g.m<sup>2</sup>) was found in June and the lowest content (3.43 g.m<sup>2</sup>) was related to January. By comparison the sediments among the months of the spring season, it was found that there was no significant difference in this season. Also, the amounts of sediments of the spring was higher than the winter. Since dust storms are occurred in the spring season, especially in April and May, therefore, the amount of sediments was higher and largest different of sediment was found between January and June. It seems that the highest amount of sediments in the spring is due to the presence of erosional winds and rainfall shortages. According to meteorological data, the average rainfall for the months of January and March is 7.7 and 6.5 mm, respectively, and the average relative humidity is 46 and 35 percent, respectively for these two months, which these values are more than other months of year. As well as in April, May and June, rainfall and humidity are minimum, and sever winds occur in the spring. Therefore, it can be concluded that there is a strong correlation between the wind speed and the amount of windy sediments, so that with increasing wind velocity, sediment rates increase and with decreasing wind speed, the amount of sediment decreases. Also, rainfall and soil moisture are the important factors in wind erosion, and with decreasing rainfall and consequently soil moisture in June, the amount of sediments has been increased. In addition, there is a strong relationship between evaporation and windy sediments, and as evaporation increases, the amount of sediments increases. Besides, the wind will increase the evaporation and reduces soil moisture which it is more important in arid areas and can increase wind erosion. According to the results, the conservation practices is needed to reduce wind erosion in studied area during the spring and summer.

Keywords: Arid Area, Dust Storm, Seasonal Variation, Windy Sediments.





## Effect of Bentonite and Zeolite Mulches on Wind Erosion

H. Emami<sup>1\*</sup>, M. Mina<sup>1</sup>

<sup>1</sup> Department of Soil Science, Ferdowsi University of Mashhad, Mashhad, Iran. \*Corresponding author Email: hemami@um.ac.ir

#### Abstract

Iran is located in worldwide erosion belt, and more than 64 percent of its area is consisted of arid and semi-arid areas with no vegetation. These areas are sensitive to wind erosion, and dust storms. Wind erosion is a function of two factors including wind speed and soil erodibility. Reducing the wind speed or increasing surface roughness are strategies to increase soil resistance against winds and controlling the wind erosion. One of the fast and temporary strategy to reduce wind erosion is the use of mulches on the soil surface. Production the cheap, environmental friendly and resistant mulch against the wind forces is vital in short term periods. Bentonite and Zeolite are cheap in Iran, and environmental friendly. Therefore, the aims of this study were to investigate the effectiveness of clay mulches (Bentonite and Zeolite) on wind erosion. For this purpose, soil samples were taken from 0-30 depths of desert region, air-dried and passed through 2 mm sieve to analyze physical and chemical properties of them. The research was carried out as a completely randomized design. Soil was homogenously filled into metal trays (43 cm in length, 25 cm in width and 2 cm in height), and their surface completely leveled. Clay mulches i.e. bentonite at two rates (100 and 200 g + 1000 ml water; B1 and B2), and zeolite at two rates (100 and 200 g + 1000 ml water, Z1 and Z2), and control (1000 ml water) in three replications were prepared. Then the mulches were sprayed on soil surfaces of the trays. The treated trays were located in outdoors to achieve air dry condition for 10 days. The control treatment was simultaneously prepared. Erodibility of treated soils was measured in a wind tunnel. Wind speed of 85 km.h<sup>-1</sup> (predominant speed in studied area) was applied to treatments for 20, 40 and 60 minutes. After each time, the amount of the eroded soil from the depository was weighed. Based on analysis of variance the effect of mulch, time and interaction effect of them on soil erosion content were significant at p < 0.01. Comparison of means showed that clay mulches significantly reduced the soil erosion content in relation to the control, and Z1, Z2, B1, and B2 treatments had no significant difference (p<0.05). According to these results, the highest reduction of soil erosion was obtained in B2 and B1 treatments, respectively, which was 71.78 and 55 times lower than the control. Regard to the results of wind erosion at all three both B1 and B2 can be considered as the most suitable treatment for controlling wind erosion. The interaction effect of time and mulches showed that the highest and lowest erosion contents were found in control after 40 minutes, and Bentonite after 20 minutes, respectively. In general, it seems that B2 may be the best treatment to reduce soil erosion.

Keywords: Mulch, Soil Erodibility, Wind Erosion, Wind Tunnel.



## Soil Erosion and Methods of Evaluating the Factors Affecting it: A Review of Studies with Emphasis on RUSLE Model

R. Izanloo<sup>1\*</sup>, S. Dokhani<sup>1</sup>

<sup>1</sup> Department of Watershed Management, University of Kashan, Kashan, Iran. \*Corresponding author Email: izanloo37@yahoo.com

### Abstract

Soil erosion is a worldwide environmental problem that reduces the productivity of natural and agricultural ecosystems. Inappropriate land use, poor farming practices and removal of natural plants cause soil erosion and reduce productivity. In this study, we addressed the important problem of soil erosion by reviewing the literature (43 studies published in scientific journals) to study methods of evaluating the factors affecting soil erosion and sediment delivery. Among the total (of 43) articles reviewed in this study, 53.33% of the articles used the RUSLE method to evaluate the effect of various factors on soil erosion and sediment and 46.67% of the studies used other methods. In addition, soil and water conservation practices (including mechanical, biological, and biomechanical; 43.14%), land-use change (31.37%), and climate change (9.80%) were the most studied practices in evaluating the effectiveness of factors on soil erosion.

Keywords: Evaluation, RUSLE, Soil Erosion, Soil and Water Conservation.



## Investigating the Possibility of Ecological Rehabilitation and Combating Soil Erosion in Arid Areas with Judas-Tree

A. Karimi<sup>1\*</sup>, M. Tabari Kouchak Saraei<sup>1</sup>, Z. Javanmard<sup>1</sup>

<sup>1</sup> Department of Forestry, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran. \*Corresponding author Email: amirkarimi.tmu@gmail.com

#### Abstract

Iran is one of the arid and semi-arid regions of the world. Due to climate change in recent years, many areas in mountainous areas are at risk of soil erosion. Therefore, the study of land adaptation of plants in order to combat soil erosion in this country is of great importance. Judas-tree is a relatively drought tolerant species and its planting in the Mediterranean and semi-arid regions of the country can prevent soil erosion, especially in steep areas. In this study, in a completely randomized design, two-year-old Judas-tree potted seedlings in Bam Khorramabad nursery were exposed to drought stress (levels of 100, 60 and 30% of field capacity) for 4 months. With increasing drought intensity, the quantity of shoot growth, diameter growth, shoot dry mass and total biomass decreased but root length increased; however, there was no change in root volume and dry root biomass. Most of the measured traits in seedlings under 60% drought stress were not significantly different with well-irrigated seedlings (100% field capacity). Therefore, it can be concluded that in this nursery or similar nurseries that face water shortage, Judas-tree seedlings are able to tolerate soils with 60% field capacity and benefit from satisfactory survival and growth traits. It should be noted that in this way, the possibility of ecological rehabilitation and combating soil erosion of sloping areas of arid and semi-arid regions of the country with this shrub species is envisaged.

Keywords: Cercis siliquastrum L., Drought stress, Shoot growth, Soil erosion, Survival Rate.



## **Evaluation of SRM Model in Simulation of Snowmelt Runoff Using Temperature Obtained From Modis Satellite Images in Taleghan Watershed**

M. Naghdi<sup>1\*</sup>, M. Vafakhah<sup>1</sup>, V. Moosavi<sup>1</sup>

<sup>1</sup> Department of Watershed Management Engineering, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran.

\*Corresponding author Email: marym.naghdi1669@gmail.com

### Abstract

Snow is one of the most important forms of precipitation in the hydrological cycle, which plays an important role in providing drinking water resources and agriculture in the form of delayed flow in high water seasons and minimum flow in low water seasons and energy production. The purpose of this study to evaluate the accuracy and efficiency of temperature extracted from MODIS satellite images in estimating runoff from snowmelt using SRM model in the watershed of Taleghan Dam. For this purpose, the classical SRM model was first implemented, calibrated, and validated with observational climatic variables including daily data on minimum and maximum air temperature, rainfall, discharge as well as snow cover level. Then, the temperature data extracted from the MODIS images replaced the minimum and maximum observational temperatures in the model, and finally the results were compared with the results of the classical SRM model and the necessary summary was made.

Keywords: Modeling, Snowmelt Runoff, SRM, Taleghan Watershed, TRMM Date.



## Evaluation of Greenhouse Gas Emissions from Fossil Fuels and Determination of its Ecological Footprint in Aryanshahr, South Khorasan

R. Chamani<sup>1\*</sup>, H.R. Moradi<sup>1</sup>, Z. Jafarpour Chekab<sup>2</sup>, M. Naghdi<sup>1</sup>, M. Gholami<sup>3</sup>

<sup>1</sup> Department of Watershed Management, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran.
<sup>2</sup> Faculty of Natural Resources and Environment, Ferdowsi University of Mashhad, Mashhad, Iran.
<sup>3</sup> Mayor, Aryanshahr, South Khorasan, Iran.
\*Corresponding author Email: ariyan\_chamani70@yahoo.com

#### Abstract

At present, due to better living conditions, opportunities, and suitable facilities, urbanization has increased and it emits more than 40% of greenhouse gases. The purpose of this study is to calculate the emission of greenhouse gases and determine its ecological footprint in Aryanshahr, South Khorasan for the years 1390 and 1398. For gasoline and oil-gas supplied by the fuel stations of this city, it was obtained from the distribution company and point products of Ghaenat city. To calculate the amount of carbon dioxide produced by fossil fuels, the instructions of the fuel optimization company were used and to determine the ecological footprint of gasoline and oil-gas, the IPCC method was used. The results of this study show that in 1398 compared to 1390, the consumption of gasoline and oil-gas has increased by 32 and 77%. Also, the amount of carbon dioxide produced in these two years is 2549.70 and 3525.66 tons, respectively. On the other hand, the ecological footprint of carbon dioxide in Aryanshahr was estimated at 9.04 ha. Considering the current per capita green space of the city (5.45 ha), to precipitate the produced carbon dioxide gas, another 3.5 ha of green space is needed in addition to the current amount.

Keywords: Aryanshahr, Carbon Dioxide, Ecological Footprint, Fossil Fuels.



### Estimation of Rain and Snowmelt Erosivity and its Relationship with Seasonal Suspended Sediment Cycle in Latian Watershed

M. Kamali Pashaki<sup>1\*</sup>, H. Asadi<sup>1</sup>, M. Arabkhedri<sup>2</sup>

<sup>1</sup> Department of Soil Science, University of Tehran, Tehran, Iran.
<sup>2</sup> Soil Conservation and Watershed Management Research Institute, Agricultural Research, Education and Extension Organization, Thran, Iran.
\*Corresponding author Email: mahdikamali.p@gmail.com

#### Abstract

Soil water erosion and sediment yield are among most important factors threat sustainable agriculture and the health environment conditions inducing serious economic and social problem especially in mountainous arid and semiarid regions. Studies have shown in many parts of the world that rainfall erosivity has a high correlation with soil erosion. Snow melt runoff can has important role in rainfall-runoff erosivity in mountain basins where snowmelt is a major runoff factor. Though contribution of snowmelt in total annual erosivity has been documented in few studies, the knowledge on monthly rainfall-runoff erosivity is still lacking. This study was aimed to predict daily snow accumulation and melting, predicting half month rainfall-runoff erosivity and evaluate the relationship between half-month erosivity and sediment yield in Latian watershed. Latian is a typical rocky mountain catchment, 360 km<sup>2</sup>, located on the southern parts of the Alborz Mountain. The elevation of the catchment ranges from 1800 m a.m.s.l. to 4250 m a.m.s.l. Latian watershed has shown high flood risk due to its mountainous condition, especially in early spring during the ground warm up and the melting of snow. In this study, the degree-day model was used to evaluate the snowmelt erosivity of R factor of the Revised Universal Soil Loss Equation (RUSLE). The results revealed that snowmelt runoff erosivity comprises about 75% of total erosivity across the watershed on average. This result means that neglecting snowmelt erosivity in similar watershed may results in under prediction of soil erosion hazards. Evaluation of the half-month cycles of rainfall-runoff erosivity and suspended sediment yield showed a similar trend, but the peak of erosivity occurred in the first half of April and the suspended sediment peak occurred in the second half of May. As a result, the seasonal cycle of the suspended sediment showed a lag in compare to the seasonal cycle of rainfall-runoff erosivity. Based on the watershed average of erosivity, erodibility, vegetation, slope length and steepness and management factors of the RUSLE which were 453 MJ. m<sup>-1</sup> ha<sup>-1</sup> yr<sup>-</sup> <sup>1</sup>, 0.017 ton ha. MJ<sup>-1</sup> ha<sup>-1</sup>mm<sup>-1</sup>, 0.83, 20 and 1, respectively, the soil erosion risk of the watershed was estimated to be 146 ton. ha<sup>-1</sup> yr<sup>-1</sup>.

Keywords: Erosivity, Soil Erosion, Rain, Sediment Yield, Snowmelt, Universal Soil Loss Equation.



### A Comprehensive Framework for Sustainable Soil and Water Conservation Based on Tolerable Soil Loss and Sediment Yield

H. Ghafari<sup>1\*</sup>, M. Arabkhedri<sup>2</sup>

<sup>1</sup> Department of Soil Science, Shahid Chamran University of Ahvaz, Ahvaz, Iran.
<sup>2</sup> Soil Conservation and Watershed Management Research Institute, Agriculture Research, Education and Extension Organization, Tehran, Iran.
\*Corresponding author Email: h.ghafari@scu.ac.ir

#### Abstract

Soil and water resources are the most important components of nature that play a critical role in achieving sustainable development goals. Accelerated erosion is one of the most important factors destroying soil resources and polluting water resources in the world. Erosion reduces soil fertility by removing fertile and nutrient-rich topsoil and, on the other hand, causes environmental problems by transporting eroded material to water sources. Therefore, controlling erosion so that both soil and water resources are preserved is one of the main goals of soil conservation programs. A fundamental question in this case is to what extent soil erosion needs to be controlled to ensure the sustainable preservation of these two important sources? In other words, how much erosion is allowable without damaging soil productivity and environment quality? To answer this question, a concept called tolerable erosion has been proposed, which is a basic indicator for knowledge and judgment about the status of soil erosion and the extent of potential economic, social and environmental hazards. Despite the importance of tolerable erosion, it has not received much attention in soil conservation programs, probably due to the lack of a comprehensive, standard and practical methodology for determining and using it. Because several definitions and methods have been provided for tolerable erosion. Initial definitions of the tolerable erosion concept were mainly based on soil productivity and soil formation, and environmental issues were added to it with rising environmental concerns in recent decades. According to the latest definition, tolerable erosion is equal to the maximum amount of erosion that, in addition to maintaining soil productivity in the long run, also ensures the health of the environment. However, so far no methodology has been proposed that can take into account all three criteria of soil formation, soil productivity and environmental health in determining tolerable erosion. In this paper, based on the new definition and considering both on-site and off-site effects of erosion, a comprehensive framework is proposed for protection of soil and water resources. The results of a case study in Gorganrood basin showed that the amount of subbasins-based soil loss was between 0.2 to 17 ton. ha<sup>-1</sup> yr<sup>-1</sup> and the amount of sediment yield was between 0 to 11 ton. ha<sup>-1</sup> yr<sup>-1</sup>. Tolerable soil loss was between 5 to 10.5 ton. ha<sup>-1</sup> yr<sup>-1</sup> and tolerable sediments were determined between 2.2 to 2.8 ton. ha<sup>-1</sup> yr<sup>-1</sup>. Using the proposed framework, about 30% of the total area of the basin was under threat of erosion and needs protection measures. Of this area, about 9% only needed measures to reduce soil loss, 13% only needed measures to reduce the sediment delivery ratio, and 8% needed measures to reduce both erosion and sediment delivery ratio.

Keywords: Sediment Delivery Ratio, Soil Productivity, Soil Formation, Sustainable Development.



## The Effect of Daily Rainfall Derived from TRMM Data on SWAT Model Performance in Runoff Simulation

M. Tavosi<sup>1\*</sup>, M. Vafakhah<sup>1</sup>, V. Moosavi<sup>1</sup>

<sup>1</sup> Department of Watershed Management, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran. \*Corresponding author Email: <u>m\_tavosi@modares.ac.ir</u>

#### Abstract

Mountainous areas and watersheds in Iran are important sources in surface water supply and groundwater storage. Therefore, accurate simulation of hydrological processes in the watersheds is important. Several models have been developed to simulate hydrological processes. One of the most common and efficient models is Soil and Water Assessment Tool (SWAT) model. Daily rainfall is an important input into the SWAT model and hydrological models; however, usually these meteorological stations are not available or their distribution is not acceptable in several watersheds. To cope with this problem, daily rainfall were extracted from TRMM data in the Taleghan Dam watershed. The extracted daily rainfall data are then imported into the SWAT model and the model was calibrated and validated using SWAT-CUP for runoff simulation. The model was also calibrated and validated using daily rainfall obtained from meteorological stations similar to the statistical period used to run the model in pervious stage. Finally, their results were compared with each other. The results showed that the high spatial and temporal resolution of TRMM rainfall data compared to the daily rainfall obtained from meteorological stations increases the SWAT model performance in runoff simulation.

Keywords: Rainfall-Runoff Model, Satellite Images, Taleghan, TRMM 3B42, Water Balance.



# **Civil Liability for Soil Utilization in Iranian Law**

E. Rouhi<sup>1\*</sup>, Y. Karimi Hajipamoq<sup>2</sup>

<sup>1</sup> Department of Law, Sanandaj Branch, Islamic Azad University, Sanandaj, Iran.
<sup>2</sup> Member of Kurdistan Judiciary Bar Association, Sanandaj, Iran.
\*Corresponding author Email: ibadruhi@gmail.com

#### Abstract

Soil is one of the most fundamental resources in the world and is a non-renewable resource in human lifetime. It constantly has encountered with massive destruction by the improper use in many ways. The expanding trend of degradation of water and soil resources, especially the human's unlawful intervention in the environment, has caused the deterioration of nature in the form of ghastly floods, landslides and land subsidence, etc. Human activities such as deforestation, fire of agricultural lands, inappropriate plowing, unmanageable livestock grazing, non-reasonable and nonequitable use of groundwater, changing the land use, urban development, soil and water pollution and, in general, non-compliance with technical principles of sustainable soil utilization, cause soil erosion and consequently degradation of environment. Breaching the applicable law on soil utilization or lack of protective and preventing rules in this area have led to serious degradation of soil by the beneficiaries. The livelihoods of all of us depends on the soil, and due to the soil situation in Iran, there are many threats in this regard. with the access to the set of new technologies and heavy machinery for road construction, agriculture and drilling, utilization and even the sale and smuggling of the soil and consequently, destruction happen in wide range. Civil liability for violation of environmental regulations, is an important principle for making the violators responsible before the law and courts. The issue of attributability and causal relationship between damages and the source of these harms, wrongful act or omission, as well as, the possibility of compensation has made these matters more important. The term of civil liability reflects the set of mandatory obligations for violators to compensate in effective and different ways. This study, using descriptive - analytical method, concluded that despite the current Iranian laws in the field of environment did not have the effective and proper protection of soil but by approving the Soil Conservation Act, an effective step has been taken in this regard. Furthermore, it can be said that according to the principles of civil liability, this rule has been accepted as a truth that "anyone who damages another should compensate for it". Court das not require especial legal texts for every cases therefore, unlawful, non-reasonable or unequitable use of soil is enough for being responsible to compensate. This paper investigates the legal gaps in the Iranian legal system related to soil conservation and based on the principle of civil liability provides some solution to make effective legal protection of soil as well as binding the soil utilizers to legal and environmental restrictions.

Keywords: Civil Liability, Responsibility, Soil Conservation.



### Time Variability of Flow-Driven Sediment Concentration in a Laboratory Study: Effects of Rill Length, Soil Type and Flow Rate

M. Hussein<sup>1\*</sup>, H. Asadi<sup>1</sup>, M. Mohammadi<sup>1</sup>, S. Kouchakzadeh<sup>2</sup>

<sup>1</sup> Department of Soil Science, University of Tehran, Karaj, Iran.
 <sup>2</sup> Department of Irrigation and Reclamation Engineering, University of Tehran, Karaj, Iran.
 \*Corresponding author Email: maiso.huss@gmail.com

#### Abstract

Extreme Rill erosion is an important type of water erosion. It happens at high runoff rates, especially on steep slopes, where the flow erosive force exceeds soil resistance causing the detachment and transport of soil particles. The development of rills should be taken into account in soil erosion modelling because using time independent model parameters results in incorrect estimation. Therefore, it is important to understand the dynamic mechanisms of rill erosion process that has a high spatial and temporal variability. This is particularly challenging under climate change-driven shifts in precipitation and hydrological cycle. The laboratory studies can help to simplify understanding of the stochasticity of rill processes and make it easy to understand. In this study, laboratory erosion experiments were conducted to simulate rill erosion under controlled and variable conditions. Whereas the influence of low inflow rates and soil type were investigated on the time variability of sediment concentrations, different lengths of rill were evaluated as well. Particle size distribution of sediment is determined over time to understand the eroded materials behaviour of runoff processes. A flume, 11 m long and 0.2 m wide, adjusted to 3% slope was used to provide construction of rectangular rills of 0.05 m width and maximum length of 10 m. The regulated inflow rate was produced in the flume by a calibrated rectangular weir. Experiments were carried out on two soil types: a clayey soil under three low inflow rates (20, 30, 40 ml.s<sup>-1</sup>), and a loam soil under one inflow rate (30 ml.s<sup>-1</sup>). The rill lengths tested were 1, 2, 3, 5, 7, 9, 10 m. For each experiment, the eroded soil materials in runoff at the flume outlet were periodically sampled during 30 to 50 minutes to determine sediment concentration. Two separate samples were taken within two time periods of the experiment to determine the sediment size distribution. The results indicated that the flow regime in rills was transitional except those tested under 20 ml.s<sup>-1</sup>, which was laminar. The sediment concentration over time showed different trend depending on the soil type. For the clayey soil, sediment concentration showed high changes with time for short rills (1, 2, 3, 5 m) under the three inflow rates, in which an initial peak was measured in sediment concentration just at the commencement of the experiment. However, after a certain period of time (some 10 - 15 min), it reached a relatively steady state. This change in sediment concentration decreased when the rill length was increased to 7, 9 and 10 m. For the loam soil, the sediment concentration showed a peak at a specified time during the experiment, which the time to peak decreased when the rill length was increased. Particle size distribution (PSD) of the eroded sediments were influenced by the particle size distribution of the original soil, the time, and the inflow rate. These effects were contrasted among long and short rills. In overall, PSD of sediment was generally coarser in comparison to the original soil, but in some cases, signs of size selectivity of particles were observed for the particle diameters of 0.2 to 0.4 mm. Furthermore, the PSD at the second sampling time was coarser than that of the first sampling time. This study showed the importance of the dynamic changes in characterizing concentration and particle size distribution of sediment under various conditions. This calls for thinking in temporal scale to understand the mechanisms of erosion processes and its potential use in modelling.

Keywords: Flume, PSD, Rill Erosion, Sediment, Time Changes.



### Investigating the Possibility of Using Processed Slag of Steel Industry to Control the Erosion of Seghesi Plain in Eastern Isfahan

F. Heidari<sup>1\*</sup>, R. Saboohi<sup>1</sup>

<sup>1</sup> Department of Soil Conservation and Watershed managment, Isfahan Agricultural and Natural Resources Research and Education Center, AREEO, Isfahan, Iran.
\*Corresponding author Email: farzad.heidari@gmail.com

#### Abstract

The aim of this study was to investigate the effect of the application of processed slag on steel industries on reducing wind erosion, controlling sand dunes and fine dust. For this purpose, first an area of about 7 hectares was selected in one of the Segzi plain harvesting centers and the design plan was implemented in the form of completely random blocks and as a split plot in 6 treatments with 3 replications, including control and 5 soil thickness levels. After distributing and distributing different sizes of slag in the plots, at the beginning and end of each plot, sediment traps were installed at two heights of 10 and 50 cm. To increase the accuracy of each treatment, a plot was selected and at the beginning, middle and end travs for collecting creep sediments. And a rolling mill was installed and measured simultaneously with the removal of soil moisture-trapped sediment traps with a TDR machine. The results showed that slag ability to control and trap wind sediments depends on the size of the slag particles (volume) and the length of the field covered with slag because changes in grain size charts along slag-covered plots indicate that Towards the end, the amount of precipitation is reduced and the granulation of the sediments is directed to the larger particles. The presence of porosity in the larger particles of slag justifies the possibility of retaining moisture in it. Restoration of lost vegetation can be characteristic of changes in the area covered with soil, which can be due to the presence of moisture as needed by the plant or increased fertility or both causes at the same time. Based on the results, it can be concluded that slag in large sizes can be an effective soil cover in controlling wind erosion. Economically, compared to oil mulch, although the initial costs of slag are higher, but due to higher durability (at least 10 years), no pollution in the environment, maintaining and in some cases increasing soil permeability, no degradation and easy regeneration are still affordable. It is economical and recommended.

Keywords: Economy, Mulch, Rate of Return, Sediment Traps, Slag.



### Relationship between Landscape Metrics and Sediment Budget in a small Mountainous Watershed, Western Iran

F. Sedighi<sup>1\*</sup>, A. Khaledi Darvishan<sup>1</sup>, M.R. Zare<sup>2</sup>

<sup>1</sup> Department of Watershed Management, Faculty of Natural Resources, Tarbiat Modares University, Noor, Mazandaran Province, Iran.
<sup>2</sup> University of Isfahan, Isfahan, Iran.

\* Corresponding author Email: <a href="mailto:sadighi.fatemeh@yahoo.com">sadighi.fatemeh@yahoo.com</a>

### Abstract

Soil erosion is one of the most important causes of land degradation and the key global environmental hazard, especially for developing countries, affecting all natural and human-managed ecosystems. Human activities such as inappropriate management of farmlands, deforestation, and overgrazing have accelerated soil erosion. Among the factors influencing the rates of soil erosion, plant cover and land use are considered the most important, beyond the influence of rainfall intensity and slope gradient. In addition to different land percentages, the spatial pattern of land use change and vegetation continuity changes have a major impact on hydrological, erosion, ecological and socioeconomic processes in the watersheds. Therefore, analyzing landscape pattern changes can be a practical and effective approach to understanding the effects of human restorative and destructive activities in many landscapes. The present study aimed to determine the relationship between sediment budget components and the landscape metrics in the sub-watersheds of Khamsan experimental watershed, west of Iran. Geographical weighted regression was used to investigate the local correlations between metric and budget components in the sub-watersheds. The results of geographical weighted regression method showed that among the studied metrics, TA, MESH, TE and NP metrics with total erosion, TA, MESH, TE, NP and with total deposition and AREA-MN and A with sediment delivery ratio were strongly related.

**Keywords**: <sup>137</sup>Cs Method, Geographical Weighted Regression, Sediment Delivery Ratio, Soil Erosion.



## Introduction of a New Windbreak to Protect the Soil with Saline Conditions (Borkhar Isfahan Study Area)

Sh. Hajehforosh Nia<sup>1\*</sup>, M. Borhani<sup>2</sup>

<sup>1</sup>Research institute of Forests and Rangelands, Agricultural Research, Education and Extension Organization (AREEO), Tehran, Iran.

<sup>2</sup> Research Division of Natural Resources, Isfahan Agricultural and Natural Resources Research and Education Center, AREEO, Isfahan, Iran.

\*Corresponding author Email: <u>sh.hajehforoshnia@areeo.ac.ir</u>

### Abstract

The city of Isfahan is exposed to soil erosion and dust due to arid climate, low rainfall with poor distribution and desertification. Borkhar is one of the important Detachment areas of wind erosion in Isfahan province. Therefore, finding solutions that can reduce soil erosion is a clear priority. Construction of a windbreak is one method to reduce the speed of erosive winds. Due to water shortage and soil limitations in the study area, it is not economical to use a live windbreak that requires a lot of irrigation. Therefore, in this study, Kochia scoparia L (Schrad) is used, which is a suitable plant for the construction of windbreaks in saline lands. In this study, the plant seeds planted in the ground and the required water provided by irrigation. This phase lasted for two month. After full growth of seedlings, irrigation was stopped and dried seedlings become non-living windbreak. This type of windbreak lasts for 3 years, stabilizes the soil and controls soil erosion. The size, dimensions and number of windbreak rows were calculated based on the data obtained from the estimation of erosion threshold and the measurement of erosion and sedimentation of treatments in the study areas was investigated. So far, this type of plant has not been used anywhere in the world, and with this method and the way it is planted, a new method can be invented without the need for much water. It is also possible to preserve crops in the shade of this plant.

Keywords: Borkhar City, Controls, Saline Lands, Soil Erosion, Windbreak.



## Torrential Flood Risk Assessment Using Fuzzy Logic and TOPSIS in Grdelica Gorge and Vranjska Valley

T. Vulević<sup>1\*</sup>, A. Baumgertel<sup>1</sup>, N. Momirović<sup>2</sup>, R. Erić<sup>1</sup>, K. Lazarević<sup>1</sup>, N. Dragović<sup>1</sup>, V. Nikolić Jokanović<sup>1</sup>, S. Lukić<sup>1</sup>

<sup>1</sup> Department of ecological engineering for soil and water conservation, University of Belgrade, Faculty of Forestry, Belgrade, Serbia.

<sup>2</sup> Institute of Forestry, Department of erosion control, Belgrade, Serbia. \*Corresponding author Email: tijana.andrijanic@sfb.bg.ac.rs

#### Abstract

Torrential floods are one of the most destructive events causing serious economic damages, loss of lives, and ecological problems. They occur in occasional, periodic, or permanent watercourses associated with intensive erosion processes. The area of Grdelica gorge and Vranjska valley was one of the most affected areas by torrential floods in the Republic of Serbia in the past. The aim of this study was to analyze the risk of torrential flood occurrence in this area applying MCDA (multicriteria decision-analysis). For the whole area, where 36 subwatersheds are delineated, the analysis of vulnerability to torrential flood occurrence is performed using fuzzy logic and TOPSIS (Technique for order preference by similarity to ideal solution) method applied in the GIS environment. The risk of torrential flood is assessed by six decision-makers using the following criteria: Topographical Wetness Index (TWI), Rainfall (R), Soil erodibility (SE), Land use/Land cover (LU/LC), Drainage density (DD), and Population density (PD). The experts in the field of soil erosion and torrent control assigned the importance of each criterion using the triangular fuzzy number. The study area is classified into five categories of flood risk: very high, high, medium, low, and very low. High and medium risk categories occupy around 12% of the territory. The area at very high and high risk of torrential floods is located in all parts of the watershed. The upper part of the watershed is under the high risk of torrential flooding due to the presence of intensive agriculture production, while in the lower part, high drainage density and intensive rainfall cause significant vulnerability to torrential flood. This study presents the MCDA approach demonstrated with the case study that could be used to assess the risk of torrential flooding.

Keywords: Torrential Flood, Risk Analysis, Multi-Criteria Analysis, Fuzzy Logic, TOPSIS.



# The Effects of Gypsum Particle Size on Physico-Chemical Properties of Saline and Sodic Soils

R. Ghazavi<sup>1\*</sup>, E. Omidvar<sup>1</sup>, F. Karimi<sup>1</sup>

<sup>1</sup> Department of watershed management, University of Kashan, Kashan, Iran. \*Corresponding author Email: ghazavi@kashanu.ac.ir

### Abstract

Soil salinization is an important aspects of land degradation, especially in arid and semi-arid regions. Saline and sodic soils have hyperirritability to erosion in physically, chemically and biologically factors. From the watershed management point of view, salinization has an adverse consequence such as erodibility, production of fine-grained sediment, reduction of infiltration, increased runoff and inhibition of plant growth in these areas. Therefore, modification of saline and sodic soils and modification of the effects of salinity using soil modifiers are considered. In this study, the effect of different treatments of gypsum particle size on physicochemical properties of saline and sodic soils was investigated. Also, the amount of water required for leaching saline and sodic soils and the quality of outflow drains water under the influence of gypsum treatment were investigated. This study was conducted in the form of a greenhouse experiment in a completely randomized block design. Experimental treatments include gypsum with different amount (5 and 50 g of gypsum per kg of soil), gypsum with different particle diameters (60, 35, 10 and 5 mesh equal to 0.25, 0.5, 2 and 4 mm), and the control. Treatments were applied at two depths of 0-15 and 15-30 cm with three replications. The cylindrical columns made of polyethylene (height 40 and diameter 35 cm) with drainage installed in the deep part were used for experiments. The defined columns were filled with saline and sodium soil (ESP = 21). The soil columns, were washed six times after complete saturation. At each stage of leaching, the effluents from the drain columns were collected. At the end of this experiment, soil samples were collected from two depths (0-15 and -30. 15 cm) of leached soil. Some physico-chemical soil properties include calcium, magnesium, sodium, EC, SAR and ESP were measured and statistically analysed. In the second stage, saline and sodium soils were treated with the optimal amounts of gypsum determined in the first stage. After each leaching, soil properties were measured at two depths. Based on the results, the best amount of gypsum for saline and sodic soils treatment was 7.5 g of gypsum per kg of soil, equivalent to 33.7 ton. ha<sup>-1</sup>. The best gypsum particle diameter was 35 mesh (0.5 mm). Finally, the results of this study showed that using gypsum modifier should reduce the amount of water required for leaching and modification of saline and sodic soils.

Keywords: Saline and Sodic Soils, Soil Remediation, Leaching, Drainage, Water Quality.



## Hydrological Modelling of Climate Changes Impact on Flow Discharge in Balikhli Chay Watershed

S. Choobeh<sup>1\*</sup>, R. Imani<sup>2</sup>, T. Parsajou<sup>3</sup>

<sup>1</sup> Department of Watershed Management, University of Urmia, Urmia, Iran.
 <sup>2</sup> Department of Rangeland and Watershed Management, University of Kashan, Kashan, Iran.
 <sup>3</sup> Department of Civil Engineering, Islamic Azad University, Ahar Branch, Ahar, Iran.
 \*Corresponding author Email: sepideh.choobeh@yahoo.com

#### Abstract

Runoff estimation is a essential activity in water resource management, and plays an great role in the best usage of a hydrologic system. Runoff estimation is usually based on different hydrological models. In this research was assessed the climate change in 2030-2050 periods with RCP scenarios that for this purpose were utilized of SS\_EC-EARTH model in ardabil station. Climate change is effective on, river flow shortages, floods, and the declining water system that with predicting the climate change can perform fair management of water resources. The Balikhli chay Watershed with 1095 square kilometre area is located in Ardabil province. To assess the impact of these changes on the watershed outlet, SWAT hydrological model was used. The time horizon 1983-1994 was used in order to calibration and 1995-2018 for validation the model. Then, after ensuring the performance of the SWAT model, the downscaled climate change data were determined by the LARS-WG for each climate factors input to SWAT model runoff change in future periods were assessed. The climate model under RCP8.5 results showed that the annual minimum and maximum temperature will be increased 1.05 °C and 0.94°C respectively. The average annual rainfall for the study area will be increased at a rate of 11 percent. Compare current flow simulation represent that the peak flow for the future period will increase nevertheless the average flow discharge will increase in the amount of 100 percent. But this increase is accompanied by an increase in extreme phenomena such as floods and droughts. As the increase in runoff in winter was due to the change in the type of precipitation from snow to rain due to rising temperatures. In contrast, the decrease in runoff in summer was due to high temperatures and drought. Therefore the climate change should be considered in order to tackle with environmental hazards and Long-term planning.

Keywords: Climate Change, LARS-WG, RCP Scenarios, SWAT, Balikhli Chay.





# Assessing Space–Time Variability of Rainfall by Using Shannon Entropy

S. Choobeh<sup>1\*</sup>, H. Abghari<sup>1</sup>, M. Erfanian<sup>1</sup>

<sup>1</sup> Department of Watershed Management, University of Urmia, Urmia, Iran. \*Corresponding author Email: sepideh.choobeh@yahoo.com

#### Abstract

Rainfall distribution has become highly disordered due to climate change and human activities. the estimation of rainfall distribution has an important in understanding the hydrological cycle and water resources management. The aim of this study on the large-scale spatial rainfall distribution in the north and south of Iran using the information entropy theory. The examinations were performed on monthly, seasonal, and annual timescales based on meteorological stations for the period of 1980 –2019. The Mann–Kendall test was used to evaluate the long-term trend in marginal entropy as well as relative entropy for stations. rainfall variability can satisfactorily be obtained in terms of marginal entropy as a comprehensive measure of the regional uncertainty of these hydrological events. The Shannon entropy produced spatial patterns which led to a better understanding of rainfall and characteristics throughout the northern and southern region of Iran. The total relative entropy indicated that rainfall carried the same information content at annual and rainy season time scales. It was also observed that the spring and winter seasons have a more variable pattern than summer and autumn. In addition, it is observed that Bushehr and Ahvaz stations have less variability in summer.

Keywords: Shannon Entropy, Information Transfer, Mann–Kendall, Variability, Disorder.


## Investigating the Temporal Changes of Water Quality Entering in the Givi Dam's Reservoir Using Iran Water Quality Index for Surface Water (IRWQISC)

R. Imani<sup>1\*</sup>, T. Parsajou<sup>2</sup>, R. Ghazavi<sup>1</sup>, S. Choobeh<sup>3</sup>

<sup>1</sup> Department of Rangeland and Watershed Management, University of Kashan, Kashan, Iran.
<sup>2</sup> Department of Civil Engineering, Islamic Azad University, Ahar Branch, Ahar, Iran.

<sup>3</sup> Department of Rangeland and Watershed Management, University of Urmia, Urmia, Iran.

\*Corresponding author Email: rasool.imani@yahoo.com

### Abstract

Identification of the temporal changing in water quality entering in dam's reservoirs is so important in determination of optimal procedures for management and conservation of water and soil as well as management of reservoirs water quality. In this study, 12 water samples from the flow entering in the reservoir of Givi Dam's reservoir, located in Khalkhal city in Ardabil province, were prepared monthly in regular intervals. Quality parameters of water samples including pH, electrical conductivity (EC), fecal coliform (FC), nitrate (NO<sub>3</sub>), phosphate (PO<sub>4</sub>), total hardness (TH) and turbidity (Tur) were measured. In order to determine the overall quality of the water samples, the Iranian surface water quality index (IRAQIs) was used. The results showed that the quality of water in July, August, September and October was relatively good and in other months it was average and relatively bad. The most important parameters limiting water quality in spring, summer and early autumn are nitrate and turbidity. Therefore, reducing the usage of chemical fertilizers in agricultural lands as well as soil conservation operations in the watershed of Givi Dam will be an important approach in improving the quality of water stored in the dam's reservoir.

Keywords: Water Quality, IRWQIsc, Soil Conservation, Givi Dam.



# Ecological and Dynamic Health of a Watershed Assessed by the Multi-Dimensional Framework of Vigor-Organization-Resilience

Z. Hazbavi<sup>1\*</sup>, S.H.R. Sadeghi<sup>2</sup>, F. Ghanbari<sup>3</sup>, R.E. Correa<sup>4</sup>

<sup>1</sup> Department of Natural Resources, Faculty of Agriculture and Natural Resources, University of Mohaghegh Ardabili, Iran.

<sup>2</sup> Department of Watershed Management Engineering, Faculty of Natural Resources, Tarbiat Modares University, Iran.

<sup>3</sup> Department of Rangeland Management, Sari University of Agricultural Sciences and Natural Resources, Sari, Iran.

<sup>4</sup>National Marine Science Centre, School of Environment, Science and Engineering, Southern Cross University,

Australia.

\*Corresponding author Email: z.hazbavi@uma.ac.ir

### Abstract

Spatiotemporal variations of regional watershed health in the Shazand Watershed, Central Iran, were studied based on the momentous concept of the Vigor-Organization-Resilience (VOR) framework. Toward this, indicators of vigor (V), organization (O), and resilience (R) were established by characterizing 14 environmental data series of 1986, 1998, 2008, and 2014 for the study watershed. Various criteria of Normalized Difference Vegetation Index (NDVI), soil degradation intensity, runoff coefficient, and slope steepness were used to calculate the watershed vigor indicator. To calculate the organization indicator, the vegetation cover situation and replacement of NDVI centroid, landscape diversity index, erosion uniformity, runoff uniformity, and the ratio of contributing area in runoff generation to the total area where applied. In addition, the landscape richness index, the slope of erosion variations, the slope of discharge variations, the slope of NDVI variations, and stream density were accomplished to assess resilience indicators. Thence, a composite watershed health index defined by the geometric mean of V. O, and R indicators was introduced. The necessary prerequisites such as autocorrelation and multicollinearity tests and standardization were also conducted before modeling VOR. The results showed that human factors affected more the health of the Shazand Watershed rather climatic and hydrologic factors. The VORs of 0.33, 0.32, 0.34, and 0.37 for 1986, 1998, 2008, and 2014, respectively, indicated moderate health for all study years. In addition, sub-watersheds has shown important spatial variability in the health state. The results of the improvised method provided a reliable basis to designate reasonable strategies for sustainable land management and development leading to integrated management of the watersheds.

**Keywords**: Eco-Health-Based Framework, Hydrological Health, Landscape Pattern, Management Perspectives, Remote Sensing.



# Land Use Changes; The Key Challenge Affecting Flood Security, Erosion Hazard and Water Scarcity

M. Heshmati<sup>1\*</sup>, M. Gheitury<sup>1</sup>, M. Kalehhouei<sup>2</sup>

<sup>1</sup> Agricultural Research and Training Center of Kermanshah Province, Agricultural Research, Education & Extension Organization (AREEO), Kermanshah, Iran.

<sup>2</sup> Department of Watershed Management Engineering, University of Tarbiat Modares University (TMU), Nour, Iran. \*Corresponding author Email: <u>heshmati46@gmail.com</u>

#### Abstract

Extreme consumerism based lifestyle and availability of heavy machinery around the world are two main anthropogenic factors affecting landuse change and consequently irreparable damage to land resources (forest, rangeland, wetland, mine, etc). This is precisely the major challenge and the root cause of crises such as floods, erosion, sediment, water scarcity, dust, desertification, forced migration and weakening agriculture. In this study, the effective factors in the land use change and its consequences have been investigated and analysed according to the comprehensive literature review. The results of our analysis showed that the landuse/cover changes are mainly affected by land ownership system, rules and current management of natural resources, government policy, the process of purchasing and selling agricultural lands, uncontrolled urbanization and civil activities and local lobby presser. Unfortunately, the climate change that occurred in the last two decades has provided the background for drought and land use change of forests, wetlands, natural meadows, high-quality pastures, and riverbeds. If the current trend continues, the response to the resulting crises in more tangible forms such as water scarcity, forced migration (spread from rural to urban regions) and huge economic losses will not be unexpected. It is believed that any kind of planning and action to deal with these consequences will not be successful without considering the issue of land use change, and this requires fundamental change in laws, administrative and, management approaches.

Keywords: Dust Storm, Land use Change, Natural Resources, Soil Erosion, Water Shortage.



## Possibility of Preserving Rural Water and Soil Resources Through Migration Reverse in the Form of Second Houses in the COVID-19 Pandemic

B. Ashtari Mehrjardi<sup>1</sup>, I. Islami<sup>2\*</sup>, A. Farajollahi<sup>3</sup>

<sup>1</sup> Institute for Cultural and Social Studies, Tehran, Iran.

<sup>2</sup> Department of Rangeland Management, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran.
<sup>3</sup> Combating Desertification, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran.
\*Corresponding author Email: i.eslami@modares.ac.ir

### Abstract

With the implementation of the land reform law in rural areas of Iran since 1940, the decrease of rural population and mass migration of villagers to metropolitan areas increased. But since 2002, in the form of second rural homes, albeit limited, we have witnessed a reversal of the migration trend temporarily and seasonally. This is the time when rural studies in Iran changed from a disciplinary to an interdisciplinary field. These conditions require the cooperation and higher participation of experts in geography, economics, tourism, anthropology, sociology, environment and natural resources to prevent further degradation of water and soil resources and for the purposes of sustainable development. Today, the inhabitants of big cities (immigrants of previous decades) are involved in problems such as population density, rising cost of living, various pollutions, diminishing values and traditions, and all kinds of social and cultural harms. In the meantime, some people with the support and financial and banking facilities of the government (for the reconstruction and improvement of rural houses) began to build second homes in rural areas that have many social, cultural and environmental effects on rural communities and resources. This trend has grown during the covid 19 pandemic due to people's concern for their families' health, urban living constraints, the possibility of controlling economic, educational and research activities remotely and virtually in the villages. Our initial assumption in this study was that according to the biological experience and studies of the last two decades in the central villages of Iran, the use of second homes has increased during the covid 19 outbreak, which leads to more protection and in general a new possibility in protecting water and soil resources. Findings obtained from the study of villages in the central regions of Iran indicate that the owners of second rural homes due to different lifestyles, higher literacy, and status and identity identification conserve more the biological resources of the villages. On the other hand, by encouraging collaborative actions and less harmful methods to nature, such as ecotourism, they have prevented the degradation and change of land use. Also during the outbreak of the corona virus, the villagers' understanding of the importance of landscape protecting has significantly increased.

Keywords: Degradation, Resource Protection, Socioeconomic Effects, Social Understanding.





# **Rill Network Evolution, Landscape Degradation and its Fractal Signature**

B.Yasrebi<sup>1\*</sup>, S.J. Bennett<sup>2</sup>

<sup>1</sup> Department of Natural Resources Research, Agriculture and Natural Resources Research and Education Center, Ahvaz, Iran.

<sup>2</sup> Department of Geography, University at Buffalo, Buffalo, NY, USA.

\*Corresponding author Email: byasrebi@gmail.com

### Abstract

An experimental landscape forced by rainfall and baselevel adjustment to form a rill network is subjected to quantitative study of growth mode using fractal dimension. This study also sought to monitor temporal variations of sediment production along with the evolution of drainage network. According to the present simulation and quantification of provided growth models, generally, three growth mode based on initial topography exhibited: (1) convex upward curve, where the values increase quickly with time, then level off it seems this growth mode seen in steeper surfaces, (2) concave upward curve, where the values change initially slowly with time, then increase rapidly, and (3) straight line curve where the values increase with time at the same rate. Sediment production variation of present simulation is proportional to growth mode. Sediment efflux spiked after baselevel adjustments then declined and did not increase even with rainfall continuation. These findings are important for land managers to prioritize measures on steeper slopes specially farmers.

Keywords: Growth Mode, Fractal Dimension, Rill Network Evolution, Landscape Degradation.



## **Conservation of Water Resources Through the Use of Unconventional Resources** in Irrigation; Simulation Perspective

S. Etminan<sup>1\*</sup>, V.R. Jalali<sup>2</sup>

<sup>1</sup> Shahid Bahonar University of Kerman, Kerman, Iran.
 <sup>2</sup> Shirvan Higher Education Complex, Shirvan, Iran.
 \*Coresponding author Email: <u>etmina.samane@gmail.com</u>

#### Abstract

In this study the effect of wastewater treatment applied in alfalfa field management was simulated under HYDRUS-1D in terms of the effects of wastewater treatment on soil nitrate pollution during four growing seasons. The trend of soil nitrate and ammonium concentration was simulated in plant root growth environment employing the HYDRUS-1D model. The Particle Swarm Optimization (PSO) method was employed to determine soil hydraulic and solute transport parameters in the simulation process of the soil ammonium and nitrate changes. Plant yield was 22000 (kg.ha<sup>-1</sup>) on average per harvest. Also, based on the results of the simulation process can be said that using wastewater treatment has been able to provide nutrients needed by plant during its growth. The results of the simulation process were indicated that the most trend of soil ammonium changes is in the soil surface layer. So that, decreased soil ammonium concentration with increasing soil depth. In contrast, with increasing soil depth, the soil nitrate concentration was increased. Studied solute had oscillating trend in the soil surface layer, even though the trend of soil nitrate changes is less than soil ammonium changes. Fluctuating soil ammonium concentration was related to irrigation water volume, convert soil ammonium to soil nitrate, and soil ammonium adsorption. The trend of soil nitrate and ammonium simulation represented the ability of HYDRUS model to predicate the trend of solute changes under mentioned irrigation method. The obtained results of the statistical indices of RMSE and NSE, from topsoil to the plant root zone showed increasing model accuracy in assessing the trend of soil solute changes. The highest and lowest values of RMSE were 0.01 and 0.004 in model validation process, and 0.008 and 0.001 in model calibration process, respectively. The model accuracy in term of NSE index was obtained 0.94 and 0.98 in the plant root zone in validation and calibration process, respectively. The highest value of soil nitrate in the root zone environment was 0.145 (mg.cm<sup>-3</sup> soil). The values of RMSE and NSE indices were obtained 0.0013 and 0.97 in the topsoil, and 0.0009 and 0.87 in the plant root zone respectively. According to the obtained results can be said that HYDRUS model is able to predicate soil ammonium changes based of its input fluctuations and its conversion using optimized soil parameters. Considering the plant yield and the accumulation of nitrate in the soil, it can be said that using unconventional water in compliance with environmental health concerns is a suitable source to supply plant nutrients, improve soil condition in terms of organic matter and provide water required of plant during the growing season in arid and semi-arid regions.

Keywords: Environment, Hydrus Model, Soil Nitrate, Soil Pollution.



# Development of a Simulation-Optimization Framework for Optimizing Best Management Practices (BMPs) for soil and Water Conservation at the Watershed Level

A. Zare Garizi<sup>1\*</sup>, A. Talebi<sup>2</sup>, E. Getahun<sup>3</sup>

<sup>1</sup> Department of Watershed Management, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran.

<sup>2</sup> Department of Rangeland and Watershed Management, Yazd University, Yazd, Iran.

<sup>3</sup> Illinois State Water Survey, University of Illinois at Urbana-Champaign, Illinois, USA.

\*Corresponding author Email: arash.zare86@gmail.com

### Abstract

Soil and water degradation has been recognized as one of the most serious environmental degradation problems that threatens land productivity and sustainable development. Planning and implementation of appropriated soil and water conservation practices is essential for sustainable utilization of soil and water resources. A suitable method for this task should be fast, economical and accurate and can consider the most important factors and processes affecting hydrology and pollutants' transport within a watershed. In this study an integrated simulation-optimization framework is developed by coupling the process-based SWAT model and Genetic algorithm for optimal selection and placement of Best Management Practices (BMPs) in the Gharesou River watershed, north-eastern Iran. After model calibration and uncertainty analysis, three pollution quantifying indices including a Load per Unit Area Impact Index (LUAII), a Concentration Impact Index (CII) and a Load Impact Index (LII) were computed for identifying critical areas within watershed. Then, eight BMPs were chosen (following consultation with local experts) for modelling and placement in the critical areas of the watershed. To optimally allocate BMPs (in terms of type and location), a simulation-optimization framework was created in the R programming environment by integrating the SWAT model as BMPs impact predictor and multi-objective genetic algorithm, NSGA-II, as the optimizer. The results of the study indicated that, SWAT performance for hydrologic simulation of the Gharesou watershed is good and for monthly sediment prediction is acceptable. Pollution impact indices identified critical areas that are the source of disproportionately large amount of pollution and so desperate for management interventions. The results of BMPs' spatial optimization in the critical areas suggest that, cropland conversion to pasture, terracing and grassed waterways are the most effective practices for sediment and nutrient reduction. By implementing BMPs in the optimal areas (or streams) suggested by the simulation-optimization program, the sediment and nutrients loss from upland would reduce by about 25 percent and in the watershed outlet by about 57 percent. The outputs of this study may serve as a quick and accurate guide for targeting soil and water conservation practices in the watershed. The approach and the program developed in this study are easily extendable to other watersheds.

Keywords: Best Management Practices (BMPs), Genetic Algorithm, SWAT Model.



## Discovery of Temporal and Spatial Changes of Dust Storms in Kermanshah Province, Iran

Kh. Shahbazi

Assistant Professor, Desert Research Division, Research Institute of Forests and Rangelands, Agricultural Research, Education and Extension Organization (AREEO), Tehran, Iran. \*Corresponding author Email: khosrw\_shahbazi@yahoo.com

#### Abstract

Climate change due to global warming can major challenges context to water resources and desertification. Arid and semi-arid areas usually have sensitive ecosystems, that can be damaged quickly. In recent years, climate change can reduce vegetation cover by decreasing rainfall and drought. Declined vegetation cover can lead to some consequences, including dust storms (DS). DS can effect on climate, crops, biodiversity, ecosystems and, most importantly, human health. The purpose of this study is to investigate the temporal and spatial changes of DS in Kermanshah province, Iran. Kermanshah province shares a boundary with Iraq, which has dust source. Data on the intensity and frequency of dust was received from the synoptic station of the province in the statistical period of 2001 to 2019. The results of this study show, that the number of days of DS with foreign origin in most stations of the province in different years has been much more than the number of days with dust of domestic origin. This shows that the province is very affected by the dust of neighboring areas. The highest and lowest number of recorded foreign and domestic dusts were related to Sarpol-e-Zahab and Islamabad-e-Gharb stations, respectively. In these two stations, 175 and 34 days of DS were recorded during the study period, respectively. Which can indicate the availability of conditions for this region in terms of DS production and the creation of an internal dust source rather than to other parts of the province. In terms of the number of DS, Sarpol-e-Zahab and Islamabad-e-Gharb stations with 6250 and 75 DS have the maximum and minimum numbers during the study period, respectively. In spring and summer, the highest number of days and in winter, the lowest number of local and extra-local dust in all stations studied. The results of this study can enable managers and planners to prioritize different areas in proportion to the severity and frequency of occurrence of fine DS, and be able to take the necessary actions.

Keywords: Biological Diversity, Climate Change, Drought, Dust Sourcs.



## Integrative Assessment of Land Degradation: A Review of Current Methodological Approaches

E. Biniyaz

Department of Geography, Landscape Ecology and Geoinformation Science, Kiel University, Kiel, Germany. \*Corresponding author Email: biniyaz@geographie.uni-kiel.de

### Abstract

The United Nations Environment Programme (UNEP) defines land degradation as the temporary or permanent lowering of the productive capacity of the land. Taking the ecological perspective, Bai et al. (2008) consider land degradation a cumulative environmental issue and define it as a long-term decline in ecosystem function which has to be measured in terms of net primary productivity. Although land degradation by itself is a physical process, the land users and their socio-economic environment are its underlying causes (Stocking and Murnaghan, 2001). Human activity coupled with natural processes can cause the loss of a sustained economic, cultural, and ecological function of the land (Johnson and Lewis, 2007). Land degradation is being assessed based on different definitions, understandings, and demands. Scientific approaches applied to the topic over the past decades with respect to various regions of the world include the employment of indicators, modelling of relevant processes (e.g. soil erosion and forest fires), the Ecosystem Service Concept, and the DPSIR. This review discusses the ongoing land degradation assessment approaches and methods. It critically addresses the following questions: To what extent do the scientific approaches recognize the interdisciplinarity of the topic? How are typical limitations, such as data availability and comparability, especially in developing countries, considered? And how can the problem be observed on different scales?

Keywords: Land Degradation, Indicators, DPSIR, Data Availability.



# Biological Soil Crusts Responsible for Degraded Lands Restoration; Accomplished Steps and Future Perspective

H. Kheirfam<sup>1,2\*</sup>, F. Asadzadeh<sup>3,4</sup>, S.H.R. Sadeghi<sup>5</sup>

<sup>1</sup> Department of Range and Watershed Management, Faculty of Natural Resources, Urmia University, Urmia, Iran. <sup>2</sup> Department of Environmental Sciences, Urmia Lake Research Institute, Urmia University, Urmia, Iran. <sup>3</sup> Department of Soil Sciences, Enculty of Agriculture, Urmia University, Urmia, Iran.

<sup>3</sup> Department of Soil Sciences, Faculty of Agriculture, Urmia University, Urmia, Iran.

<sup>4</sup> Department of Sediment Processing, Urmia Lake Research Institute, Urmia University, Urmia, Iran.

<sup>5</sup> Department of Watershed Management Engineering, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran.

\*Corresponding author Email: h.kheirfam@urmia.ac.ir

### Abstract

Land degradation is known as a global threat to food security and ecosystem health, which the world needs a transition from the current system to a state where it can achieve defined Sustainable Development Goals by the United Nations. Adopting land management policies, as biological soil crusts (BSCs) creation/reclamation, can help to achieve the transition goals. However, outlining the path is taken and the outlook for the future can make researches and actions more targeted. Thus, we reviewed a wide range of global studies focused on the BSCs and analyzed the relevant researches trends to date. We also tried to draw the next steps that are expected to be taken and the challenges that lie ahead. We found more than 10,600 documents to analyze all aspects of BSCs capabilities and behavior from 1948 to 2021 AD. Our review showed that BSCs studies are classified into three time periods. From 1948 to 1972 AD, the studies have focused on assessing the environmental factors on biological soil crusts behavior. Then, numerous studies were then started (1972 AD) to investigate the impact of BSCs on the soil properties and the behavior of the land degradation indicators (e.g., runoff, soil loss, and biodiversity) and continued until 2009 AD. After confirming the role of the BSCs on land health, laboratory-scale/controlled conditions research to artificially create BSCs through inoculation-based techniques, stimulation of crustal microorganisms, and transfer of rich BSCs to degraded lands began from 2009 to 2019 AD. Forasmuch as the experiments under laboratory have pointed out the positive results of the inoculation technique in terms of BSCs creation/restoration, one step ahead, new researches have recently (2020-2021 AD) planned field-pilot experiments to use soil inoculation for BSCs creation in line with degraded lands restoration programs. We also found, however, there are concerns regarding the large field-scale application of the inoculation technique for BSCs creation/reclamation, which poses challenges to the future of this approach. High inoculum production, tools required for large-scale inoculation, harsh environmental conditions in the establishment times of BSCs, and durability of artificial BSCs are some of the challenges ahead.

Keywords: Biocrust, Ecosystem Restoration, Land Degradation, Soil Cyanobacteria, Soil Inoculation.





# The Comparison the Organic Carbon Loss between Rangeland and Agriculture

M. Miri<sup>1</sup>, A. Beheshti Ale Agha<sup>1</sup>, S. Aghabeigi Amin<sup>2\*</sup>

<sup>1</sup> Department of Soil science and engineering, Faculty of Agriculture, University of Razi, Kermanshah, Iran.
<sup>2</sup> Department of Natural resources, Faculty of Agriculture, University of Razi, Kermanshah, Iran.
\*Corresponding author Email: <a href="mailto:saghabeigi@yahoo.com">saghabeigi@yahoo.com</a>

#### Abstract

The issue of soil erosion and its environmental consequences, including the reduction of organic carbon, soil structure degradation and reduced soil fertility have become the concerns of the present century. In this study, in order to investigate and compare the loss of soil organic carbon in both rangeland and agricultural land uses, erosion plots in dimensions of one in two square meters were used. Five rainfall events were sampled during one year. Runoff and sediment from the plots were collected and the amounts of sediment runoff and organic carbon loss from the plots were measured in the laboratory. The results showed that the change of land use from rangeland to agriculture has led to increased runoff and sediment in agricultural land. Also, the amount of organic carbon in the rangeland was 1.3 times more than agriculture, but the loss of organic carbon in agriculture was 4.46 times more than the rangeland use.

Keywords: Experimental Plot, Land Use Change, Runoff, Sediment.



## Effect of Life Form Vegetation on Runoff and Sediment Yield on Mountainous Rangelands (Case Study: Asadabad-Hamedan Rangelands)

R. Bayat<sup>1</sup>, B. Fattahi<sup>1\*</sup>, S. Aghabeigi Amin<sup>2</sup>, H. Nouri<sup>2</sup>

<sup>1</sup> Department of Natural Engineering, University of Malayer, Malayer, Iran.
 <sup>2</sup> Department of Natural Resources, University of Razi, Kermanshah, Iran.
 \*Corresponding author Email: <u>fattahi b@yahoo.com</u>

### Abstract

Vegetation has always played an important role in preserving the soil and preventing its erosion. Density and type of vegetation are influential factors in the amount of runoff and sediment created in an area. Accordingly, this study was conducted on the effect of vegetative form of plants on runoff and sediment production in mountain pastures in Assadabad region. Using rain simulator in two types of grassland and shrub land, plots with dimensions of 1\*1 are installed in the area and rainfall with three time intervals of 2, 4 and 6 minutes in both types of vegetation (grassland and shrub land) and It was created at densities of 20, 30, 40, 70, 80 and 90% and the runoff and sediment produced from each plot were accurately measured. The results showed that the grasslands is much more effective than the shrub lands in controlling runoff and sediment. Also, the average runoff production in both types of vegetation increased with increasing rainfall duration, and the amount of sediment in the shrub type acted inversely with increasing rainfall, and the amount of sediment decreased. In Grassland type, the amount of sediment production increased exponentially with increasing rainfall interval and then increased.

Keywords: Life Form, Sediment, Runoff, Rangeland.





# The Importance of Topography in Hydrological Process on Complex Hillslops

A. Talebi

Department of Watershed management, Yazd University, Yazd, Iran. \*Corresponding author Email: <u>talebisf@yazd.ac.ir</u>

#### Abstract

As hillslopes are the basic landscape elements of many catchments, but their shape are not simple. Most of hillslopes are complex (different length profile and plan curvature. To investigate the real shape of complex hillslopes, we considered the curvature in flow direction (concave, straight or convex) and curvature in perpendicular to flow (convergent or divergent plan), means that there are nine complex hillslopes in the nature. All hydrological process (rainfall, surface runoff, subsurface flow, sheet erosion, sediment particles) have been investigated using the physically based models in complex hillslopes. The presented models are composed of three parts of a three-dimensional (3D) hillslope geometry, a nonlinear storage (kinematic wave) model for hillslope hydrological response, an unsteady physically based surface erosion model and statistical analysis of collected data in lab using rainfall simulator and erosion plots. According of our research model inputs, on hillslopes with concave profile (1, 2 and 3), in portion of length detachment and in on another portion deposition is occurred. In hillslopes with straight or convex profile shape, soil detachment is occurred on whole hill length. From hydrologic viewpoint, the convergent hillslopes saturate more quickly compared to the parallel and divergent ones. Also, the travel time of the divergent hillslopes is, on the average, twice that for convergent case. The concave hillslopes saturate sooner in comparison with the straight and convex ones, with shorter travel time. According to the results, the subsurface flows travel time of the divergent hillslopes is less than that of parallel and divergent ones. The convex, straight, and parallel hillslopes showed almost the same travel time. From erosion viewpoint, based on the obtained results, in hillslopes with convex and straight profile curvatures, sediment detachment only occurred in the whole length of the hillslope. However, in concave ones, sediment detachment and deposition only occurred together in hillslope. The hillslopes with straight profiles and convergent plans have the highest rate of detachment. Also, results show that most detachment rates occur in convex profile curvatures. The presented models also were performed in laboratory conditions using a rainfall simulator. Then, the divergent convex hillslope in the plot was designed and filled with soil. Finally, the amount of total sediment and runoff in each event was measured under a rainfall intensity of 30 mm.hr<sup>-1</sup>. The results showed that the amount of total sediment and runoff decreased in conservation treatment compared to the control plot respectively of 17.07 and 59.38%.

Keywords: Complex Hillslopes, Subsurface Flow, Water Erosion.



## Some Physical and Chemical Soil Properties of Orchid Growing Areas in Vercenik Mountains

S. Ercisli

Faculty of Agriculture, Department of Horticulture, 25240 Erzurum, Turkey \*Corresponding author Email: <u>sercisli@gmail.com</u>

### Abstract

In the present study, some important physical and chemical soil characteristics of orchid (Dactylorhiza spp.) growing areas in Northeastern Turkey (Vercenek Mountains) were determined. A total of 5 soil samples from different Dactylorhiza spp. growing areas within the border of Vercenek Mountains were collected and analyzed. The main parameters searched to determine soil characteristics were water retention characteristics, pore size distribution, bulk density, electrical conductivity (EC), pH, organic matter, carbonates and microelements. The water retained at the low tensions (<0.03 MPa) in Dactylorhiza spp. growing areas soils were between 27.33-43.34 based on % of volume. The soil samples showed 24.73% and 17.44% the highest and lowest water retention capacity between 0.03-1.5 MPa, respectively. Among the samples bulk density were 0.33 and 1.01 g.cm<sup>3</sup>, respectively. EC, pH and organic matter values of samples varied from 0.36-1.77 dS.m<sup>-1</sup>, 6.02 to 7.19 and 2.44-16.18%, respectively.

Keywords: Soil Properties, Dactylorhiza spp., Organic Matter.



# Effectiveness of Watershed Management Measuresin the Nekarood Watershed, Northern Iran

E. Mokhtarpoor<sup>1</sup>, K. Sharifi<sup>2</sup>, S. Dadashi<sup>1</sup>, L. Amozgar<sup>1\*</sup>

<sup>1</sup> Technical Deputy of Watershed Management, General Department of Natural Resources and Watershed Management of Mazandaran Province-Sari, Sari, Iran.

<sup>2</sup> Deputy of Planning, Management Development, and Resources, General Department of Natural Resources and

Watershed Management of Mazandaran Province-Sari, Sari, Iran.

\*Corresponding author Email: lale\_amozgar@yahoo.com

### Abstract

Recently, inappropriate land and water resources in watersheds increased surface runoff and soil erosion and decreased the infiltration rate and groundwater level. Eroding fertile upstream soil causes sedimentation downstream of the rivers. Watershed management projects are prepared and implemented to ensure soil and water conservation, flood control, and reducing their destructive consequences. Evaluation of watershed management projects is essential to identify their effects and make the optimum decisions in various conditions. In the present study, the effectiveness of watershed management measures was carried out in the Nekarood Watershed, Northern Iran. The watershed with a total area of 121046.32 ha has 15 sub-watersheds, six of which were studied in detail. Different types of mechanical projects, including 44 stone-mortar check dams, nine sidewalls, and one branch strap dam, have been implemented during 2005-2020. The results showed that 72.4% of the structures are stable, 22.2% need to be repaired, and 5.6% have been destroyed. Some 75% of the volume of check dam reservoirs was filled with sediments, and 3.4% of the volume of constructed structures is filled with sediments, which implicitly indicates the high sediment trap efficiency of the structures. Determination of peak flood discharge using the precipitation-runoff model showed that peak flood discharge has significantly decreased after watershed management measures in all studied sub-watersheds. In order to evaluate the stored water through applying biological projects in each sub-watershed, the SCS method was used. The results approved a significant decrease in runoff control after the implementation of biological projects. The results also showed that the specific erosion rate in six studied sub-watersheds with erosionsensitive formations before watershed management measures varied between 804.75 and 921.10 m<sup>3</sup> km<sup>-2</sup>, while it ranged from 754.17 to 843.73 m<sup>3</sup> km<sup>-2</sup> after watershed management measures. This decrease can be attributed to reducing peak flood discharge, increasing runoff time of concentration, and decreasing erosion intensity coefficient.

Keywords: Flood Control, Runoff, Soil and Water Conservation, Sediment Control.



# Usability of Weather Forecast Based Advisory in Terms of Water Saving in Jammu District of J&K

Ve. Sharma<sup>1\*</sup>, M. Singh<sup>1</sup>, B.C. Sharma<sup>2</sup>, Vi. Sharma<sup>3</sup>

<sup>1</sup> Agromet Section, SKUAST-Jammu, UT of J&K, India.
 <sup>2</sup> Division of Agronomy, SKUAST-Jammu, UT of J&K, India.
 <sup>3</sup> Division of Soil Science and Agricultural Chemistry, SKUAST-Jammu, UT of J&K, India.
 \*Corresponding author Email: veena sharma29@rediffmail.com

#### Abstract

Weather plays vital role in growth, development and yield of Crop. Weather changes with time and space. Erratic weather is beyond human control. Location specific timely weather forecast based advisory helps farmers to make day to day decision in all agricultural operations viz. crop planning etc. irrigation scheduling, application of fertilizer, insecticide as well as plant protection chemicals which assures reduction in crop losses and efficient use of input including water. Rice is one of the water intensive crop. The rise in population has led to an increase in its demand and in turn escalating the amount of water required for its irrigation. Conventional method of cultivation needs 3,000 to 5,000 liters of water to produce a kilo of rice. Also the rain water use is free of cost and saves cost of fuel as well as labour employed in irrigation. The combination of irrigation and rainfall can reduce rice farmers need for irrigation water, enhance grain production, and assist in alleviating food and water shortages in rice producing regions. The present study was conducted keeping in view to cope up with increasing threat of water scarcity conditions. Weather forecast value added by Met Centre Srinagar after issued by India meteorological department since 2015 was compared with actual weather data recorded at Agrometerological Observatory AMFU-Chatha for the same duration to assess the validity and accuracy of rainfall. Various test criteria were used to test the reliability and accuracy of the forecasted rainfall. Further accuracy and its usability in terms of saving irrigation in rice crop was studied. The forecast was 67.3% accurate during the year 2015 and 2016. 70.66, 60.83, 62.9 and 7.19 % accuracy was observed during the year 2017, 2018, 2019 & 2020 respectively. 4 irrigations were saved during the year 2015, 2016. 3 irrigations were saved during 2017, 2018, 2020 and 5 irrigations were saved during 2019.

Keywords: Rainfall, Irrigation, Water Saving, Weather Forecast.



# سومین همایش بینالمللی جوانان انجمن جهانی حفاظت خاک و آب

Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, NOOR, IRAN



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Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, NOOR, IRAN



H. Zheng: (23) H.R. Azizi: (47) H.R. Moradi: (72) Hs. Jat: (32) I. Homayoonnezhad: (57) I. Islami: (88) I. Kostić: (26) I. Lazić: (30) Ia. Samofalova: (43) J. Beloica: (39) J. Gao: (40) J. Gou: (23) J. Guo: (31) J. Jiao: (20) J. Li: (21) J. Wu: (23) J. Zhao: (31) J.Niu: (29) Jm. Sutaliya: (32) K. Lazarević: (81) K. Prokopeva: (62) K. Rangzan: (53) K. Sharifi: (99) K. Solaimani: (55) Kh. Haji: (50, 52) Kh. Shahbazi: (92) L. Amozgar: (99) L. Gholami: (35) (Basu.Ac.Ir) L. Gholami: (36) (Sanru.Ac.Ir) L. Mauri: (54) L. Rui: (5) L. Wang: (22) L. Zhang: (29) M. Arabkhedri: (33, 73, 74) M. Borhani: (80)

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Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, NOOR, IRAN



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Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, NOOR, IRAN



Sh. Pandey: (27) Sh. Qi: (21) Sh. Wu: (29) S.Wang: (23) T. Glade: (55) T. Liu: (24) T. Parsajou: (83, 85) T. Vulević: (81) V. Đurđević: (30) V. Golosov: (37) V. Hochschild: (34) V. Ivanov: (65) V. Moosavi: (46, 59, 71, 75) V. Nikolić Jokanović: (81) V. Rončević: (38) Veena Sharma: (100) Vikas Sharma: (100) V. Sheikh: (17) V. Spalevic: (10) V.R. Jalali: (90) V.R. Krishna: (7) Vp. Panwar: (27) W. Dang: (22) W. Li: (40) X. Bai: (25) X. Li: (23) X. Lin: (29) X. Liu: (22) X. Peng: (24) X. Yu: (29) Y. Cheng: (25) Y. Deng: (31) Y. Karimi Hajipamoq: (15, 76) Y. Li: (20, 21) Y. Long: (22) Y. Wang: (25)

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www.IYFSWC.modares.ac.ir Email: IYFSWC@modares.ac.ir