

DTXIV International Conference of Arid Land Studies



September 7th - 10th 2021
Tokyo

7th September

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| 9:45-9:55 | Opening remarks |
| 9:55-10:00 | Important points of presentation |

**President of IDC,
Prof. Takahiro Morio**
President of DT14ICAL,
Prof. Yoshiko KAWABATA

Oral Presentation**7th September Stress biology in arid land**

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| 10:40-11:00 | Electrochemical degradation mechanism of trichloroethylene in grass beads mock soil | Kazuki Ito, Kazuki Sugawara, Seiichi Suzuki, Takuya Ito, Shigeru Kato and | 3 |
| 11:00-11:20 | The tendency of plant species identified in the Djibouti Republic of East Africa registered in the global biodiversity database | TANAKA Satoru, TAKAHASHI Simpei, KIMURA Rikako, SHIMADA Sawahiko | 4 |
| 11:20-11:40 | Beyond Tsunami disaster: Ten years' Activities to use uncultured field for biomass production of willow after the Great East Japan Earthquake in Miyagi, Japan. | Yuichi Ishikawa, Hideo Sugimoto, Yasunobu Matoba, Toshio Oshida, Atsushi Fukuda, Hisao Ushiki, Tetsu Nishioka, Yuji Aoki, Takahiro Miyai, Shunsuke Kikuchi, Ryo Fujita, Satoshi Wakamiya, Shota Sasaki, Shota Nagasawa, Moe Satoh, Sachiko Yabuki, Hitoshi Kanno, Hidetsugu Morimoto, Shin Hidaka, Atsushi Hayakawa, and Tadashi Takahashi | 5 |
| 11:40-12:00 | Basic Study on the Mechanism of 1,4-Dioxane Phytoremediation by Willows. - Comparison of Three Willow Species. | Takahiro Miyai, Osamu Kiguchi, Tadashi Takahashi, Naoyuki Miyata, Atsushi Hayakawa, Yuichi Ishikawa | 6 |

12:00-13:00 Lunch

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| 13:40-14:00 | Profiling of the phenolic compounds from <i>Aloe djiboutiensis</i> in Djibouti | Ko Hinokidani, Ryuichi Tachibana | 9 |
| 14:00-14:20 | Preliminary study on improvement of soil water retention characteristics by <i>Spirulina</i> | Shinji SUZUKI, Satoru WATANABE, Fumio WATANABE, and Sawahiko | 10 |

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19:00-19:20 **Opening Remarks**

Prof. William Payne

Why Drylands Matter to the United States and Other Advanced Economies

Water technologies combating arid land

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| 14:20-14:40 | Analysis of the Impacts of Irrigation Water Management Practices and Climate Change on Water Availability for Rice Production. A Case in Uganda | Denis Bwire, Hirotaka Saito and Emmanuel Okiria | 29 |
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| 15:00-15:20 | Soil water distribution using subsurface string irrigation for water saving by the negative pressure difference | Atsushi MARUI, Kiyoshi OMINE, Zentaro FURUKAWA, Noriyuki YASUFUKU, Mattashi IZUMI, Indree TUVSHINTOGTOKH and Bayart MANDAKH | 31 |
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| 17:20-17:40 | Suitability of arid land rehabilitation technologies: simulation of water harvesting based solutions in Middle Eastern agro-pastures | Stefan Strohmeier, Margherita Sarcinella, Mira Haddad, Sadahiro Yamamoto, Steve Evett, Geert Sterk | 37 |

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| 14:40-15:00 | Study of effects of pre-harvest paper bagging practice on quality of fruits of Deveji pear in climatic condition of Uzbekistan | Gafurov Jakhongir Akhroljon oghli, Keisuke Katsura, Kayumov Abdurashid | 49 |

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18:00-19:30 **Conference Party**

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| 11:20-11:40 | Current status of Agricultural sector in Kyrgyz Republic from the perspective of increasing presence of individual entrepreneurs | Junko ISHIKAWA | 62 |
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| 15:40-16:00 | Food insecurity is expecting in upcoming decades in the Zarafshan River Basin of Uzbekistan | Dildora Aralova, Temur Khujanazarov, Kristina Toderich, Anvar Kodirov | 72 |

16:00-16:10 **Closing Remarks**

**President of IDC, Prof.
Takahiro Morio**

Statistical analysis for estimating survival of licorice (*Glycyrrhiza uralensis* Fisch.) and improvement effects of surface ground environment

Zentaro FURUKAWA*¹, Noriyuki YASUFUKU¹, Kiyoshi OMINE², Atsushi MARUI³,

Indree TUVSINTOGTOKH⁴, Bayart MANDAKH⁴

Desertification and decreasing of vegetation in Southern Mongolia has been progressing due to unstable rainfall and disordered human activity. Unstable rainfall causes lowering of groundwater level and shortening water supply to native plants. Overgrazing of domestic animals such as goat, sheep, and horse also gives critical damage to rangeland. Numbers of domestic animals are increasing year by year, so that grazing pressure exceeds over productivity of land.

Authors have been working on greening experiment for Licorice (*Glycyrrhiza uralensis* Fisch.) to establish countermeasures for combating desertification. We developed Greening Soil Material. It can be controlled moisture and nutrient retention capacity in shallow part of ground for growing plants healthily by only mixing local sand and dried animal manure and setting 10 ~ 30 cm depth in targeting ground.

GSM is made of sand and dried animal manure that can be taken around targeting ground. Sand can be taken around habitat of licorice and other vegetation. Dried animal manure is from domestic animals. It is ordinary kept for fuel in nomad's house, however there is excessive portion which is discarded. GSM can utilize the excessive portion of dried animal manure as high water and nutrient retentive material. Therefore, it can be eco-material which can achieve low-cost and environmentally-friendly method.

A targeting plant, licorice, is one of the most valuable medicinal plants growing naturally in arid region, such as Mongolia and China. However, its distribution area is decreasing and productive resource had reduced to 1/7 for about 30 years due to above-mentioned human factor and climate change. Therefore, planting licorice by using GSM could be sustainable and high value-added greening which can be accomplished greening with cultivation.

In this paper, for clarifying key geo-environmental, setting and time factors of survival licorice, principal component analysis, multiple regression analysis and logistic regression analysis on several conditions were conducted. 15 types of experimental conditions such as volume of GSM per root, settings of root (vertical or horizontal), cultivation periods, initial water content, initial dry density, initial pH, initial electric conductivity, Initial calcium carbonate (CaCO_3), and initial water soluble cations (Ca^{2+} , Mg^{2+} , K^+ , Na^+) were used as explanatory variables. Moreover, survival rate was estimated by proposed formula using geo-environmental parameters of future greening area.

Keywords: Soil moisture, Soil saline environment, Statistical analysis, Licorice (*Glycyrrhiza uralensis* Fisch.)

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Development of CO₂ fixation technology by afforestation of fast-growing paulownia trees: An example in Fukushima Prefecture, JAPAN

Kazuki SUGAWARA*¹, Kazuma OMIYA¹, Hiroyuki FUJII¹, Shigeru KATO¹, Seiichi SUZUKI¹

Since the Industrial Revolution, the concentration of carbon dioxide (CO₂) in the Earth's atmosphere has risen rapidly and, has exceeded 400 ppm in recent years. CO₂ is known as a type of greenhouse gas, and because of the large amount of emissions from human industrial activities, it is considered to be a causative agent of large-scale climate change on Earth. For this reason, global efforts are being made to reduce CO₂ emissions. In this study, we conducted a field experiment to verify the amount of CO₂ fixed in biomass by afforestation with fast-growing paulownia and compared CO₂ fixation with the other tree species. The experimental sites were located in Koriyama City, Fukushima Prefecture, Japan and seven-year-old fast-growing paulownia trees were surveyed in three sites (named H, HM, and INA). The survey included tree height, girth at breast height (GBH), and measurement of essential plant elements concentration in the soil underneath the trees. In addition, trees were cut down and biomass weight was measured in the Site H. The average tree height was about 16 m at Site H, HM, and only about 11.4 m at INA. The average GBH was about 70 cm at Site H and HM, and about 56 cm at INA. A positive correlation between phosphorus concentration in soil and annual growth of tree height and GBH was also observed. The reason for the large difference in growth between Site H, HM and INA may be the effect of the location of the field as well as the concentration of elements in the soil. Site H and HM are common farmland, while INA was located on the shore of a lake and may have been affected by different factors such as groundwater levels. The biomass weight of trees at Site H was about 560 kg on average, and the correlation between the biomass weight and tree height and GBH was examined, and it showed a strong correlation with GBH. Based on this relationship, an allometric equation was derived and CO₂ fixation by fast-growing paulownia trees was estimated to be 46.8 t-CO₂/ha/year, which is much higher than that of afforestation species such as Japanese cedar and eucalyptus.

Keywords:

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Electrochemical degradation mechanism of trichloroethylene in grass beads mock soil

Kazuki ITO¹, Kazuki SUGAWARA¹, Seiichi SUZUKI^{*1}, Takuya ITO¹, Shigeru KATO¹, Toshinori KOJIMA²

Electrochemical degradation of trichloroethylene (TCE) in grass beads mock soil was investigated. Various organochlorine compounds have been used in metal parts rinse and dry cleaning, for their characteristics as solvent and chemical stability. With careless handling, these chemicals caused contamination of soil and underground water, in Japan, United States and other countries. As the toxicity to central nerve system and carcinogenicity of TCE was recognized, remediation of TCE contamination became an urgent issue. However, technologies, such as removal of soil or aeration in deep ground water need large amount of expenditure. To cope with the TCE contamination issue, we explored quick and cost-efficient technique of in situ TCE degradation in soil. We studied the electrochemical TCE degradation assisted by Fe ion catalysis in Fenton reaction. Electrochemical degradation mechanism of TCE is not well known. In this study, TCE solution was contained in a semi sealed vessel with 1 mm ϕ grass beads to avoid evaporation. Directive current (DC) voltage of 10 V was applied with iron electrodes, placed 8.6 cm apart. Reaction vessel was kept at 15 °C during voltage application by immersing in water. As the DC voltage applied, Fe ion was dissolved into the solution from positive and negative electrodes, and moved to the other electrode by electrophoresis. These ion species are expected to promote TCE degradation. Remaining TCE concentration after reaction was measured by GC-ECD. TCE concentration was decreased by 2-10 % around the surface of the electrodes in 120 min. TC, TOC, IC were also measured after 120 min. Chloride ion concentration was measured by liquid chromatography. Almost all the reacted organic carbon was converted to carbon dioxide, and little intermediate product was observed in GC-MS analysis. These results suggest the possibility of TCE degradation with low cost ion electrode by application of DC voltage to the soil.

Keywords:

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The tendency of plant species identified in the Djibouti Republic of East Africa registered in the global biodiversity database

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In the Republic of Djibouti in east Africa, desert greening and animal feed production are needed. It is crucial to select appropriate plant species for both activities. The flora of Djibouti does not serve information on the frequency of occurrence, and the actual abundance of plant species is not clear. Therefore, it is important to get information on the abundant plant found in Djibouti. The Global Biodiversity Information Facility (GBIF) database has been developed in order to assess global biodiversity as a web-based resource. The database records the occurrence of organisms all over the world by integrating specimens and discovery information. By using this database, we tried to grasp the vascular plant species, frequently found in Djibouti. The purpose of this study is to provide basic data of the plant species in Djibouti especially on frequency in occurrence of vascular plants, by using the GBIF database, for understandings of the potential in greening and grazing.

As a result of searching the GBIF database, the total number of vascular plants registered was found to be 6982, and the total number of plant species was 561 (GBIF.org 2021). In the literature, the number of vascular plants was 783 in Djibouti (Audru & Lebrun 1994). Thus, 71.6% of the species are registered in the GBIF database. The most frequent registered family was discovered to be Fabaceae (19.2%), followed by Poaceae (10.9%), Asteraceae (8.0%), Solanaceae (4.8%) Malvaceae (4.4%) and Euphorbiaceae (4.4%). The most frequent registered species was discovered to be *Vachellia (Acacia) tortilis* (3.8%), after that *Solanum somalense* (2.2%) and *Rhigozum somalense* (2.1%). *Vachellia* spp. accounted for 5 out of the top 10 species. It was considered that the Fabaceae can grow on infertile soil by nitrogen fixation. Poaceae and Asteraceae are most evolved taxa and they considered to have been adapted to arid lands. Rank-frequency relationship (log–log scale) were significantly on a line ($P < 0.001$), following to the Zipf's law.

GBIF.org (4 March 2021) GBIF Occurrence Download <https://doi.org/10.15468/dl.kb4tw9>

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Beyond Tsunami disaster: Ten years' activities to use uncultured field for biomass production of willow after the Great East Japan Earthquake in Miyagi, Japan

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The tsunami associated with the Great East Japan Earthquake on March 11, 2011 caused devastating damage to the Pacific coast of eastern Japan. Especially in Miyagi prefecture, the damage to the agricultural land reached about 15,000 ha. The authors have continued to respond to the earthquake for 10 years through the effective use of the disaster-stricken areas caused by the tsunami. In this report, we would like to introduce the activities comprehensively.

1. Activities by Commission of Agricultural Development for Arid Lands (CADAL), The Japanese Association for Arid Land Studies (JAALS)

Based on the activities of the members, CADAL held a lunch-on meeting at the annual conference and several symposiums with the field tour in Miyagi Prefecture, Japan in 2012-2016. At the lunch-on meeting, we were able to discuss how to utilize in the disaster area the knowledge gained by JAALS. Exchanging information with local stakeholders and farmers regarding the improvement of salt damage and the utilization of soil with low fertility was conducted in the symposiums. Such activities could provide reconstruction support to local people.

2. Willow growth test of fast-growing willow plantation

As part of the extensive effective utilization of the tsunami-stricken farm lands, we conducted a cultivation test using fast-growing willow (*Salix* spp.) and attempted biomass production. The cultivation trials were conducted in two fields in Watari Town, Miyagi Prefecture, Japan in 2014-2020. Yields cultivated in 2 fields for 3-4 cultivation years amounted as 5.0 to 19.1 and 9.0 to 10.7 t · ha⁻¹ · y⁻¹, respectively. As 10 t · ha⁻¹ · y⁻¹ is regarded as a commercial criteria for biomass production, woody biomass more than the criteria can be collected even in sandy low fertility soil, depending on the appropriated strain selection and cultivation techniques such as mulching.

On the contrary, we would like to utilize the knowledge obtained in the trials to further desertification prevention activities.

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Basic study on the mechanism of 1,4-dioxane phytoremediation by willows. - Comparison of three willow species

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Soil and water contamination with volatile organic compounds (VOCs) is one of global environmental problems not only in Japan but also in developing countries, many of which are located in semi-arid area. 1,4-Dioxane, one of the VOCs, is suspected as carcinogens and growing issue in difficult to remove from contaminated sites. Treatment of 1,4-dioxane by UV and ozone is at present an excellent technology; however, the treatment cost is still quite high. Phytoremediation of 1,4-dioxane is expected to be an inexpensive and effective method on widely sites in low concentration water containing of 1,4-dioxane. The objective of the study is to clarify contribution ratio of function concerning phytoremediation of three species of willow on 1,4-dioxane. This investigation studied phytoremediation of 1,4-dioxane removal efficiency and mechanism of willow, with three species of willow (*Salix pet-susu* (KKD), *S. pseudolinearis* (FXM), *S. sachalinensis* (SEN)).

Experimental Design and Method

In an experimental system using polypropylene 2 L bottles, three species of willow (KKD, FXM, SEN) were grown in Hoagland hydroponic solution contaminating 1,4-dioxane for 15 days, 3 cycles of 5 days per cycle. Two species of SEN and FXM were cultivated in summer 2021 and autumn 2020, KKD were in summer 2021. Six plants of each cultivar were grown separately in triplicate, with and without ¹³C labeling of 1,4-dioxane. Hydroponic solution was prepared to be 2 mg L⁻¹ of 1,4-dioxane, was exchanged every cycle, and the hydroponic solution was sampled before and after the exchange. Once per cycle, 1,4-dioxane volatilized by transpiration was adsorbed on activated carbon. The concentration of 1,4-dioxane in the hydroponic solution, the activated carbon eluate, and the plants was determined by headspace GC/MS, and the ¹³C content of the plants was determined by isotope ratio mass spectrometry.

Result and Discussion

The result in autumn season, the removal rate of 1,4-dioxane in 5 days was $12.2 \pm 8.0\%$ for FXM and $14.0 \pm 1.5\%$ for SEN. The functions that contributed to the removal by FXM were, in order, transpiration (52.5%), assimilation (20.4%), and accumulation (1.0%), and unknown (26.1%). Compared with the contribution of assimilation plus accumulation by poplar (6%) in the previous study, the contribution of FXM in this experiment was 3.4 times higher, suggesting the high assimilation capacity of 1,4-dioxane in willow. On the other hand, the contribution of FXM to assimilation may have been relatively higher due to the decrease from transpiration in autumn season. Further the results of KKD will be reported in the conference.

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Solvent polarity control in direct liquefaction of eucalyptus wood

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In 2015, with the conclusion of the Paris Agreement, the world has begun to move toward the achievement of the IPCC RCP2.6 Scenario. One of the keys is the large-scale deployment of afforestation. The afforestation tree absorbs CO₂ as it grows. The carbon is stocked on the ground if arid land without vegetation becomes forest and the equivalent amount of CO₂ in the atmosphere decreases. However, the mature forest absorbs very little CO₂. Therefore, it is necessary to harvest the tree regularly and to use it effectively for CO₂ reduction such as the alternatives to fossil fuel. By reducing the amount of fossil fuel used, CO₂ emission into the atmosphere is reduced. The authors considered the arid land of Australia is expected to be afforested with eucalyptus. Since woody biomass is a non-uniform solid, it has poor handleability, and since it contains oxygen in its structure, it has a low calorific value. However, by liquefying woody biomass, handleability and calorific value are improved. The liquefaction method is roughly divided into direct liquefaction and indirect liquefaction, but the authors focused on the direct liquefaction under mild reaction conditions. In the process of direct liquefaction, some solvent is required to transport the solid sample and to transfer heat uniformly to it. The previous study reported that the use of an alkaline aqueous solution as a solvent increases liquefaction rate. The liquefied oil is assumed to be used as a diesel oil mixed fuel, but the problem is that the liquefied oil and diesel oil phase separate due to the high polarity of the liquefied oil. On the other hand, another previous study reported that by the use of diesel oil as a solvent, the homogeneous liquefied oil can be obtained. However, the problems are the residue yield is high and the liquefied oil, low. Therefore, to obtain a low polarity liquefied oil with high yield, the authors used a diesel oil solvent added with alkaline aqueous solution. The present result showed that the higher yield of liquefied oil was obtained with alkaline aqueous solution mixed with diesel oil as a solvent than that without it. Furthermore, the liquefied oil separated from aqueous phase was found to form a single phase with more yield than the diesel oil used as the solvent.

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Utilization of hydrogel as an alternative water holding amendments on survival and growth of *E. equisetina* plant seedlings

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Soil conditions of arid and semi-arid land with sufficient irrigation supply have a great potential for obtaining high yields of agricultural crops, but the constant lack of moisture constrains the increase in their production. Agriculture sector in Uzbekistan at present facing the frequent water shortages and limited soil moisture evaporated from the upper horizons under the influence of solar radiation. To achieve stable production and crop diversification, prevent soil moisture losses is necessary. Thus, we proposed an application of the absorbent polymers hydrogel to ensure effective preserving productive moisture in the soil. The method was investigated in the Advanced Plant Factory of Tokyo University of Agriculture and Technology for comparing the process of preserving soil moisture in the upper root layer of the sandy soil.

The results of our study indicate that application polymer hydrogel influenced positively on germination rate of *E. equisetina* plants seeds and have been efficient for prolonging the survival rate of *E. equisetina* plant seedling subjected to drought. It was revealed that *E. equisetina* plants growth in the hydrogel treatment in the first year of the experiments contributed to the growth of stem height almost same as in control. In subsequent year, the increase in stem height was not so significant in the hydrogel treatment. Despite that our results showed that the *E. equisetina* plant survival rate achieved by application of hydrogel in light (sandy) soils without irrigation. Most importantly, our results indicate the highest ability of hydrogel to release retained water for obtaining best water use efficiency under controlled condition.

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Profiling of the phenolic compounds from *Aloe djiboutiensis* in Djibouti

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Abstract

Aloe plants have been used since ancient times as medicinal plants. For example, the inner leaf gel part can help soothe the pain of burned skin, and leaf extracts also have a property as laxatives. However, these properties are not indicated in all Aloe species; it has been recognized in only a few species (e.g., *Aloe vera*). For this reason, aloe plants, which has medicinal properties, can be significantly useful plants with high cashability. In recent years, a new aloe species, *Aloe djiboutiensis*, was recorded in Djibouti, East Africa. This aloe species is used as a medicinal plant in Djibouti. However, since it has not been examined fully what kind of chemical components are contained, the aloe's health benefits remain unclear. To evaluate the usability of the aloe plants in Djibouti, further studies focused on phenolic components and their related anthraquinone is needed. In this study, phenolic compounds in *A. d.* were determined by using LC-MS systems, for the first. Next, it was examined the antioxidant activity of the aloe extracts.

Seedlings (6 to 8 cm height; $n = 5$) of *A. d.* cultivated in a greenhouse were used for this study. The phenolic components in *A. d.* were extracted by methanol with sonification. Screening of phenolic compounds in the extracts of *A. d.* was conducted by using LC-MS systems. The compounds of the extracts were identified by comparing their mass spectrum data with published literature values and comparing their HPLC retention times to those of standard. To evaluate the antioxidant activity of the extracts, DPPH radical scavenging activity was tested and compared to those of the extracts from medicinal Aloe.

As a result of LC-MS analysis, seven peaks were detected in the extracts of *A. d.*. Among them, it was indicated that *A. d.* contained aloin A (m/z 417; $[M-H]^-$), aloin B (m/z 417; $[M-H]^-$), and isoaloesin D (m/z 555; $[M-H]^-$) as medicinal ingredients. The present results supported the previous report, which surveyed *A. d.* collected at an altitude of 1500 m mountains in Djibouti. Antioxidant activity was recognized in the extracts obtained from *A. d.*, but the levels were not remarkable compared to reference materials. However, containing some medicinal ingredients in cultivated *A. d.* would be attractive points for cultivation and marketing in the future.

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Preliminary study on improvement of soil water retention characteristics by Spirulina.

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Spirulina is a planctonic blue-green alga classified as cyanobacteria, which inhabits strongly alkaline water bodies in the tropics and subtropics. Further, the microalgae including the spirulina secrete Extracellular Polymeric Substances (EPS). Since the improvement of the soil water retention characteristics is necessary for desert greening and prevention of desertification in arid and semi-arid areas, the current study aims to study the effect of application of the spirulina and the spirulina-derived EPS on the improvement of water retention characteristics of soils.

Three different types of soil were used. One is Toyoura sand, and the others are collected from Kourimale and Ali-fareen, Djibouti. The texture of those soils were Sand, Silty Loam, and Sandy Loam, respectively. For those soils, 0.5 and 1.0 % by mass of the spirulina powder and 1.0 % by mass of the EPS powder were treated respectively. A significant increase in the readily available water content for crop growth was observed under both the spirulina and the EPS treatments for the Toyoura sand. Although further research is required, it is suggested that the effect of the application of the spirulina and EPS on the soil water retention depends on the texture.

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Farmers' preferences of the agricultural inputs for rice farming in Senegal River Basin, Mauritania: A best-worst scaling approach

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In Mauritania, consumption of rice, which is a staple food, is increasing rapidly, because rice takes less time to cook than other cereals such as millet, sorghum, and maize. To meet this growing demand, Mauritanian food policy encourages rice imports. However, the 2008 food crisis led to rice shortage, owing to a steep rise in the price of imported rice. To ensure overall food security, the government has adopted certain agricultural policies and projects to bolster rice production in the Senegal River Basin. Under these circumstances, numerous previous studies suggested solutions for improving productivity and efficient farm management. Whereas, these studies were led by the field observation to grasp current farm condition and the questionnaire survey for understanding the actual amount of inputs (e.g. fertilizer and pesticide) and harvest, the preferences and perceptions of local farmers regarding rice farming have been neglected. In order to achieve the sustainable agricultural development, cooperation of local farmers is indispensable. Therefore, farmers' perceptions should be taken into consideration of agricultural policy making.

In this study, we attempted to evaluate the farmers' preferences of the agricultural inputs for rice farming quantitatively in Mauritania. Furthermore, we clustered farmers with similar preferences and tried to discuss the heterogeneity of preferences based on the characteristics of each group.

In order to evaluate these farmers' preferences, a best-worst scaling (BWS) method was applied with 29 farmers on March, 2018. BWS is a method to evaluate preferences by choosing "most important attribute" and "least important attribute" one by one. In this survey, six attributes which are seed fertilizer, pesticide, irrigation, labor and machinery were assumed. Moreover, based on these results, farmers who have the similar preferences was grouped by a cluster analysis.

As the results, while most farmers value seeds and irrigation in rice production, pesticide and labor tend to be neglected. In addition, based on a cluster analysis, farmers were grouped into three groups: (1) group that emphasizes irrigation, (2) group that places the highest priority on agricultural machinery, and (3) group that prefers seeds.

On the other hand, as a characteristic of each group, Group 1 includes many farmers engaged in rice production on paddy field equipped with irrigation facilities, and it can be seen that they understand the importance of irrigation. In group 2, farmers have relatively large-scale paddy field. In order to improve the efficiency, agricultural machineries are emphasized.

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Effects of plastic mulching on productivity and profitability of cotton (*Gossypium hirsutum*) in Uzbekistan

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Uzbekistan has about 4.65 million ha of cultivated area which was considered to be only 18 % of total cultivable area because of irrigation shortage (Saidazimova, 2009). Out of the area, cotton plantation is about 1.45 million ha (Djanibekov et. al., 2010). Hence, developing water-saving cotton production technology is one of the urgent issues in Uzbekistan. One of main reasons of water shortage is improper water use by farmers. Mulch is defined as a coating material spread over the soil surface (Kasirajan & Ngouajio, 2012), and it helps to improve crop growth and yield as well as optimises water use efficiency (Yu, et al. 2018). However, its effect on cotton production has not been studied very well in Uzbekistan. The objective of this study was to quantitatively evaluate the effects of plastic mulching on yield and water productivity in cotton in Uzbekistan.

Field experiment was conducted in typical gray soil of Tashkent Province, Uzbekistan. Plastic mulching treatment (MT) and without plastic mulch treatment (control, CT) were tested in three replications in paired comparison design. In MT, polyethylene film was mulched on the brooklets before the first irrigation. The amount of water input by flush irrigation was measured with Thompson instrument. It was placed in the beginning (brutto) and at the end (netto) of every plots.

The average water input was significantly smaller in MT (591 m³/ha) than in CT (1035 m³/ha). Cotton yield in MT (3.53 t/ha) was significantly larger than in CT (2.7 t/ha). Consequently, the water productivity (yield/water input) in MT (5.99 kg/m³) was significantly larger than in CT (2.60 kg/m³). Expenses for purchase, setting and removal of plastic mulching are 58.2 USD/ha. The extra harvest in MT is 0.83 t/ha or 664 USD/ha. Thus, the overall net profit is 605.8 USD/ha. Mulching soil surface with black polyethylene film in crop cultivation had a benefit to save more water in irrigation and to increase yield. Disadvantages of plastic mulching, such as limitations, difficulties, and environmental impacts are aimed to study in further research.

Keywords: soil moisture, plastic mulching, water productivity, yield, netto, brutto, water input

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Circular halophytes mixed farming (CHMF) to improve food security in salt-affected irrigated arid and semi-arid ecosystems

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The overall premise of this study is that halophytic plants (broadly defined to highly include salt-loving wild species and salt -tolerant crops) can be cultivated to maintain agricultural productivity with food and fodder production potential of saline lands. The technologies and business models for the sustainable saline agriculture on the marginal saline lands are developed based on the concept of *Circular Halophytes Mixed Farming* (CHMF). CHMF focuses on the development and application of a soil-water-plant salinity dynamics model to the stimulation of the cultivation and management options over multiple growing seasons. The scheme is supposed to evaluate the potential for halophytic plants to improve the long-term food security. A dynamic economic analysis of the scheme and its implications would become an important socio-economic factor and governmental policies in the regions where cultural, and political constraints are also discussed. Field demonstrations for the alternative land use options with CHMF concept is being performed in the Shortanbay, the lower stream of Amudarya River Basin. Since halophytes are the plants capable to live in saline environments, the natural/intentional existence of this plant species can reduce the salts present in the root zone. The plants are capable to cope with the problems of salinity in various ways; some of them avoid salinity by completing their growth cycle when salinity is low (rainy periods), some can resist against salinity, and a few are tolerative against salinity. The later species can accumulate salts in their cells and/or secrete the substances through their inherent organs/salt glands/trichomes and are thus useful for reversing salinization. The idea of CHMF implies that the intentional continuous cultivation and later recovery (and/or management) of the above ground plant tissues with high salinity could reverse the salinization levels and eventually reclaim the lands with minimum salinity towards a new/remediated agricultural use. The physiological/ecological information how halophytes adapt to the saline soils is also of great interest for breeding new cultivars which can tolerate higher levels of salinity.

CCHF is expected to facilitate farms in the regions to replicate the practices which, in a long run. This also may yield increased supply of quality agricultural products for domestic market. A new strategy about scheduling irrigation and integrate surface/groundwater resources may be created based on the water and salt dynamics models. These approach and concept for the sustainable resource utilization are guided by the principle of efficiency: making an effective use of marginal land while the resources saved can be more profitably concentrated on the productive croplands.

Keywords: circular halophytic farming, toxic salts removal, value chain, ecosystem services, Amudarya Delta

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Cultivation of quinoa to improve food security in arid climate and salinization of the Southern Aral Sea region

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Provision of food to the population, using non-traditional crops resistant to drought and low water (African millet, Sinapis, Camelina, Quinoa). It is planned to use these crops in unsuitable for use traditional cultures in a number of areas.

Quinoa (*Chenopodium quinoa willd*) - as a multipurpose agro-industrial crop that can grow well in extreme soil and climatic conditions, is of great interest for ensuring the food security of the Southern Aral Sea region. Since, in terms of its composition, quinoa grain can be used as a food, medicinal plant. The seeds, stems and leaves of quinoa can be used not only for human consumption, but also as feed for livestock and birds.

The use of various components of quinoa, such as oil, starch, saponin and dyes, is under study, which could become raw materials for the chemical, cosmetic and pharmaceutical industries. Possessing a powerful root system, the plants contribute to the preservation of the sandy soils of the region and increase their fertility. At the same time, according to studies carried out in other regions of the world, the most resistant quinoa varieties are able to withstand high levels of soil salinity, are heat and drought tolerant. Moisture consumption and transpiration coefficient are 2.2-2.7 times lower compared to traditional crops such as wheat, rice and cotton.

In solving the problem of diversification non-traditional culture of quinoa on different degrees soil salinity in conditions of low availability of irrigation water for agricultural lands of the Republic of Karakalpakstan, research on the study biology and technology growing five varieties of quinoa has been carried out in the region since 2015. Data were obtained on the growth and development of plants at different sowing periods, testing of various rates of mineral fertilizers, and rates of sowing seeds.

The preference for early spring sowing dates has been established, in which plants, before the onset of hot weather, form sufficient biomass to form an optimal grain yield. An inverse correlation was determined between late sowing (mid-April-mid-May) and the accumulation of biomass and plant productivity, which depended on the high temperature of June. In recent years, there has been an increase from long-term normal temperatures by + 6-8 ° C. Such deviations are especially unfavorable at late sowing dates. In the conditions of the South Aral Sea region, quinoa plants were reviewed for high rates of mineral fertilizers in combination with irrigation.

Keywords: food security, quinoa, varieties, climate aridity, soil salinization

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Seasonal variations and obstacles of cocoon production in Tashkent region, Uzbekistan

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Uzbekistan's sericulture tradition dates back to ancient times and is of national proud. Despite considerable production of fresh cocoons at 25,000 t/year or sharing 80% in Central Asia until 2012, the sector is now struggling to reach its previous volumes. Being one of the main income sources in rural areas, family sericulture program has not yet contributed to poverty reduction due to outdated technique of cocoon rearing. Considering those statements, we conducted a study based on a questionnaire survey to identify the obstructing factors of cocoon production in Tashkent region. Major sericulture activities are practiced in spring; however, the autumn sericulture has also recently been launched on a regular basis. Therefore, we compared both sericulture seasons with a focus on sericulture farmers whose livelihoods largely depend on sericulture. We surveyed 107 sericulture farmers in total, practiced with 70% sericulture alone followed by 14% horticulture. They were presumably selected based on rearing seasons and taking care practice of mulberry plantations.

Surveyed farmers had 29 % agriculture background while 59% being temporary workers engaged in seasonal sericulture, having 51 % income from sericulture followed by horticulture (27%) and subsidies (22%). Mulberry land areas of 1, 2, 3 ha and other (<1 ha) used by spring and spring+autumn farmers were 44%, 32%, 4%, and 19%, respectively. 86% of land occupied by mulberry, while 25% intended to cropping purposes, of them 77% rented from government for mulberry. Interesting case was seen at sericulture experiences where spring farmers were greater in number (28%) of 1-3 years of experience while spring+autumn group with 39% over 10 years of experience. Therefore, number of silkworms raised by spring farmers at 65% case consisted of 1 box followed by 35% of 2 boxes, where spring+autumn farmers instead of one, grown two and three boxes at 71% and 29%, respectively ($p = <0.01$). Similarly, both sericulture farmers found main obstacles as climate related at 60-62% case, followed by diseases at 20-24%, relatively ($p = <0.01$). These struggling factors could not be prevented due to traditionally home-based sericulture ($p = >0.05$), occupying both living rooms (43-44%) and cow sheds (30-38%). Therefore, particular efforts are required to maintain the day/night temperature, and humidity in cowshed or living rooms used as rearing places; keeping the mulberry leaves freshness in autumn while washing out the dirty leaves in autumn before feeding the silkworms which were even more effortful and time-consuming.

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Development of technology for the evaluation and cultivation of medicinal plant Ravoch (*Rheum L*) growing in Karakalpakstan

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Medicinal plants are valuable sources of herbal products, and they are disappearing at a high speed. The higher market demand and the shortage of wild resources enforce us to carry out cultivation practices. Researchers have recently placed high hopes on the artificial cultivation methods for medicinal plant production, which can solve the problems for conservation of medicinal plants from wild collection.

The study was carried out in the arid and semiarid land where increase in commercial demands for medicinal plant naturally growing Western Uzbekistan. This study evaluated *Rheum tataricum L.* medicinal plant with different production methods including cultivation with seed and root propagation, and wild collection to guide medicine plant production for sustainable utilization of plant resources. As a result of surveys, the 10 samples of the *Rheum tataricum L.* medicinal plant wild species were collected at 4 different locations of the Usturt Plateau. Cultivation experiment was conducted on the basis of randomized complete block design with three replications at experimental field of the Nukus Agriculture Institute. Seed germination and morphological traits of cultivation experiments were determined at the vegetative stage. Results indicated that using phytohormon and chemical fertilizer significantly improved effective root propagation. However, seed germination had more negative effects than root propagation. In general, it was concluded that integrated treatments for root propagation have more beneficial effects on the vegetative propagation of *Rheum tataricum L.*

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Agrochemistry and microbial activities under halophytes grown under different salt affected soils

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Management of innovative strategies for marginal low-quality soil and plant resources utilization is crucial in the Aral Sea Basin saline environments. This article is focused on the development of technology of cultivation of wild halophytes and non-conventional crops on saline farmlands in the Delta of Amudarya (Aral Sea Basin) and their phytoindicative role in improving the agrochemistry of saline soils properties. Changes in physical and chemical soil properties along an evident salinity gradient were interrelated with botanic diversity and seasonal activities of soil microbial communities under different halophyte ecological groups and non-conventional crops (NCC). A multi-step approach was used to mobilize appropriate halophytic plant resources in pure stands or in mixed plantations to support salt affected lands restoration and to improve crops-livestock-feeding farming and to secure income for rural communities. Experiments were conducted in the Muynak region (43°46' N 59°02' E) under different categories of marginal lands, characterized by different soil chemistry and level of salinity in the topsoil profile.

Significant variation in physical and chemical parameters of soils under wild and cultivated crops were revealed. Differences were in the aggregate composition, structure coefficient, number of salts in the soil at slight change in pH value. According to the content of humus and mobile ions (NPK), these soils are characterized as low-income: total nitrogen 0.022-0.042%; total phosphorus 0.076-0.088%; total potassium 0.7%. The humus content ranges from 0.42-0.56%; the level of N-NH₄ is 2.18-3.41 mg / kg of soil; N-NO₃ is 0.26-3.5 mg / kg, P₂O₅ is 1.22-2.30 mg / kg, while there is an essential difference between soils chemistry of different farmlands categories (e.g., abandoned by farmers paddy rice fields, fields margins, wet marches etc.)

The activity and number of soil microorganisms depends on the total impact of biotic and (or) abiotic factors, as well as the degree of anthropogenic pressure on the agricultural lands. There were differences in numbers and diversity of microorganisms of the soils in cultivated farmer lands. Co-existing of various ecological and trophic groups of microorganisms, such as oligonitrophilic, oligocarbophilic, ammonifying, amyolytic, free-living nitrogen-fixing bacteria, as well as active hydrolytics, bacilli, actinomycetes and micromycetes were detected. Availability of appropriate proportion of nutrients in salt affected soils is considered the main limiting factor of microbial communities' diversity and activities. Obviously, this is a reason why oligotrophic microorganisms (oligocarbophilic and oligonitrophilic) dominated in all categories of marginal saline lands, i.e. those microorganisms that are not competing under low soil nutrient compounds (C, N. and P). There is a wide variety of representatives of microorganisms of other ecological and trophic groups. We have also revealed variation in the level of enzymatic activity (ureases and phosphatases), which indicates high metabolic adaptive potential of soil microbial communities and capacity of arid soils to resist negative factors.

Keywords: soil agrochemistry, microbial activities, salinity stress, Aral Sea

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Immediate Effects of Burning Sagebrush Vegetation on Soil Nutrient Dynamics and Fertile Islands in a Cold Desert Ecosystem

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Wildfire is a major disturbance in western U.S rangelands that causes changes to soil nutrients. In cold desert shrublands, microsites form under shrubs where soil biochemical cycles are more active. We aimed to determine the immediate effects of prescribed burning on soil nutrients under big sagebrush (*Artemisia tridentata*) canopies and the interspaces between shrubs. We hypothesized that burning *A. tridentata* vegetation would lead to an immediate increase in total C (TC) and N (TN), bicarbonate phosphorus (HCO_3^- -P), nitrate (NO_3^-), and ammonium (NH_4^+) under shrub canopies. The study was conducted in October and November 2018. The treatments included Control-Interspace (CT-ISP), Control-Undershrub (CT-USB), Burned-Interspace (BRN-ISP) and Burned-Undershrub (BRN-USB). Soil samples were collected at 0-5cm depth before, nine and twenty-three days after burning. In burned treatments, NH_4^+ was significantly higher under the canopies than the interspaces between shrubs nine and twenty-three days after burning. In the unburned treatments, there was no difference in soil pH, NH_4^+ , NO_3^- , TC, and TN between and within the shrub canopies. NO_3^- showed no significant changes after burning. HCO_3^- -P was greater under canopies in the unburned treatments and increased mainly in the canopies nine and twenty-three days after burning. In the burned treatments, TN and TC were greater in the canopies than interspaces nine and twenty-three days after burning. Soil pH increased in the canopies and interspaces nine and twenty-three days after burning. Soil nutrients were greater under shrub canopies compared to the interspaces, therefore highlighting the impact of fire in sustaining island of fertility in sagebrush ecosystem.

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Values of δD and $\delta^{18}O$ and concentrations of 3H and ^{14}C of deep groundwater in Djibouti

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Djibouti is located at the northeast end of the African Continent. Rivers are not formed normally in this country due to the extremely low amount of rainfall (c.a. 150 mm annually) and rain falls irregularly in a short time. Consequently, deep groundwater in the volcanic aquifer has been thought to be the only available resource of fresh water in most of the region of the country. As it is difficult for the habitants to grow crops due to the extremely arid condition, nomads occupy over 30 % of the national population. The nomads are strongly dependent on fresh water from groundwater and some advanced farmers have started to use groundwater for growing cash crops in rural area of this country. Although some research have been conducted to find out the depth, quality and age of groundwater, the data is not still enough to construct a scheme of agricultural development using groundwater in larger area of Djibouti. Then in this study, the purposes are firstly to estimate the original recharged area of deep groundwater of this country, using stable isotope analysis (δD , $\delta^{18}O$), and secondary to calculate the age of groundwater, using radioactive isotope analysis (3H , ^{14}C). We have collected groundwater samples from 16 wells in 4 area (Djibouti City, Arta, Ali-Sabieh, and Dikihil) in 2019. This report shows the results obtained so far. The results on EC indicated higher than 0.8 mScm-1 for all the samples. According to the clustering analysis based on the ionic constructions, the samples collected from 2 areas (Djibouti City and Arta area) were classified into the Na-Cl type and the other two (Ari-Sabieh area and Dikihil area) into the Na-HCO₃ type. The results on δD and $\delta^{18}O$ showed a possibility that there are multiple recharge areas of the groundwater. The concentration of 3H on the 6 samples was very low (under 0.3 T.U.), indicating that the age of the groundwater samples was older than 70 years.

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A study on water distribution management and water-saving potential in a large scale irrigation district -Case study of Beni Amir irrigation district, Morocco

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The frequent droughts in recent years have made agricultural production unstable in Morocco. However, there are few studies on monitoring and assessment of water delivery management on lateral and tertiary canal level in the irrigation districts. Therefore, this study aimed to clarify water distribution in Beni Amir irrigation district, one of the large irrigation districts in Morocco and discuss the water-saving potential through improving water distribution.

Water distribution records of all fields with areas were collected for 4 years from 2016 to 2019. Monthly precipitation data was collected for 48 years from the dam meteorological station. The average monthly meteorological data of Tadla region was referred from the global meteorological database, CLIMWAT. In order to clarify the water distribution in the study district, the amount of irrigation water per unit area, the amount of irrigation water per irrigation, and the frequency of irrigation by lateral canals, tertiary canals, and fields were statistically analyzed focusing on the irrigation periods II (Apr. - Jun.) and III (Jul. - Sep.), during both of which more water is distributed than other periods. Monthly reference evapotranspiration of the study area was calculated by FAO-Penman Monteith method, and the balance of water supply and demand of the study area was analyzed. Finally, the water-saving potential was discussed by improving water distribution management.

The results showed that large variations in amount of water allocation among lateral canals were observed in drought years while it was small in normal years. However, this does not mean that the upstream in the study area took more water. It might be due to the differences in the proportion of area of priority crops among the canals. In addition, even in wet years, enough amount of water has not been supplied to meet the demand and this situation has not changed significantly over the past decade. Regarding the analysis on water-saving potential, 4.4 - 6.6 Mm³ of water could be saved by shortening the irrigation time unit from 1 hour to 30 or 15 minutes. This enhanced water distribution practice also contributes to improve the more equitable water distribution. Even if it is difficult to shorten the time unit for irrigation, water for distribution management could be saved by making the field area an integral multiple of 1.2 ha through merging and readjustment of fields.

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Water saving with permanent skip furrow irrigation under Cut-soiler drainage condition

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Irrigation is essential for agricultural production in drylands, but improper water management such as over-irrigation and poor drainage has caused salinization. In India, although border irrigation (BI) is widely adapted, the high salinity of irrigation water and tendency of over-irrigation have promoted salinization, the area of salt affected soils extend to approximately 6.7 million ha. Water saving and improved drainage are effective in mitigating salinization. Still, it is difficult for farmers to introduce drip and/or sub-surface drainage because these require high initial and maintenance costs. Therefore, it is necessary to introduce low-cost measures that farmers could easily implement.

Permanent skip furrow irrigation (PSFI) is an easy and low-cost water saving method which can save water by irrigating every alternate furrow instead of all furrows, and the irrigated furrow is fixed. Cut-soiler is a low-cost shallow sub-surface drainage technology which can make drain hole at 50 cm depth for burying the crop residue by pulling the tractor attachment. In this study, we evaluated the how much is saved by PSFI under drainage conditions implemented with the cut-soiler.

A Field experiment was conducted using mustard (October to April) during the dry season in 2019 and 2020. Test plots (30 m square) were set up without drainage and 2.5, 5.0, 7.5, 10.0 m construction interval of Cut-soiler. In each plot, BI, every furrow irrigation (EFI) and PSFI was applied with 10 m width respectively, and yield of mustard was measured. Totally applied depth of EFI and PSFI were approximately 90 % and 45 % of BI, respectively.

The results showed that the yield was highest in the plot with Cut-soiler at 2.5 m interval, 5 and 19 % increases compared with no construction in 2019 and 2020, respectively. In terms of irrigation method, the yield in EFI and PSFI decreased by 7% and 23%, respectively, in 2019 as compared to BI. On the other hand, the yield increased by 46% in EFI and 4% in PSFI as compared to BI in 2020. Although PSFI saved around 50%, there is a possible risk of reduction in yield. Therefore, applying PSFI, supplementary irrigation should be conducted according to the growth condition.

Keywords: Salinization, Drylands, Water-saving, Skip furrow irrigation, Cut-soiler

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Assessment of water delivery performance in charge of farmers responses to sufficiently and timeously of adequacy; A case study in the North Nile Delta

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Different water delivery performance indicators have been developed and widely used in irrigation districts over the world. Those indicators help users detect what the current water distribution problems are and where they are occurring. However, since these indicators are calculated only with water quantity, the relationship between them and farmers' satisfaction with irrigation and yield is unclear, and few studies have addressed this issue. Therefore, this study attempts to examine the correlation between relative water supply (RWS) and farmers' satisfaction with irrigation and yield in an irrigation district of the lower Nile Delta in Egypt. Structured and semi-structured questionnaires were used to interview 84 randomly selected farmers from upstream, midstream, and downstream of the branch canal. On the other hand, field data of adequacy, night irrigation, and yield were collected to understand to what extent adequacy of water supply can perform the irrigation system and farmers' irrigation practices. The results showed a strong relationship between calculated adequacy and farmer's satisfactory level to spatiotemporal distributions of water delivery. The insights into the analysis showed that when adequacy was poor, some farmers were satisfied and vice versa. Further, a strong relation between calculated adequacy and yield was observed. With poor adequacy, farmers can yield 9.2 t ha⁻¹, which around the optimal yield. As a result, farmer's satisfactory levels with yield were higher than their satisfactory level of water delivery. This was mainly due to the difficulties to allocate water in a proper time and amount, where around 25% of water supplied was pumped at night with its associated issues such as fear, darkness, and labor. Consequently, weak relation between calculated adequacy and night irrigation was observed. The study questioning whether poor adequacy could express the performance of the irrigation system or not. Eventually, to estimate farmers' satisfaction from the RWS of the irrigation district, the time of irrigation must also be taken into account.

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Estimating irrigation water amounts for tomato cultivation using observed meteorological data in Djibouti

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Irrigation is essential for crop cultivation in dry and semi-arid areas with limited rainfall and water resources. Efficient and effective use of water resources is required but saving irrigation water is important. The study area is in Ali Faren farm located in west of Djibouti which lies in the Horn of Africa. Djibouti is a very dry region with annual rainfall of about 150 mm and an average annual temperature of 28.6 °C. Due to such meteorological conditions, water resources depend mostly on groundwater, and this makes water extremely scarce. Therefore, water saving in the agricultural field is indispensable.

This study aims at effective and efficient use of irrigation water in Djibouti. The appropriate irrigation water for tomato cultivation were estimated using CROPWAT provided by FAO and observed meteorological data at Ali Faren farm in Djibouti. The observed meteorological data include air temperature, relative humidity, wind speed and sunshine hour. The conditions required for calculating the amount of irrigation water were medium loam soil texture based on the laboratory results of soil particle size test, and the tomato cultivation period from October to March according to the local farmers.

The result showed that the average monthly reference evapotranspiration was 5.7 mm / day annually. Reference Evapotranspiration was maximum in July with 7.9 mm / day and minimum in December with 3.9 mm / day. It was observed that the effective rainfall from October to March was 55.2 mm which corresponds to the local tomato cultivation period. Additionally, the required water amount for tomato crops varied between 2.9 to 4.2 mm / day.

Finally, the appropriate irrigation area of this farm will be determined based on the measured amount of groundwater discharge at an existing well and the estimated irrigation water amount.

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An analytical study on enhancing water preservation utilizing the capillary barrier system in drylands for cultivation

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Recently, global warming and desertification have become critical environmental problems. The authors have been working in the dryland of Mongolia to develop technologies of efficient irrigation and greening systems by planting local medicinal plants with local materials and biomass. Field studies in the targeted areas have shown that rainfall and irrigation water is not retained in the soil and percolates downwards, resulting in insufficient moisture for plant growth.

This research aims at developing a water retention technology utilizing the capillary barrier concept for irrigated ground in drylands using local geo-materials. To optimize the system, clarifying the ground conditions including the layers' thicknesses ratio (fine/coarse), grain size distributions, and watering method to maximize the water retention efficiency through experimental and numerical approaches is considered.

In the experiment and numerical analysis, the water retention efficiency of the capillary barrier system was evaluated based on the volumetric water content distribution to reflect the water availability. Various thickness ratios of double-layered soil profiles comprised of sandy soil in the upper layer (fine layer) and soil with a relatively larger grain size in the lower layer (coarse layer) were adopted. The variations and redistribution of the volumetric water content with time through the ground was measured, while a predetermined amount of water was supplied from the top at specific intervals. The main findings are delineated as follows:

- ① The experimental testing of the capillary barrier with drip irrigation revealed that the volumetric water content at depth of 200 mm exceeded the target value of at least 0.1 on the third day of the experiment when watering twice a week with 1000 mL per irrigation is carried out.
- ② From the numerical analysis, supplying water twice a week was enough to maintain the volumetric water content within a depth of 200 mm higher than the targeted value of 0.1. Consequently, maintaining these conditions of the assumed drylands is expected to ensure that plants can grow and survive.
- ③ Based on the numerical analysis, to maintain at least a volumetric water content of 0.1 extending up to 200 mm depth with supplying 1000 mL water twice a week, an optimum configuration with an effective grain size ratio $R_{D10} = 5.2$, mean grain size ratio $R_{D50} = 3.9$, and a thickness ratio $X/L = 0.1$ of coarse and fine layers utilizing the adopted sandy soil materials was confirmed.

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Effect of shallow subsurface drainage constructed by Cut-soiler on mitigation of soil salinization

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The “Cut-soiler” is a low-cost and easy to adopt technology developed in Japan for improving poor drainage condition in farmland. It is attached to a tractor and is used to make shallow subsurface drainage into the soil with depths of 40-60 cm by filling with crop residues. Construction of the drainage by Cut-soiler may contribute in mitigating soil salinization through physical destruction of soil structure and improvement of drainage efficiency in farmland. The purpose of this study is to clarify the effect of the subsurface drainage constructed using Cut-soiler on mitigation of soil salinization in India. We investigated the crop yield after the construction and monitored the fluctuation of soil water and soil solutes using the dielectric moisture/salinity sensors in salt affected farmlands.

This study was conducted in experimental fields located in Hariyana State of India. We set four Cut-soiler treatments installed at 60 cm soil depth at intervals of 2.5, 5.0, 7.5 and 10 m for the subsurface drainage and one treatment without construction, with three replicates for each treatment. The Cut-soiler was operated in June 2018. Monitoring was conducted using GS3 Greenhouse Sensor (METER Inc.), a dielectric moisture/salinity sensor with digital data logger (Em50, METER Group, Inc.), in plots with subsurface drainage at 2.5 m and 7.5 m intervals and in plot without subsurface drainage. The experimental field was cultivated with pearl millet during the rainy season (July-October) and mustard during the dry season (October-April) from 2018 to 2020.

The yield of pearl millet was highest in non Cut-soiler treatment immediately after the construction but the yield for the following year under construction was higher than under non-implementation, and the highest yield was obtained under 2.5 m interval. There was no increase in the yield of mustard due to poor germination rate but the highest yield was obtained under 2.5 m interval among all treatments. Monitoring by the sensor during pearl millet cultivation showed that electrical conductivity of soil pore-water (EC_p) in 2.5 m and 7.5 m intervals was lower than in non Cut-soiler treatment. In addition, the monitoring during mustard cultivation showed that increased EC_p eventually dropped after rainfall and irrigation only in 2.5 m and 7.5 m intervals.

Therefore, the subsurface drainage constructed by Cut-soiler can contribute to decrease soil salinity level and increase crop yield in salt affected farmlands.

Keywords: Salinization, Drylands, Leaching, subsurface drainage, dielectric soil moisture and salinity sensors

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Sub-surface sodicity management using Cut-soiler for residue and gypsum placement in Indo-Gangetic Plains

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The north-western states of Punjab and Haryana account for 69% of total food grain production representing a highly productive zone of IGP (Indo-Gangetic Plains) in India. Sodic soils extend over 0.18 and 0.15 M ha in these two states, respectively. Rice-wheat rotation is the most important dominant cropping system followed in IGP. Cereals constitute 58% of 84-141 MT yr⁻¹ total crop residue surplus produced in India and their on farm burning poses a major environmental and soil health concern. The rice residue management especially involves high cost, and time and energy intensive. To tackle the problem of sodicity and increasing residue burning in rice-wheat cropping system especially in poorly drained soils; an 'On farm technology' solution, that can be adopted at individual farm/farmer level, is the need of the hour. ICAR-Central soil salinity research institute (CSSRI) Karnal in collaboration with Japan International Research Center for Agricultural Sciences (JIRCAS) have introduced Cut-soiler to develop low cost and farm scale salinity management technique. Cut-soiler is a low-cost and easy to adopt technology developed in Japan. Cut-soiler constructs residue filled shallow sub-surface drainage channels, the sodicity amelioration amendments like gypsum can also be placed at subsurface that may effectively reclaim the sub surface sodicity.

Therefore, a farmers' participatory field study was undertaken to assess the Cut-soiler based sub-surface placement of gypsum and rice residue on sub surface sodicity reclamation across space and time and consequent improvement in production of rice-wheat system. The experiment is being conducted at farmer's field in Panjab region (India). Cut-soiler was run, at 2.5, 5.0 and 10.0 m spacing, using rice crop residue/straw lying on ground surface, gypsum and straw+gypsum.

The results indicated that rice straw residue and gypsum placed at 40 cm depth reduced subsurface sodicity (ESP) by 31, 23 and 4% at lateral distance of 0.30, 0.60 and 1.25 m, respectively. Grain yield of rice and wheat also increased with decreasing Cut-soiler spacing. The respective increase in rice and wheat yields were 17.7 and 18.3 % in 2.5 m and 7.6 and 10.8 % in 5.0 m spacing, respectively over control, but no significant increase was noticed in 10.0 m spacing. Therefore, closer spacing (2.5 m or less) seems promising for subsurface sodicity management.

Keywords: Sub-surface sodicity, Residue burning, Exchangeable Sodium Percentage (ESP), Cut-soiler

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Cut-soiler based salinity management practices enhancing production of mustard-pearl millet cropping system in India

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Soil salinity is a global issue threatening land productivity, and estimates predict that 50% of all arable land will be impacted by salinity by 2050. Salt affected soils are an important ecological entity in the landscape in most arid and semi-arid regions. In India these soils occupy nearly 6.7 million ha area and represent a serious threat to country's ability to increase food production to meet the expanding needs. India loses annually 16.84 million ton of farm production valued ~ ₹ 230.2 billion due to salt affected soils (Mandal *et al.*, 2010; Sharma *et al.*, 2015). The salinity management, especially in arid regions, needs an 'on farm technology' solution that can be adopted at individual farm/farmer level. Cut-soiler is a machine developed in Japan that use and manage surface scattered straw material, residue or remaining stems to construct residue filled shallow subsurface channels, while running on the field. The preferential drainage from these channels reduces soil salinity. In this background, Japan International Research Center for Agricultural Sciences (JIRCAS)-ICAR-Central soil salinity research institute (ICAR-CSSRI) collaborative research project is being conducted to evaluate utility of Cut-soiler on salt removal and effect on crop yields in salt affected soils with the use of saline irrigation water. Three saline irrigation water treatments (EC_{iw} 4, 8, 12 $dS m^{-1}$) were applied in two soil types i.e saline and heavy textured. Mustard-pearl millet a major cropping system in hot, arid and saline regions of North West India was evaluated.

Cut-soiler based preferential subsurface drainage reduced 19% salinity in one year of study across the soil types. The saline soil filled plots had higher E_{ce} ($5.07 dSm^{-1}$) than the heavy textured non-saline soils ($1.39 dSm^{-1}$). The salinity (EC) of 12 dSm^{-1} applied irrigation water was significantly ($p < .0001$) higher (3.6) than 8 dSm^{-1} (2.96) that was further higher than 4 dSm^{-1} (2.74) applied irrigation water. The study found that saline irrigation water up to 8 dSm^{-1} could be used without any additional salt loading. The lower salinity resulted in marginal increase in mustard yield in maiden season and 18.6% increase in pearl millet yield in successive season. Therefore, the Cut-soiler based preferential sub surface drainage may be a possible solution for salt removal from saline soils and preventing salt accumulation with application of saline irrigation water for sustainable crop production in salt affected areas having saline groundwater.

Keywords: Salinity, Cut-soiler, Pearl millet [*Pennisetum glaucum* (L.)], Mustard [*Brassica juncea* (L.)]

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Salinity management under a capillary driven automatic irrigation system based on electrical conductivity

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Capillary driven automatic irrigation system (new sand ponics, NSP) has been known to have an advantage for famers to control saline stress and giving fruit with high brix, but it requires laborious application of water using a showering can for leaching salts. To save the labor cost for leaching, we present a new leaching method based on electrical conductivity (EC) in the reservoir of NSP. To evaluate the effectiveness of the new method, we carried out an experiment.

Tomato (*Solanum Lycopersicum*) was grown in a greenhouse in Arid Land Research Center, Tottori University. Water was applied through a drip irrigation tube with a spacing of 20 cm. We set following five treatments. 1) saline water was used for irrigation, and criterion of leaching (drainage) was carried out when EC reached at 7dS / m which is based on 50% reduction in yield (NSP1). 2) same as NSP1, the threshold EC was 10dS / m which is based on 75% reduction in yield (NSP2) 3) saline water was used for irrigation, grown on sand beds with 60 cm wide and 7 cm thick and trigger volumetric water content was set at 0.06 (SP). 4) same as SP, but fresh water was used for irrigation (SPFW). 5) Saline water was used for irrigation and water was applied automatically when volumetric water content (theta) monitored with WD3 sensor decreased below 0.06 (G). Three replicates were set with 12 plants for each. Leaching depths were determined according to the FAO's guideline. Salinity of water for saline irrigation was 1 g / L NaCl solution with liquid fertilizer.

We compared net income using a price of 30 \$ / kg of the product of brix and fresh weight, a water price of 1 \$ / m³.

Results showed that G attained the highest net income, followed by NFSW and NSP1. NSP1 gave the highest yield of 0.267 kg / plant and sugar content of 9.9 brix%. New leaching method removed 76 % and 60 % of salts for NSP1 and NSP2, respectively indicating that difference in threshold EC affected saline percentage in soil.

Keywords:

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Analysis of the impacts of irrigation water management practices and climate change on water availability for rice production. A case in Uganda

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Water, food, energy and climate have intrinsic relations. Worldwide, climate change has negatively impacted water resources and rice production. The vast majority of climate change impacts on rice production range from unpredictable rainfall patterns, floods, landslides, the high temperature which affects reproductive and development stages of rice and thereby causing a decrease in plant height and root elongation, and the increased use of pesticides. As a developing country, Uganda is highly vulnerable to climate change despite its insignificant contribution to global warming. With the current annual population increase of 3.32 %, the role of agricultural water management in ensuring food security cannot be ruled out.

Rice cultivation in Uganda is carried out on large and small-scale irrigation schemes managed by the government and small-holder farmers. The irrigation method is mainly traditional flooding which wastes water as compared to other irrigation practices. Additionally, rice production requires a lot of water, both sunny and wet conditions during cultivation periods since its yield is strongly affected by weather and water availability.

While the country is suitable for rice cultivation, the demand for water for agricultural production would double with the current climate change. To secure rice production and productivity in Uganda, the dwindling water resources, and increased climate unpredictability should be matched with a shift from business as usual to climate-smart irrigation practices. These include among others alternate wetting and drying, dry seeding, monitoring of soil and weather conditions, etc. Water productivity has diverse benefits such as food production, and reduction of greenhouse gas emissions, groundwater recharge, carbon sequestration and ecological services.

Further, the impacts of irrigation practices, water management, and drainage in paddy rice fields are less documented, calling for questions into the sustainability of current irrigation water management practices.

Given the background above, the paper analyzes the history of irrigation and water resources developments, management practices especially for paddy rice in Uganda. Further, we look into the climate change impacts on rice yields, existing studies on how farmers are adapting, and the need for integrated soil and water management practices.

Keywords: Irrigation Water Management, Climate Change, Climate Smart

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Detection of geographic faults using deep learning model from DEM and remote sensing data in Djibouti

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Underground water flow delineation is critical for understanding the groundwater cycling systems and their utilization at arid land areas, such as in Eastern African Djibouti. However, such regions lack essential data, such as borehole data, and this becomes a challenge. One solution is through fault detection to evaluate the possibility of fault-driven groundwater flow into the water cycling systems. This study focuses on geographic faults which exist in Djibouti where the plate tectonic activities are remarkable. Our study aimed to utilize the fault lines delineated on existing geology maps since fault lines distribution has potentiality for high correlation with groundwater flow volumes. It is essential to evaluate if the fault systems can contribute to the simulation of groundwater volume modules.

This work develops on our previous research of fault inspection using relief image in fault distribution derived from adaptive gradient filter applied on PALSAR-1/2 image data. In this study, deep learning techniques are used in fault detection analysis based on Digital Elevation Model (DEM) and remote sensing data in training a multi-input deep convolutional neural network (Deep CNN) model. We used ortho-rectified PALSAR-1 RTI and PALSAR-2 Global Mosaic, DEM data as well as curvature and slope images derived from the DEM. We used fault labels digitized and rectified from the existing geology map, specifically on the Ali Faren catchment as the target region for this study.

The result showed that using multi-input data in our derived deep CNN model, fault lines were detected. Further, we determined and derived the extent of primary faults in a higher accuracy. Results also showed promising level of groundwater flow evaluation with deep CNN detected geographically fault lines. Further, our proposed deep CNN model could be applied to other watersheds in Djibouti to help in groundwater flow model simulations and eventually help locate the potential area for groundwater resources in entire Djibouti.

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Soil water distribution using subsurface string irrigation for water saving by the negative pressure difference

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Water saving irrigation is important in arid area because of the water shortage and the prevention of salt accumulation. Subsurface irrigation is one of the most effective method of water saving, and the irrigation method by the negative pressure difference is also effective. In this study, the water characteristics of the string which is the main material of the string irrigation system were measured in the water absorption and drainage process. As the type of string, Nylon, Cotton and Cremona (60 % vinylon and 40 % polyester) which diameter of 6mm and 3mm were used. The pot experiment of the subsurface string irrigation by the negative pressure difference for water saving was conducted under three conditions of Cotton (6 mm), Cotton (3 mm) and Nylon (3 mm). The condition of hydraulic head from groundwater was 5 cm and 10 cm. Further, the numerical simulation of soil water distribution using Hydras 2D was conducted. As the results, 1) Water characteristic curve of each string were obtained. The water retention capacity of Cotton (6 mm) was the highest in all potential ranges in the drainage process. The water retention capacity of Nylon (3 mm) and Cotton (3 mm) were high from pF 0.5 to pF 1.5 in the water absorption process. 2) The maximum water supply was 79 g/day per pot on average at the condition of the cotton string (ϕ :6 mm, hydraulic head:10 cm). The minimum water supply was 34 g/day per pot on average at the condition of cotton string (ϕ :3 mm, hydraulic head:10 cm). 3) Since the soil water distribution could be expressed by the numerical study, the calculations corresponding to the shape and arrangement of strings could be performed. These results will contribute to save water in arid area irrigation.

Keywords: Negative pressure difference, String irrigation, Water saving

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Optimization of irrigation depth for mungbean considering the cost for water under a saline condition

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We have presented a new scheme, “optimized irrigation”, in which irrigation depth is determined such that net income considering the price of water and weather forecasts during each interval is maximized using WASH_1D/2D which are numerical simulation models of water flow and solute transport in soils and crop growth. To evaluate whether the optimized irrigation is also able to restrict salinity stress and avoid salinization without any intentional leaching, we carried out an irrigation experiment.

Mungbean (*Vigna radiata L.*) was grown in a greenhouse in Arid Land Research Center, Tottori University, using a drip irrigation system whose emitter distance was 20 cm and lateral spacing was 60 cm. Seeds were sown on May 18 below each emitter after leaching with more than 200 mm. Three treatments were established: 1) irrigation with fresh water (F), 2) irrigation with 1.5 g/L of NaCl solution (C), 3) irrigation with 1.5 g/L of NaCl solution and irrigation depth was determined with the proposed scheme (O). Treatments F and C were irrigated with automated irrigation systems using two tensiometers each installed below 10 cm. Each treatment had three replicates. After June 12, irrigation using the saline water started for treatments C and F. A 2.8 mm of leaching was carried out on July 2.

Treatment F received the largest amount owing to the largest transpiration rate without any stresses. Treatment C received the lowest amount because of low transpiration rate due to severe salinity stress. We compared net income under producer price of 0.9 \$/kg, common miscellaneous costs at 50 \$/ha, water price of fresh water at 0.2 \$/m³ and that of saline water 0.1 \$/m³. Treatment F gained the highest gross income owing to the largest yield (835 kg/ha). Treatment C gained the lowest income and yield (448 kg/ha) while treatment O gained the highest net income owing to lower cost for water than that for F, revealing the effectiveness of the proposed scheme.

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High-Resolution and Long-Term Land Surface Analysis in the Aral Sea Basin

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Starting in the 1940s, the Soviet Union conducted a large-scale irrigation policy in the Aral Sea basin. As a result, the Aral Sea shrank drastically and it became 1/10 size of original area. Since the collapse of the Soviet Union, there has been no concerted effort among the independent countries to deal with water resources, and sloppy water management is still practiced. It is essential to provide scientific evidence to achieve sustainable water resource management in the basin as soon as possible.

In this study, the land surface model (SiBUC¹) of the Aral Sea basin was improved by increasing the spatial resolution of the analysis and by using newly available data, referring to the analysis methodology of Touge²). We increased the spatial resolution of the analysis by 20 times higher comparing to the analysis conducted by Touge. By doing this, we can capture the topography and land use in more detail, and the analysis results of various hydrological quantities can be improved. This is particularly effective to calculate with high accuracy by capturing the elevational characteristics of mountainous areas without averaging its elevation in an analysis mesh. In addition, new forcing data and Aral Sea bathymetry data were used in parallel to improve the analysis. The specific analysis outline is as follows. We analyzed the Aral Sea basin using the land surface model SiBUC¹) for a period of 50 years from 1961 to 2010 with a spatial resolution of 30 seconds. The Aral Sea shrinkage and the increase of irrigated area, which are remarkable area changes in the analysis period, were considered, referring to the methodology of Touge. We prepared Land use data with different irrigated area fraction for each year, and did coupling of the results of SiBUC to the dynamic change of the Aral Sea area for each year. The GSWP3³) was newly used as the forcing data for the calculation of land surface processes.

As a result, the overestimation of runoff in the water balance of the Aral Sea catchment, which was an issue in the Touge's paper, was improved. The water balance of the Aral Sea was analyzed with good accuracy, and the Aral Sea area was successfully reproduced considering its depth. In addition, we succeeded to visualize land use change and climate change in the watershed, and also, by comparing the results between 30sec resolution and 5min resolution, we found some usefulness of high-resolution analysis.

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Estimating the impact of rainwater harvesting system installation on floods using hydrological models

Case study: Nyabugogo valley, Kigali

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Rwanda, a landlocked country located in East Africa, is under the temperate climate due to the high altitude though near to the equator. 5.3% of the territory is covered by water bodies, lakes, and rivers. Both rainy and dry season come twice a year with frequent inundations and water shortage. Kigali, the capital city, and the most populated city in the country, is affected by floods during rainy season. Nyabugogo valley, the downtown of the capital is the typical affected area with devastating damage. The mitigation measures such as widening Mpazi drainage channel were taken by the government based on a number of researches. However, the inundation still occurs every year. This research aims to propose rainwater harvesting (RWH) that can supply water to each household, as a mitigation measure to floods. In order to assess the effect of RWH installation on the flood control, Runoff modeling and simulation of Flood inundation was carried out.

Nyabugogo river catchment area, delineated using DEM, is 1663.95Km². The dominant land cover is forest (65%) and crop land (22%). Run-off from the upper catchment area was simulated using SWAT model with input data of elevation, soil, and land use data. The simulation was done for 3 years 2011-2013 and calibrated using SWAT CUP.

IRIC Nays2Dflood Model was used to simulate and visualize the flooded area with the input data of the discharge simulated by the above modeling and water level at downstream of the flooded area for the flood event reported on March 2nd and 3rd 2020. The boundary conditions were set along the river, with two inflow points: Nyabugogo river and Mpazi outlet. The maximum water depth and the maximum velocity were observed at the confluence of the two streams; and flood extended throughout the valley. The accuracy of the simulation was checked by comparison with the sentinel2 satellite images.

The RWH system installation will be simulated and its hydrological impact on flood will be assessed as the final outcome of this research. Rainwater harvesting system installation, additionally to reducing flood mitigation, can contribute to improvement of the population's health and sanitation, which aligns with the SDGs. Knowing the extent at which RWH can reduce flood, will open to further studies on design and cost analysis of the system.

Keywords: Flood; Runoff; Hydrological model; Rainwater Harvesting

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Prediction of the discharge in Pech River for the flood warning system, based on the time series of snow cover area and meteorological data

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Floods in the arid areas provide fertile soil and water resources, enabling agricultural production. Based on its productivity, towns with a large population have developed along the riverbanks. On the other hand, large flood beyond the expectation will cause enormous human and economic damage. The Pech River, our study site, is a tributary of the Kunar River, which runs through eastern Afghanistan. The catchment area of the river is populated by 35.5% of the population and has 21% of the agricultural land of Kunar province.

The main source of the river discharge is melted snow in the upper mountainous areas, and the maximum discharge that appears in the following spring changes depending on the amount of snowfall in the previous winter. In the year of heavy snowfall in the upper mountainous areas, the residential areas and the agricultural lands along the river experienced severe inundation.

Therefore, it is necessary to predict the peak discharge in spring in advance and provide appropriate flood warnings so that the local residents can take evacuation and damage mitigation measures. In this study, we tried to develop a method for predicting the peak discharge based on the fluctuation of snow cover area evaluated with satellite images, temperature, and rainfall of the upper reaches of the Pech River.

First, the boundary of the river catchment was identified based on the DEM of 30m mesh acquired by Advanced Land Observing Satellite (ALOS). Next, the Snow cover distribution data between 2008 and 2018 at weekly intervals was downloaded from the National Snow & Ice Data Center (NSIDC) database, and the catchment area was extracted. Daily temperature and precipitation data at the station nearby the catchment stored in the database of National Oceanic and Atmospheric Administration (NOAA) were expected as the parameter explaining the snow melting process in spring.

We tried to reproduce the discharge of the Pech River using these explanatory variables related to the process of snowfall and snowmelt with some statistical and stochastic methods. The multi-regression analysis and Neural Network were examined to reproduce the discharge fluctuation of Pech River.

Keywords: Pech river catchment; Flood; Snow melting; Peak discharge

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Water resources survey and model analysis in Dikhill area,Djibouti

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The Republic of Djibouti is a dry region with a large part of the country covered by the desert, and the majority of its people are nomadic despite the harsh environment of an annual maximum temperature of 50 degrees Celsius and an annual rainfall of 150 mm or less. Most of the people's access to water resources depends on groundwater from wells. In addition, the Ministry of Agriculture has turned to agriculture using a small amount of water resources to cope with the drought that has occurred frequently in recent years.

The Ministry of Agriculture and UN agencies have created maps summarizing information on water resources in the past, but many of the final survey years were in the 1990s, and were updated again based on changes in location accuracy and water use at the time.

The study area covers the Hanle Catchment, which is located on the west side of Djibouti and runs from south to north in the Dikhil area where the number of farmers is highest. A survey was conducted to find out how water resources were used. As a result, a total of 18 surveys were conducted, and information was obtained on the current usage and water quality. In addition, in order to understand the change of flowing groundwater resources, analysis using a model is performed and the results are reported.

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Suitability of arid land rehabilitation technologies: simulation of water harvesting based solutions in Middle Eastern agro-pastures

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The enhancement of Middle Eastern agro-pastures' productivity through water harvesting originates from ancient technologies and indigenous knowledge. More recently, integrated watershed rehabilitation practices, such as the combination of mechanized micro water harvesting for forage shrub production in upstream areas, and flood water harvesting based cereal agriculture in the downstream, have been successfully tested at local level in Jordan. However, the erratic nature of rainfall, exacerbated by climate change, and the ongoing degradation and depletion of the fragile dryland-ecosystems create a complex environment for out-scaling of proven technologies.

A hydrological assessment campaign, conducted in Jordan, aims at establishing new linkages between plot and field scale soil, water and vegetation processes and global hydrological modeling. The aim is to bridge scales and to unlock the potential of globally harmonized information available. The research tests the out-scalability of water harvesting based measures, applied locally, through intense on-site investigation of soil, water and vegetation dynamics, merged with large scale hydrological modeling for out-scaling suitability and ex ante impact assessment. The concept is based on a likelihood approach integrating several environmental layers, such as top-soil, terrain and vegetation cover with surface hydrological modeling using global datasets. The goal is to investigate spatio-temporal surface water availability - as the driver of water harvesting based rehabilitation and productivity enhancement measures.

The test-phase is ongoing for further data assimilation and process verification. Evaluated results will be initially presented at the DT14, International Conference on Arid Land in Japan in September 2020.

Keywords: arid land rehabilitation; water harvesting; surface runoff; soil moisture

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Improving monitoring technologies for the salinity of irrigated lands based on GIS/RS and satellite imagery for the conditions of the Syrdarya region, Uzbekistan

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Soil salinity is one of the widespread environmental threats all around the world, especially in arid and semi-arid area. Saline soils mainly occur due to inadequate irrigation and extensive agricultural activities, which account for a number of soil degradation processes. Nowadays innovative technologies are widely implemented in agriculture in order to increase yields and monitor any changes occurring in any given areas timely. Advanced technologies such as remote sensing (RS) data have become an economically and efficient tool for assessing, detecting, mapping, and monitoring saline areas along with their spatial and temporal variations.

This study aims to develop spatial database for the evaluation of salinization using RS and GIS. This research employs various soil salinity index calculate based on Landsat 8 OLI images and other related data to the water resources condition of the study area. We conducted a preliminary analysis using six indices (SI2, SI3, SI4, NSI, VSSI, and NDSI) of salinity using Landsat images. Statistical relationship between state developed in-situ based soil salinity map and remote sensing indices: salinity index (SI2), normalized difference salinity index (NDSI) and GIS layers showed that the highest effect on soil salinity and modelling capacity and the highest correlation among all indices. And these data showed mean of the indices value had a good tendency on displaying soil salinity level.

This research will contribute to improving the quality of monitoring and improvement of the state of irrigated lands, and also to develop a preliminary step towards decision making tools for agricultural policies, such as the management of saline areas related to crop production.

Keywords: Soil salinity; remote sensing; Landsat; salinity index, NDSI

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Comparison of soil physical and chemical properties in salt-affected soil amelioration with desulfurization gypsum and waste concrete in China

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In countries with arid and semiarid regions, decrease in agricultural production due to excessive salts is a very serious problem. In China, because environmental problems due to air pollution have caused much damage to the ecosystem and humans, the new usage with the increase in the desulfurization gypsum is required recently. Moreover, the accelerating urbanization has generated a huge amount of construction and demolition wastes. Therefore, the need for the recycling and reuse of both desulfurization waste and waste concrete is very urgent and necessary. In this study, the physicochemical amelioration effects in the salt-affected soil with desulfurization gypsum, cement fine powder (CFP) and waste concrete (WC) were reported. Sodic soil in Yinchuan, China was used in amelioration test. Waste cement fine powders (CFP) ($\leq 200\mu\text{m}$), waste concrete particles (WCP) ($\leq 0.6\text{mm}$, $0.6\text{-}1.0\text{mm}$, $1.0\text{-}2.0\text{mm}$ and $2.0\text{-}4.75\text{mm}$) were examined as soil amendment. The CFP and various WCPs based on both 0.5wt% application rate of wet FGD gypsum (W-FGDG) and 1.0wt% application rate of semi-dry FGD gypsum (SD-FGDG) were added to soil. Soil properties (pH, EC, exchangeable Na, soluble ions (Na, Ca, Mg and K)) before and after mixing with soil amendments were measured. Consequently, the order of Ca concentration that is effective for sodic soil amelioration was SD-FGDG>W-FGDG>WCP>CFP. All sodic soils decreased drastically in EC and ESP, and soil pH decreased gradually after three and six weeks. Consequently, the smaller WCP could ameliorate at a smaller amount of application rate. In addition, we investigated the change of hydraulic conductivity and the solute transport in soil amelioration. In order to analyze the solute transport due to soil amelioration, soil column equipped with tensiometers and four-electrode sensors has been used. Consequently, the initial Na leaching was confirmed from the results of EC of leachate and quantitative analysis of leachate. And the increase in hydraulic conductivity due to waste concrete application could be confirmed. These results indicated the effectiveness of waste concrete as salt-affected soil amendments in China.

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Ecosystem land cover and vegetation trends under climate change in the low stream of the Amu Darya River watershed

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The Amudarya Delta (N42°36' E59°28') is a showcase for a wetland complex lying downstream in a transboundary river basin from the northwestern part of the Kyzylkum, the Zaunguz Karakum (the territories adjacent to the Uzboi), Ustyurt, the valley and delta of the lower reaches of the Amu Darya River, bordering to the Aral Sea. The area represents a downstream conflict over water competition between water users: irrigated agriculture and natural ecosystems. Due to climate change and water shortage, the Amudarya Delta watershed zone faces the challenges associated with soil salinity, rising water table, and loss of agrobiodiversity and food insecurity. Ecosystem-based land use and conservation are recognized to be among the most severe natural resource degradation factors. Salt affected irrigated lands in the Amudarya Delta (Karakalpakstan, Khoresm regions, and some territories in the northern part of Turkmenistan) increased at average from 1,16 mln. ha in 1990 to 4,43 mln ha (more than 80%) in 2017. Access to irrigation water in this region has drastically decreased in the last decades, which caused additional obstacles to agricultural production, especially grazing capacity of natural pastures. The hot spots of degraded pasturelands due to low species richness and botanic diversity occurred on the Artemisia foothill-plains transects along the Lower Amu Darya Biosphere Reserve (LABR) near the settlements Beruni, Mangit, Nazarkan towards Khoresm and Northern Turkmenistan.

This study is focused on Land Use/Land Cover (LULC), vegetation/plant communities, and agrobiodiversity trends under climatic variables for the period 2011-2018. Tugai-forest and wetlands category, which frequently occurred at LABR is under serious threat now. The vegetation composition is also rich in edible species and thus, this type of vegetation can be used during the year, but local pastoralists prefer to have it in the winter season since tugay forest can stand as a good shelter for livestock against cold weather. Channels overgrow with aquatic vegetation, which leads to their rapid shallowing because of the large halophytes forming dense thickets. They play the role of a filter and precipitate suspended particles at the collectors' bottom, which contributes to the rapid shallowing of the network. Overgrowing and silting often lead to the fact that saline water enters the fields and salinizes them repeatedly. Scenarios for sustainable water and land-use practices are suggested.

Keywords: climate change, tugai-wetlands, ecosystem land use, vegetation trends, Amudarya Delta

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Land surface identification and land cover classification of arid land in Djibouti using UAV imagery

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In recent years new technologies have emerged that can be used to enhance field surveys. One of these technologies are Unmanned Aerial Vehicles (UAV), that are equipped with a camera that can take images applicable for remote sensing, and which allow collection of data in places that may be difficult to access. The study site is located in Ali Faren (42° 49' 48" E, 11° 21' 43") at the Province of Arta, Djibouti, which is a hot semi-arid country with a yearly average precipitation between 50 to 200 mm and daily maximum temperatures that range from 32 to 41 degrees centigrade. The main geological characteristics found in Ali Faren are volcanic formations of early Miocene age, particularly those of Basaltic series of Dalha (lower set and upper set undifferentiated in Ali Sabieh sector) and volcanic formations of early Miocene age. In this study, a field survey was conducted using Mavic Pro (DJI) and Disko-Pro AG (Parrot) drones which are equipped with a Multi-spectral camera (Parrot Sequoia) and a fully stabilized 12 megapixel camera. Imagery acquisition was conducted over several major faults on Ali-Faren in order to observe the land cover in these sections and to identify land surface attributes that may contribute to a more accurate mapping of geological features, which will contribute in further research regarding water cycling simulations.

Keywords: UAV, drone-acquired imagery, photogrammetry, Djibouti, Ali Faren

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Analysis of the surface layer properties influence on the actual evaporation and efficiency of the soil-cover system to combat desertification

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Recently, global warming has become one of the most alarming environmental issues around the world. Scientists have been warning that one of the primary effects of climate change is the disruption of the natural water cycle and the augmentation in the likelihood of more intense droughts and precipitation events. As mentioned by the United Nations Convention to Combat Desertification in 2017, deserts and drylands form about 40% of the total earth's land, with approximately 12 million hectares being lost every year. The soil-atmosphere fluxes including evaporation and infiltration are complex processes that follow ambiguous mechanisms. In general, these processes are mainly controlled by the demand and supply, the ability of the porous medium to transmit water, and the vegetation. It must be noted that in arid and semi-arid regions the evaporation rate is extremely high and greatly exceeds the precipitation rate. Evaporation is a multiphase boundary complex phenomenon in which water gets lost from soil pores into the adjacent atmosphere. A typical actual evaporation curve can be divided into three stages, the constant rate stage, where capillary flow is dominant. Followed by the falling rate stage, which involves vapor diffusion transport through the top dry layer supported by capillary flow from the bottom. Finally, the residual stage, where vapor diffusion becomes dominant. A simple and environmental-friendly method that limits and controls the actual evaporation rate in arid and semi-arid regions is in great need to efficiently combat desertification.

Through this paper, a soil cover system that functions in a way to reduce the actual evaporation rate and maximizes the water conservation capabilities is proposed. The influence of the soil cover properties on the actual evaporation and water redistribution is investigated using 1-D column evaporation testes. Furthermore, considering the inevitable complexity associated with the governing flow mechanisms especially during the falling rate stage, an equivalent and robust micro-scale index that considers the variations in the pore-size distribution of each layer is approached to adequately elaborate the evaporation stages. It was found that the cover layer properties strongly affect the evaporation rate and the water storage capabilities through the bottom layer. Besides, focusing on a single macro-scale index to evaluate the evaporation flux and the dynamics of water movement might not be efficient. Instead, a comprehensive and robust microscale index is required to accurately estimate the actual evaporation behavior.

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Drying front dynamics during the falling rate stage of evaporation from homogeneous sandy soil profiles

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In recent decades, arid and semi-arid areas have been suffering from high evaporation rates and scarcity in rainfall events. Besides the soil degradation and reduction in groundwater availability, those severe conditions are exacerbating desertification. The need for finding innovative solutions requires a thorough understanding of the surface-atmosphere boundary fluxes and the water movement through unsaturated soil profiles. Among those crucial fluxes is the evaporation flux, which is dominant in dry regions. Evaporation is a complex process where water moves through soil pores and gets lost into the atmosphere. It involves three stages that differ in their actual evaporation rates and water transport mechanisms. One of the main controlling factors of the process is the region separating the saturated and the unsaturated zones known as the drying front. During the constant rate stage (Stage 1), the capillary transport from the drying front to the soil surface maintains a high and constant evaporation rate. At a specific drying front depth, governed by the pore size distribution, a sudden drop in the evaporation rate occurs, marking the onset of the falling rate stage (Stage 2). During this stage, a continuous reduction in the evaporation rate develops due to the change in the transport mechanism. It is believed that a new vaporization plane forms below the soil surface, allowing water to transport by capillarity from the drying front and continue as vapor through an air-dry soil layer to the soil surface. Finally, when the evaporation rate converges to a low constant value, the residual stage (Stage 3) starts.

The drying front during Stage 1 was theoretically and experimentally elaborated in the literature. However, due to the complexity of the transport mechanisms during Stage 2, the drying front behavior is not clearly understood. This paper investigates the spatial and temporal development of the drying front during the falling rate stage for sandy soils. The drying front was traced experimentally through 1-D homogeneous drying column tests. The soil samples used for testing vary in their pore structure, where the influence of the related soil properties on the drying front dynamics from a micro-scale perspective is studied. This study is expected to serve as a fundamental step towards understanding and systemizing the determination of the drying front dynamics during the evaporation process.

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Extraction of Farmlands in Djibouti from Satellite Imagery using Deep Learning

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In Djibouti, about 25% of the population engage in livestock production including nomadic herders. Recent frequent occurrence of droughts caused by climate change has resulted in grass shortage, making sustainable nomadic condition difficult. In order to improve this situation, the government has formulated the plan which aims to help nomadic in rural areas strengthen their means of livelihood through agriculture. To establish more farmland areas, it is necessary to develop access points for sustainable water resource. For this purpose, assessment and analysis for location environment. Remote sensing is an effective technology for wide-area analysis. However, most of the papers focus on the development on algorithms of deep learning (DL). In this study, the DL analyses to identify the in-use farmlands were conducted using satellite image covers all over Djibouti.

Firstly, the ground truth data of the farmland polygons were extracted to create polygon datasets from both using ALOS pan-sharpen images (2006-2011) and Google Earth images (2018-2020). Environment of farmland location was analyzed by overlaying with the geology map, DEM, and wadi flow paths derived from the DEM. Training image datasets were set from ALOS 3-layer composite image of RGB. We used Mask R-CNN, the DL toolsets of ArcGIS Pro, to identify the agricultural land in use by location and area. The accuracy of the model was evaluated by the indicator of precision, recall, target rate, and hit rate.

As results, from the Pan-sharpen imagery of ALOS (2006-2011) and Google Earth image (2018-2020), 337 and 670 farmland parcels with 687 and 1090 ha in total area, respectively, were discovered to be exist throughout Djibouti. The total area of the farmlands increased by about 60%. Many farmlands (44%) were discovered to be locate on Fluvial alluvium and sand geological features, and 36% of the farmlands locate at elevations of less than 100 m. It was also discovered that 87% of the farmlands located within 100 m from the center line of wadi flow paths. The DL model of automatic farmland extraction for ALOS pan-sharpen images showed a low precision of 1.1% with recall rate of 34.8%. The target rate and hit rate were 27.7% and 21.1%, respectively. The densely distributed farmland regions were discovered to locate in the eastern and the south-western part of Djibouti, where the accuracy of the prediction was very low.

Keywords: Arid area, ALOS, NDVI, Sentinel-2, Vegetation index

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Synthesis, evaluation and usage of a new generation of hydrogel-coated fertilizers with soil improving properties

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Salinity is one of the most severe environmental factors limiting the productivity of agricultural crops. Most crops are sensitive to salinity caused by high concentrations of toxic sodium chloride and other types of salts in the soil. Agricultural losses caused by salinity are difficult to assess but estimated to be substantial and salinization impact will continue to increase under climatic and anthropogenic variables. Secondary salinization of agricultural lands is particularly widespread in arid and semiarid environments where crop production requires usage of large amounts of inorganic fertilizers (e.g., ammonium sulfate, potassium nitrate, various phosphate and chloride fertilizers) to guarantee yield production. At least 20% of all irrigated lands are salt affected, with some estimates being as high as 50%. The situation will become worse with increasing world population.

Optimization of crop production under salinization required elaboration of a new generation of fertilizers.

We are proposing an effective granular fertilizer covered by a new type of hydrogels with a positive multi-effects to plant growth under saline drylands. Our findings showed that polymer hydrogels have a good ability to retain water and plant nutrients and release them to plants. The process of new type of polymer synthesis of hydrogel has been synthesized through polymerization of acrylonitrile, and maleic acid with formalin in the presence of glycerin. The formation of hydrogel used the copolymerization reaction of glycerin and a cross-linking agent formalin. Obtained product is more effective than others to water saving and gives slow release effects to fertilizers.

Free functional carboxyl groups in the composition disturb the balance of poorly soluble polyvalent cationic salts in the soil, in contrast to well-structured soils due to specific ion exchange. In contrast to the action of inorganic acids, dissolved salts are protected from recrystallization, and amorphous structures are formed. Thus, water easily penetrates into stratified areas where difficult-to-dissolve salts are formed. The low content of salts of polyvalent metals in the soil compared to acid functional groups in hydrogel completely destroys water-insoluble salts in the soil and prevents an increase in the total salt balance. The new type of hydrogel coated fertilizers became the formation of molecular pores in the crystalline layers in soil, and used as a water saving fertilizers product with the slow release effects.

Toxicological properties of these products were studied and it was determined that it belongs to a class of relatively less toxic substances. It was also found that the product does not have a negative effect on the dynamics of the number of beneficial microorganisms in the soil.

Keywords: salinity stress, hydrogels, biofertilizer, toxic salts, drylands

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Construction of virtual reality space of the Tottori Sand Dunes using UAV

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The Tottori Sand Dunes in Japan are a popular tourist attraction due to the beautiful scenery and leisure activities with millions of visitors every year. In addition, the Tottori Sand Dunes have been designated as a special protection zone of Sanin Kaigan National Park and a UNESCO Global Geopark because the characteristic landscapes and unique ecosystems have high academic value from the aspects of geology and ecology. However, the tourism in the dunes is sometimes very hard due to the vast and undulating landscape and inclement weather conditions (windy, hot summer and cold winter). Additionally, there are no guide boards, information boards and no constructions in the dunes to keep the beautiful scenery. It seems that construction of virtual reality (VR) space of the dunes can contribute to solve these problems in the tourism. In the VR space, everyone can enjoy the beautiful scenery without influence of the weather conditions and landscapes. Virtual information boards will help to understand the characteristic landscapes and unique ecosystems for the tourists. Three-dimensional (3D) models are needed to construct the VR space. Recently, the combination technique of UAVs (Unmanned Aerial Vehicles, or drones) and structure-from-motion (SfM) photogrammetry have been attracting attention that can yield 3D models. The objective of this study was to construct of the VR space of the Tottori Sand Dunes using the 3D models generated from UAVs. The optimal photographing conditions and model creation conditions were also examined to make beautiful and small size 3D models for the construction of the VR space.

Two types of UAVs, Phantom4 and Phantom4-RTK, were used in this study. Agisoft Metashape was used as the SfM software to make 3D models. Number of polygons and textures are changed and examined to make beautiful and small size 3D models in the model creation processes. Unity3D, a cross-platform game engine, was used to construct the VR spaces. HTC VIVE was employed as the head mounted display for the VR system. As the results, the VR space which enables free virtual walk in the beautiful sand dunes was constructed. Increase in number of polygons of the 3D models increased file size but did not affect to the looks of the VR space. On the other hand, increase in number of textures strongly improved to the looks of the VR space. Similar approach is applicable to other sand dunes and deserts and will contribute to improve tourisms and environmental educations.

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Meteorological characteristics with the windbreak effect evaluation of hedgerows in agricultural lands of Djibouti on the basis of wind dynamics simulation

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The purpose of this study is to clarify the meteorological characteristics of a farm at Dikhil in Djibouti and to evaluate the windbreak effect of the hedgerows in order to utilize the results to plan and design of a pilot farm in Ali Faren on the basis of simulated wind dynamics from meteorological observation parameters. From the results of Dikhil farm land meteorological observation, the highest temperatures and the lowest relative humidity were observed from May to July, and the southerly prevailing wind from May to September, with the east-northeast prevailing wind from October to April were observed. The east-northeast winds during October to April was discovered to be twice stronger than the southerly winds during May to September season. As a result of the wind dynamics simulation on the inflow from east-northeast at a height of 3 m above the ground level, the windbreak effect of the hedgerows (the 2 rows of *Leucaena leucocephala* with a height of 2 m, the *Phoenix dactylifera* with a height of 6-7 m) on the leeward side was confirmed to be effective. The vegetable fields in the farm will be protected from the wind on the leeward side of the hedgerows. From the Ali Faren pilot farm observation, the south-southeast prevailing winds throughout the year. As a result of the wind dynamics simulation on the inflow from south-southeast at a height of 3 m above the ground, the windbreak effect of several scenarios of the hedgerows plan of the Ali Faren pilot farm was confirmed to be effective. The several scenarios of the hedgerows plan on the basis of wind dynamics simulation is useful for consensus building and decision making with local farmers, agriculture ministry, universities, etc. on the farmland structure and layout designings.

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Research on solar desalination system and water-saving farming methods for small-scale farmers

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In 2017, the United Nations designated 2019 as the "Decade of Family Farming" and requested the promotion of measures and sharing of knowledge related to family farming, which plays a significant role in eradicating poverty and hunger. We are proposing a water-saving farming method for small-scale farmers using a solar-powered desalination system and purified raw water. Desalination plants generally use reverse osmosis membranes, disinfection chemical materials, and consume large amounts of fossil fuels. The solar desalination system we have developed so far is a low-cost, repeatable system that uses the same vacuum heat-absorbing tubes used in solar water heaters. We consider that small-scale farmers are also less burdened by using solar heat, a renewable energy source. The result of calculating the energy conversion efficiency from the measurement of evaporation was 43.9%. Next, water-saving agriculture is so crucial for the efficient use of purified raw water for agriculture. And the water-saving farming method base on the stone mulch farming method, laying bricks on top of root-proof sheets and using localized tillage. The stone-mulch farming method reduces evaporation of water, and the root prevention sheeting relatively reduces competition from weeds. Fertilizer and soil can be added to a locally tilled area to provide intensive nutrition. It also allows for continuous cultivation without removing stones and prevents soil drying and deterioration caused by full tillage. Although in Japan, the experiment of cultivating onions in the open fields using this farming method resulted in nearly double the harvest compared to the conventional method using a tiller.

In the future, we will develop the technology so that small-scale farmers, such as family farmers, can engage in production by also combining it with drip irrigation. And we will also continue to develop a desalination system using a flat plate heat absorber, which is easier to handle.

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Study of effects of pre-harvest paper bagging practice on quality of fruits of Deveji pear in climatic condition of Uzbekistan

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The pear (*Pyrus communis* L.) cv. Deveji was introduced from Turkey to Uzbekistan and the variety is valuable with owning longer shelf life and well-appreciated flavour. Since the fruit matures at very high temperature and dry condition in Uzbekistan, water loss in fruits is one of the biggest problems in Deveji pear production in Uzbekistan. The water loss leads to a decrease in the assimilation of essential elements, resulted in the deterioration of fruit quality. Hence, it is important to develop cultivation techniques for retaining water in the fruits. The objective of this study is to evaluate the effect of different pre-harvest paper bagging practices on fruit quality.

The fruits of Deveji pear were covered with double layered white (penetrating 79% of light), orange (penetrating 26% of light) and black (penetrating 0% of light) papers during the growth period of fruits in 2019. The fruits dry matter and calcium concentration of fruit juice were analyzed after the harvest. The water content of uncovered fruits and the fruits covered with white, orange, black double layered papers were equal to 85.1% 85.1%, 85.2% and 86.8%, respectively. The calcium concentration of juice of uncovered fruits and the fruits covered with white, orange, black double layered papers are equal to 3.66, 3.84, 4.98 and 6.14 mg/dL, respectively. Black paper bag treatment significantly enhanced the water content and juice calcium concentration in fruits.

We could demonstrate the positive effect of pre-harvest paper bagging on maintaining high quality of Deveji pear. Especially, black paper is suggested to be the best bagging material.

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An investigation on abnormal dry-cold weather at Kurobe headstream area of the Northern Japan Alps in August 2018 as an example for estimation of alpine-rocky desert climate

Taichi MAKI*¹

There are wide alpine desert and rocky desert of mountainous area except wide sandy desert in the world. As an elevation is high and air temperature is low in high mountain, clouds appear and heavy rain is found occasionally, but it flows out and dry up quickly. Then vegetation is rare based on dry and cold weather.

As there is almost no meteorological data in such a mountainous area, it is necessary to estimate meteorological data from topography, elevation and the other information. But estimation procedure is a little, it is necessary to investigate. In this paper, an estimation method of mountainous weather or climate was introduced as an example of abnormal cold and dry condition in the Northern Japan Alps.

The author climbed in the Northern Japan Alps from August 17 to 20 in 2018 and evaluated a local weather or climate at a high mountain by a chance observation of characteristic weather in midsummer.

It showed particularly a new record or an equal record of minimum air temperature at 125 points of AMeDAS from Chugoku-Shikoku to Hokkaido, as an abnormal weather based on the cold continental air mass of anticyclone.

The monthly minimum air temperature was recorded in 8 levels from 11 km to lower layer on Aug. 17 and 3 levels of the lowest layer under 1000 m level on Aug. 18 at Wajima aerological observatory, because of the strong cold anticyclone from the northern continent. Inversion layer was observed at the level of about 2000 m on Aug. 17-18 at Wajima and temperature gaps were found at the level of 1350-2330 m in the Alps.

A dry, cold and rather strong wind of 10.7 m/s from northern direction affected on 1500-3000 m layer in the daytime, and minimum air temperature at Tarodaira was 4.1 °C by the estimation, and at the cottage was 4.0 °C by the observation on Aug. 17. On Aug. 18, minimum air temperature was -2.8 °C with a dry, cold and weak wind at Tarodaira ridge by the estimation at 400-1350 m, and visible estimation was -3 to -4 °C at the height of 1900-2300 m in Yakushisawa basin of Kurobe headstream area where frosted.

The author experienced those phenomena of dry-cold air mass and frost mentioned above by mountaineering. An analysis of sensible local climate was introduced the first step of an estimation of mountainous desert climate. It will be able to apply for one of alpine weather estimation.

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Impacts of climate change and vulnerability of African pastoralists

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This presentation attempts to assess the impacts of climate change on vulnerability of Nigerian pastoralists based on the results of a recently conducted questionnaire. The general situation of climate change impacts on African pastoralists will also be reviewed. Pastoralists in Africa face several challenges of climate change that constrain their livelihoods and stifle their ability to adapt to changes in their external environment. The challenges can be grouped into four categories: climate change, political and economic marginalization, inappropriate development policies, and increasing resource competition. Pastoralists have lived with challenges of climate change and variability for millennial, and they are known to be highly resilient to erratic weather and climate conditions. However, the unprecedented rate and scale of human-induced climate change, especially in Africa, is beginning to pose problems, especially where social, political and economic factors are inimical to their livelihoods. Vulnerability is most often represented by a suite of socio-economic, political and environmental factors that represent the sensitivity and exposure of a population to climate hazards. Climate change impacts on pastoral households are evident in livelihood outcomes of higher temperature, changing landscapes and ecology, increased risk of drought, fire and floods, heat related illness and diseases among others. Climate plays a significant role in the sustainability of livelihoods of pastoralists. Pastoralists in Africa particularly are nowadays facing bigger challenges of land accessibility and lack of integration into the socio-cultural life of home communities. Climate change will be an additional stressor that outstrips their current adjustments. A survey of climate change perception has been conducted in Nigeria on numerous pastoral groups. The results will be analyzed, and compared with the existing reports on other pastoral groups in Africa. The understanding of vulnerability of the pastoralists will help us understand the root causes of violence and insecurity that are concealed in the interaction between the environmental, socio-political, and economic factors.

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Comparison of nutritional status of domestic and nomadic goats in the suburbs of Djibouti City

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In recent years, the settlement of nomads has been promoted in the Republic of Djibouti, and the number of farmer who settle and run livestock is increasing. However, many livestock feeds that can be obtained in the suburbs of cities where humans settle are closer to human diets than those that natural plants. Therefore, this survey was conducted with the aim of comparing the nutritional status of goats owned by nomads in the Djibouti with those owned by settled farmers and collecting insights into the nutritional supply of natural forage plants in the Djibouti.

The survey was conducted on dairy farmers in Ambuli near the capital and nomads grazing around Ali Sabieh in the second city. Dairy farmers raise around 50 dairy cows, 11 camels, 130 goats, and 50 sheep. They own 2-3 ha of pasture, and have shallow wells and 1000 L water storage tanks as water sources. Nomad was a breeding scale of 30 goats, 6 sheep, 3 donkeys, and 1 camel. The moving distance is 10 km square. In this survey, among the domestic animals, the survey items conducted on breeding female goats were age, body length, chest circumference, body height, body weight, blood glucose level, and blood β -hydroxybutyric acid (BHBA).

As a result of this survey, the goats raised by Nomad had a small body size and a light weight for their age. However, the ratio of waist circumference to body weight is high, and it is inferred that the lumen is well developed for the physique. In addition, there is not much difference in blood glucose level between Nomad and dairy farmers, and it is presumed that the nutritional status of Nomad goats is not bad. Furthermore, for BHBA, the value of nomad goats was high, suggesting that the organic acid produced in the lumen efficiently supplies energy. From the above points, it was considered that the goats bred by Nomad were less produced but not in poor nutritional status than the goats bred by dairy farmers.

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A lysimeter study on the dynamics of salt and water in salt affected soil after the construction of material-filled subsurface drainage

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In drylands, the progress of salt accumulation due to excessive irrigation and poor drainage has negatively affected agricultural production. Water-saving and improvement of drainage system are effective to prevent salt accumulation. However, the introduction of drip irrigation and subsurface drainage requires initial and maintenance costs, making it difficult for farmers in developing countries.

As a low-cost and easy technique to improve drainage function, a new subsoil breaker called “cut-soiler”, was developed in Japan, which fills crop residues at 40 - 60 cm depth in soil and that works as a drainage. The cut-soiler has been designed to contribute to the improvement of poor drainage fields in Japan. However, its applicability to salinity control in dryland is unknown. The purpose of this study was to experimentally demonstrate the use of cut-soiler at a salt affected field in India.

An experiment was carried out to evaluate the cut-soiler's effect to remediate saline soil by using lysimeter facilities (2 m square each) with and without cut-soiler plots during the dry and rainy seasons from October 2018 to August 2019. The soil salinity (EC) was continuously monitored by dielectric soil moisture sensors (5TE) in order to comprehend its dynamics by cut-soiler. The maximum EC at the depth of 12 cm with cut-soiler was 18.7 % lower than without cut-soiler during the dry season when it was irrigated. In the rainy season, the EC at the depth of 50 cm (filled depth by crop residue) with cut-soiler was decreased in response to rainfall, and the EC with cut-soiler was 38.2 % lower than without cut-soiler. Based on these results, it is concluded that the salts in the soil would be dissolved by irrigation or rainfall and the infiltration water containing dissolved salts would have been flowed along the subsoil drainage constructed by the cut-soiler and leached out from the outlet pipe.

Keywords: Cut-soiler, Drylands, Lysimeter, Salinization, Subsurface drainage

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Structure of agriculture sector in the southern part of Djibouti

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The agriculture sector plays an essential role in the country's economic development, such as food and funds for other sectors. This rule also applies to Djibouti, which locates in arid areas. Traditionally, self-sufficient nomads have practiced in Djibouti. Still, conventional nomads are no longer possible due to the limitation of natural resources such as grassland and the effects of population growth and climate change. Therefore, the government has promoted nomadic settlement agriculture. However, it is difficult to popularize settlement agriculture in Djibouti, where water resources are scarce. However, the number of farmers is steadily increasing due to technological developments. At first, the agricultural village, which used to be several farmhouses, has expanded to dozens of farmers, with the assistance of international organizations, and the number of such villages is also increasing. Farmers have diverse backgrounds, but farmers manage less water and produce food while settling down, and the domestic agricultural market is expanding. Thus, Djibouti's agricultural sector is still slowly but steadily developing. When considering the future development of Djibouti agriculture, clarifying the structure of agricultural and rural areas will be necessary for policy formulation. Still, few papers structurally explain Djibouti agriculture.

Therefore, this paper aims to sort out the development of agricultural villages and clarify the current agricultural structure in the southern part of Djibouti. Specifically, the focus on agriculture entitles, products, technology, market condition, and income formation ability will organize and analyze.

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Water and salt management of irrigated open fields using drainage water of an aquaponics

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An aquaponics which the water is repeatedly used between aquaculture and hydroponics facilities, is one of food production technologies effectively using water resource. Recently, we developed a new type of aquaponics combined with open culture in arid regions and conducted its feasibility studies in a pilot plant in Mexico. Since the drainage water discharged from the hydroponics in our system is finally used in open fields as irrigation water, it may be extremely a water-saving system. It has, however, potentially risk that accumulated excess salts in the open field. Therefore, we conducted open culture experiments in a pilot plant for monitoring the water and salt movements in soil of the open field in Mexico and estimated the salt accumulation risk through some numerical experiments. In the open culture experiments, irrigation was carried out once a day for about 40 minutes by a farmer who managed the test field. The amount of irrigation at one time was around 18 mm/d. Electric conductivity of irrigation water (EC_w) was around 4dS/m. Soil water and salinity were monitored by capacitance sensors at the point of a 3-cm distance from a drip tube and a 12-cm deep from soil surface. Although the field experiments had been conducted for 120 days, there were no remarkable increases of soil water and salinity at the monitoring point. HYDRUS 2D/3D were used for numerical experiments. The simulation conditions were that the amounts of irrigation at one time were 18mm/d and 6mm/d and irrigated once a day the water of 2, 4 and 8dS/m in EC. We had run the simulation model under the condition that the same climate with the potential evapotranspiration of 6.4 mm/d continued for 30 days. In this simulation, no remarkable salt accumulation in the root zone was estimated with the current irrigation condition (18mm/d and 4dS/m of EC), but the percolation loss toward lower layers were greater than water-saving irrigation condition. Although under the water-saving irrigation condition, the moisture condition of root zone was adequate for crops, it proceeded salt accumulation at the edge of a wet zone which formed by the water dripped from the tube. However, the water-saving irrigation can leave much amount of water than the ordinary irrigation. We might be able to leachate the salts from root zone using the surplus water. These results showed that the drainage water of the aquaponics can be used as irrigation water without salt accumulation by the adequate irrigation control for open fields in drylands.

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Optimum operational conditions of surface suction leaching method for effective removal of partially accumulated salts from salt-damaged soil

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In dry climates, salt accumulation in soil is a large problem for agriculture. Salts accumulate partially and in a very thin surface layer of the soil at an early stage of the progress. At this stage, leaching should be conducted only in the salt accumulation zone. The Surface Suction Leaching Method (SSLM) is a desalinization method that uses minimal water. An instrument for using the SSLM consists of three components: a water supply, drainage parts, and insertion parts. The water supply has a storage tank for the leaching water and a flow pump. The drainage parts include a vacuum pump and a collection tank for the drained water. The insertion parts include a disc-shaped container with a stainless-steel guide for insertion into the soil, a ceramic or stainless-steel filter, and an inlet/outlet pipe with a bidirectional stopcock. The instrument is inserted directly into a salt accumulation zone on the soil surface. Through the stopcock, the inlet/outlet pipe is connected with the water supply and drainage parts, respectively. An operator can select the stages of water supply for either leaching or collection of water for removal of salts by switching the stopcock. The desalinization process is as follows: 1) Leaching water is poured onto the soil surface by the flowing pump; 2) The water dissolves salts accumulated in the soil surface layer. The saline remains in this layer because the amount of water supplied is too small to percolate into lower layers; 3) After switching the direction of the stopcock, the vacuum pump of the drainage parts sucks the soil saline through the insertion parts. The process is continued until the soil salinity decreases to the desired concentration. It is very important for effective desalinization using this system to determine the supply time of the leaching water and the suction time of the dissolved salts. In this study, we conducted numerical experiments to clarify the relationships among the water supply time, the suction time, the collection rate of the water, and the removal rate of the salts. We determined that the optimum technique for saving leaching water with this method is to make the water supply time short and the suction time long. However, too long of a suction time increased the amount of leaching water required. The optimum combination of water supply time and suction time under the conditions of this study was 15 seconds of supply and 600 seconds of suction.

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Improvement of water stress tolerance of plants by endophytic fungus *Leptosphaeria* sp. strain T-2

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Endophytic fungi are a microbe that doesn't show the symptom even though it can infect to the host plant. They sometimes confer some function such as plant growth promoting (PGP) effects and environmental stress tolerance on the host plant. If it will be possible to use endophytes having useful ability in agriculture, they can be strong tool for sustainable agriculture under environmental stress conditions.

Leptosphaeria sp. T-2 was isolated from barley root grown at Toyama prefecture (Japan) in 2018. This fungus showed PGP effect on host plant, and this effect need direct fungal infection to host plant. Because, strain T-2 showed the plant growth promotion only when strain T-2 infected to the plant, whereas it didn't express the plant growth promotion when the culture broth of strain T-2 was applied. In addition, pot experiment showed that fresh weight of harvested plant was significantly heavier in the plant with strain T-2 than that without strain T-2. There was no significantly difference in dry weight of harvested plant, indicating that strain T-2 might enhance the water uptake of host plant. In order to reveal this fungal ability, strain T-2 grew on the MS medium with water stress using PEG8000. The results indicated host plant with strain T-2 survived even in the high water stress conditions compared with control (Fig. 1), indicating that the strain T-2 improved the water uptake capacity of host plant. Moreover, when strain T-2 grew on the MS medium added NaCl as salt stress, the host plant with strain T-2 obviously grew even in the salinity condition. Conclusively, this endophytic fungus, *Leptosphaeria* sp. T-2, was infected plant roots without any symptoms and improved the host plant growth. Moreover, strain T-2 could confer the drought and salinity stress tolerant to host plant. Further studies are contemplated to obtain a more information about the mechanisms for environmental stress remains unknown.

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Impact of TICAD (Tokyo International Conference on African Development) process on trends in extension of Japanese Enterprises in Africa

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Recent exploration of natural resources and rapid economic growth of Africa has been attracting enterprises in the world as a great opportunity of their business extension.

Japanese government has also put emphasis on business partnership with African countries rather than regarding as a target of development assistance of donors. The change of measure is reflected in trend of the main topics of a series of Tokyo International Conference on African Development (TICAD), held periodically under auspice of Japanese Government. Especially at TICAD IV held in 2016 and thereafter, economic and social growth was more emphasized rather than giving aids such as relieving poverty. In addition, contribution of Japanese private sector is encouraged and a series of measures has been taken to promote Japanese enterprises to African market.

This study aims to evaluate the impact of the measures related to the recent TICAD process on the extension of business of Japanese enterprises. A set of the lists of Japanese enterprises having business on Africa published by African Development Bank External Representation Office for Asia as of 2013, 2015, 2017 and 2019 was compared and analyzed the changes by countries and business categories.

So far South Africa and Egypt were the focal points of the business of Japanese enterprises and their local branches. However, since 2017, Kenya, Morocco and Nigeria have become additional focal points, which reflects in identification of several strategic economic corridors by Japanese government at TICAD VI.

Concerning the trends of business categories, extension of business of manufacturing enterprises, especially automobile related ones has been rapidly growing. Business of trading firms and financial services has been also growing rapidly in recent two years. Interestingly, Japanese used car trading shows unique trend of extension, starting from Zambia and surrounding countries and expanding to Southern and Eastern countries. On the other hand, construction business has been shrunk due to high competition with China.

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Nomads' perceptions of grassland in Töv Province, central Mongolia

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The aim of this study was to verify nomadic perceptions of grasslands, which are based on a view of nature held by the people who use these lands. According to our survey, the nomads believed that if the grasslands that are in poor condition were to be abandoned, the number of species and the amount of grass would increase. However, artificial environmental changes that have greatly exceeded nature's resilience have been carried out, and the grasslands cannot recover naturally, as predicted by the nomads' understanding. The vegetation ecosystem of abandoned cultivated land has irreversibly shifted to another state so, even if recovery by vegetation succession were to occur, the original grassland would not return. All the nomads had basically hoped to restore a degraded grassland, although some were concerned about the financial burden this would entail. Hence, the development of inexpensive and effective restoration methods for abandoned agricultural land is an urgent issue for the nomads. To consider sustainable grassland usage from multiple perspectives, it will be necessary to continue discussions that include the values of all stakeholders who are using agricultural land.

Keywords: Nomadic perceptions, Thoughts on grasslands, Land use, Restoration

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Does China's Belt and Road Initiative affect oasis agriculture in Central Asia?

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Located in Central Asia, Kazakhstan is characterized as a semi-arid region which includes dry steppe land in the south. Agriculture carried out in this area is typically oasis farmland with water taken from local rivers used for irrigation. During the former Soviet Union, irrigation projects were widely carried out to expand agricultural land, and large-scale irrigation projects were created in several areas. However, many of these areas were abandoned since the collapse of the Soviet regime in 1991. In recent years, agricultural reforms have been carried out in Kazakhstan, and the privatization and fragmentation of agricultural land has progressed due to the free trade of agricultural land use rights. The study area of the Zharkent (Panfilov) Region is located on the border between Kazakhstan and China, is a semi-arid area and has been cultivating corn by irrigation from the Ili River and the Usek River for many years. Therefore, there are many abandoned agricultural lands because of salinization. However, this area is the start point of the railway and highway of China's One Belt One Road (OBOR or Belt and Road Initiative, BRI) project to Europe, and corn production and exports are expected to flourish. In this study, we focus on the vulnerability of oasis agriculture and extract changes in agricultural land for about 30 years from 1989 to the present using Landsat series and Sentinel series and visualized them using RGB col-or combined techniques. The results show that agricultural land is disappeared or desertified at the Ili river basin and at the foot of the Zhongar-Alatau Mountains and that there are several years of fallow even in areas where agriculture is active. Using the Zharkent region in the irrigated alluvial fan of zhongar-Alatau Mountains of eastern Kazakhstan as an example, we classify the farm field changing using Landsat TM and Sentinel-2 satellite imagery and identify of vulnerability to the disappearance of oases farmland.

Keywords: Oases farmland changes, OBOR (BRI), Kazakhstan, Remote sensing

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Restoration of the distribution of pit-type Yaodong dwellings in the 1970s using US military reconnaissance satellite images in Luoyang Basin, China

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Yaodong is a traditional cave-type underground dwelling distributed in the rural Loess Plateau, China. It is widely found in the places where there is semi-arid, altitude is high, underground water level is deep, and loess deposits are thick. Particularly pit-type Yaodong is a form in which a rectangular pit is dug on the surface of the plateau, which is used as a courtyard, and a plurality of holes are excavated horizontally on the side of the pit. It is mainly observed in western Henan, the southern tip of northern Shaanxi, and eastern Gansu provinces.

Yaodong has various advantages suitable for the climate. For example, fluctuations in outside air temperature can be suppressed, creating an indoor environment that is “cool in summer and warm in winter.” Besides, Yaodong maintains a relatively steady indoor air temperature and therefore has an energy-saving effect. It can reduce energy consumption by about 40% and CO₂ emissions by about 60% compared to modern houses constructed on the ground. Moreover, the construction cost is reduced to about one-tenth of that of constructing a building on the ground, which contributes to reducing the economic burden on residents and sustaining resource utilization in areas with few trees. However, since the mid-1980s, when moving to a market-oriented economy progressed, the “New Rural Construction” movement aimed at reducing poverty, urbanization, and the rapid decrease of domestic farmland and flat land due to tree-planting campaign in mountainous areas and the demand for securing farmland on flatlands have led to the disappearance most of the pit-type Yaodongs and made it difficult to predict the situation at that time from the current landscape.

In this paper, therefore, we attempted to restore the distribution of pit-type Yaodong in the Luoyang Basin, Henan province in the 1970s by visually interpreting US military satellite images and using previous field survey data as a teacher. Furthermore, we examined the factors of Yaodong distribution, by analyzing the relationship between the restored Yaodong distribution and the altitude and topography on GIS. This study provides new knowledge from a geographical point of view on the architectural and cultural study of Yaodong and the loess plateau, by estimating in detail and extensively the number, distribution range, and distribution tendency of the pit-type Yaodong which is now lost and unknown. In addition, it provides the basic spatial information required for the evaluation of energy consumption and regional resource utilization associated with urbanization.

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Current status of Agricultural sector in Kyrgyz Republic from the perspective of increasing presence of individual entrepreneurs

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Agriculture is a major sector in the economy of Kyrgyz Republic (Kyrgyzstan), a small landlocked mountainous country in Central Asia. The National Development Strategy of Kyrgyz Republic defines agriculture and agroindustry as strategic priority sectors in the economy of the country. Collapse of Soviet Union in 1991 caused a drastic decrease in Gross Agricultural Output (GAO) in early 1990's, but GAO recovered to its level of 1990 in 2002 owing to the increasing output of peasant farms (“фермерские хозяйства” in Russian). Kyrgyz Republic implemented comprehensive and innovative land and agricultural reforms, especially land privatization policy adopted in 1998 caused dissolution of “Kolkhoz” and “Sovkhoz” and brought mass emergence of individual peasant farmers with their own small land. Output of peasant farms accounts for about 60 % of GAO and the number of officially registered individual entrepreneurs among peasant farms has more than doubled from 2007 to 2019, with the percentage of 26 % of the total in 2019.

Since early 2000's, the agricultural output growth has been slowing down due to low productivity, soil degradation, poor maintenance in irrigation system and lack of agricultural inputs etc. Under these conditions, the government intends to improve competitiveness of the agricultural sector through consolidation of the fragmented farmland and promotion of creating clusters. This new direction stated in the National Development Strategy obviously conflicts with interests of peasant farms, greatly contributed to the recovery and growth of the sector, especially emerging individual entrepreneurs might lose their incentive for investment under the consolidation policy initiated by the government.

On the other hand, the National Development Strategy stipulates that the government policy gives priority to production of environmentally friendly organic products, using Kyrgyzstan's geographical and climatic advantages in the regional markets. In late 2018, parliament ordered the government to develop a plan to achieve 100% shift to the organic farming within 10 years, and “Law on organic farming” was adopted in 2019.

Increasing presence of individual entrepreneurs might be defined in the context of promotion of organic farming to increase competitiveness of Kyrgyz agricultural products in the regional markets. In addition, the activities of “social entrepreneurs in agribusiness” who try to solve social challenges through business are notable in recent years. They are expected to contribute to the sustainable agricultural development and regional community vitalization in Kyrgyz Republic. Reforms in educational programs to foster entrepreneurs in sustainable agriculture has just started in collaboration with “social entrepreneurs”, the national agrotechnical college and Japanese agricultural high school in Hokkaido.

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Impact of grape production to improved family income in Uzbekistan: (Case study of small-scale grape producers in Samarkand region, Republic of Uzbekistan)

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Uzbekistan is one of the developing countries in Central Asia (CA) with an area of 447,400 sq. km. Agriculture production almost fully developed under irrigated agriculture. Arable land accounts 4.4 million hectares, or about 10% of Uzbekistan's total area. The role of agriculture is vital in national economy, especially in terms of food security, employment and considered as important income source for 4.7 million of households that operate *dehkan* (small-scale) farms in rural and disproportionately poor communities.

Uzbekistan is one of the top 15 grape producer country with 1.7 millions of tons (2.19%) for table (78.4%), dried (17.8%) and wine (3.7%) grapes. (FAO 2019, 2019 statistical report on world vitiviniculture). Most table grapes are grown in the south, especially in Samarkand and Fergana Valley, as well as in the Tashkent region. One of the cash crops for *dehkan* is grape and can improve of household income of the rural areas.

This study was carried out in thirteen villages: Samarkand region to identify the current conditions and challenges of local *dehkan* grape producers, regarding their income, consumption expenditure and food security, with due attention to heterogeneity among the farmers. Results from the analysis showed that viticulture contributed to more than four-fifths (84.1%) of total *dehkan* income and played a significant role in its welfare. We divided respondents into four groups by farm size (1st group: <0.36 ha, 2nd group: 0.36-0.50 ha, 3rd group: 0.51-0.70 ha and 4th group: >0.70 ha), and found differences among them in various household characteristics including the importance of viticulture income. Also, several challenges were identified; namely, lack of infrastructure, prevalence of pests and diseases, high prices of inputs, water shortage, low prices of grapes and raisin, lack of capital, limited access to markets, and lack of skills. This study has provided important implications toward viticulture development and further increases in *dehkan* income and their well-being.

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Increasing the export potential of raisin (dried grape) in Uzbekistan by implementing AHP approach for developing export strategy

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Agriculture plays an important role in Uzbekistan's economic development. Grape production is one of the historical agricultural products for Uzbek people. The most part of the grapes are exported as table grapes and raisins. Nowadays, Uzbekistan is gradually increasing the production of raisin. Therefore, raisins are Uzbekistan's one of the main product in agricultural export. Raisin production share in Uzbekistan is 17.8% of fresh grape, which is much more than the world average, 7.0% (OIV statistic 2016). Due to the raisin's positive health effects, its consumption is increasing gradually in the world by creating a higher demand in the world market. Even though Uzbekistan is one of the top exporting countries in the world by volume, its average price for raisin is remaining very low comparing to the world average price. Achieving the world average price would be a better opportunity for agribusiness participants, in particularly, indirectly increasing the incomes of *dehkans*, *farmers*.

Therefore, the aim of this research is to develop sustainable export strategy for the agribusiness in Uzbekistan by finding out the factors for raisins' low price in the world market. We conducted a questionnaire survey and analysed the AHP model. As the export strategy is subject to multi-criteria decisions, using the Analytical Hierarchy Process (AHP) model will be powerful method. All criteria or factors influencing the final price of raisins were grouped into six main criterions clusters. The questionnaire had send to more than 500 exporters and received responses from about 10% of them. The results of the questionnaire show that the most important factor in deterring the prices is the quality of the product, availability quality control laboratory, and certification with the best alternative as Golden raisin, following the other varieties. The solution of these factors alone would improve the current issues with the export price by almost half. Another finding of the study is that new agribusiness entrants with less than 3 years of experience in the international trade prefer less capital-intensive raisins comparing to Golden raisins such as black raisins and black raisin *soyaki* varieties.

(Reference: Saaty Th, Vargas L. 2012. Models, Methods, Concepts & Applications of the Analytic Hierarchy Process. 2nd ed. New York (NY): Springer.)

Keywords: raisin, dried grape; agribusiness analysis; AHP model; export of raisin; Black raisin *soyaki*; Golden raisin

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The perspectives of sustainable development of agritourism in Uzbekistan

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Agritourism is being mentioned as a useful alternative activity for income growth on farms and rural development. Therefore, agritourism is increasing quickly worldwide and one of the most significant supplementary income sources for farmers. The study deals with the development of agritourism in Samarkand, and it is based on several scientific researchs and statistical data as well as there is a great opportunity for agritourism activities. There is a need to increase the economic potential of rural areas and it is necessary to create modern activities on *farmers* and also ensure their sustainable development. Samarkand has extremely favorable conditions for many forms of tourism, especially for agritourism. The main purpose of the study is to identify the current situation and issues of sustainable development of agritourism in Samarkand Region, Uzbekistan. There are 10 *farmers* carry out agritourism in Samarkand. We conducted a survey on all 10 of these *farmers* as well as surveyed 100 random selections from *farmers* that do not carry out agritourism in Samarkand Region. The collected data were analysed using Logistic regression model and t statistic to estimate the probability of participation of *farmers* in agritourism. The results show that there are significant socio-economic differences among agritourism and non-agritourism farmers, as well as only 0.10 % of *farmers* are already engaged in agritourism, and they earned additional income from agritourism, and they are, as well as they plan to offer more agritourism activities for tourists. Out of 110 *farmers*, 46 *farmers* plan to participate in agritourism and aim to earn additional income in the future. As shown in the results, farmers in Samarkand are undergoing many challenges to participation in agritourism, such as lack of knowledge on agritourism, lack of financial assistants, poor infrastructure, lack of marketing, inadequate Government support, and a low number of tourists.

Keywords: Agriculture, tourism, agritourism, sustainable development, rural development, rural areas, Samarkand Region

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An interval regression analysis of Japanese consumer's preference for cosmetic argan oil

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The argan tree is an endemic specie which is located in the south-western part of Morocco, in arid to semi-arid areas. Recently, it gained fame as a patrimonial wealth as it celebrates its international day in May 10th. The argan oil has a large-scaled interest as an economic opportunity, as it is used by many companies in several cosmetic products. The Moroccan export of Argan oil also increased exponentially – 483 times between 2000 and 2016, driven by its expansion to the international markets.

In order to better valorize and commercialize this rare natural resource, we should acquire better knowledge on the foreign consumers' behavior, their knowledge on argan oil, their product experience with argan oil, how much they would pay for argan products and how to increase their willingness to pay (WTP).

In this study, as the Japanese cosmetic market is wide, prolific and remunerative, we aim to search for main variables that increase the overall consumers' willingness to pay, and hence, evaluating the consumer preference for cosmetic argan oil in Japanese market using the payment card method. For that reason, an online survey comprising of 20 questions was conducted which collected data on 836 respondents. Based on these data, consumer's preference for cosmetic argan oil was evaluated using interval regression.

Displayed results showed high variables significance and comparative model efficiency. Regression coefficients are higher for variables that indicate information (knowing argan oil), category experience (experiencing vegetable oil based products), product experience (experiencing argan oil based products), and interest for vegetable oil based cosmetic products (gathering information, purchasing from pharmacy). Therefore, argan oil should first be introduced to consumers so that they may purchase it and be willing to pay more.

Keywords: Consumer preference, Cosmetic Argan oil, Japanese consumers, Interval regression, Willingness to pay (WTP)

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Refugee settlement and heat in arid regions: The case of Jordan

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Arid regions are characterized by an ecological environment with abundant solar radiation, little precipitation, and a marked diurnal variation in temperature. In these ecological conditions, heat is one of the factors that determine all aspects of the lifestyle of the local people, such as clothing, housing, and livelihood. It is to be expected that in arid lands a great deal of knowledge about heat has been accumulated. In this study, the contemporary event, the refugee settlement, and elucidate its relationship with heat are analyzed. By focusing on the refugee camp established in Jordan in response to the influx of Iraqi refugees, it analyses their life of encampment in arid area.

It is pointed out that the area is a desert area, where it is very hot in summer and when storms blow, the refugees' tents are immediately filled with sand, making it a harsh environment to continue living in. This situation has been reported worldwide and the Jordan's inhumane treatment has often been criticised by international organizations. Though Jordan's position has been one of outright refusal to accept them, as most of the refugees were Palestinian or Iranian Kurds. Jordan already has more than half of its population of Palestinian descent, she could not tolerate any more of them. The camp was therefore surrounded by a fence, under constant surveillance by the Jordanian army and with limited freedom of movement.

In the camps, most of the infrastructure, such as water, electricity, shelter, and food, was totally dependent on aid. In terms of housing, although the framework has been strengthened and some improvements have been made to provide more space, it is believed that the basic form of housing has continued to be simple tents. As a result, the camp was closed when all the refugees had been resettled in third countries, but it is obvious that it would have been preferable to close the camp at an earlier stage. Despite this, the fact that the camp continued to be established for 6 years should be noted above all. The fact that the camps were able to continue shows that in the desert, people can live in simple houses as long as they can secure scarce water resources.

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Comparison of pastoralists' pastoral strategies in the Mongolian Plateau

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This presentation will compare pastoralists' pastoral strategies in the Mongolian plateau, which is divided into Northern and Southern Mongolia politically.

The Mongolian Plateau is one of the central places of pastoralism in inner Asia. Because of its dry and cold climate, mobile pastoralism was traditionally prominent.

However, global capital investment started to involve pastoralists into cash economy more and more deeply, by way of paved roads and availability of mobile phones after 2000s. The characteristic of today's situation is coexistence of two pastoralists' pastoral strategies according to the place they live; that is, suburban pasture and remote pasture.

In Northern Mongolia, the trigger which made change of pastoralists' pastoral strategies happen was a nationwide cold and snow disaster from 1999 winter to 2002 spring.

It drastically reduced number of livestock, which rapidly increased during 1990s after the collapse of socialistic economic system. However, the lowest number by which they could keep sustainable life as pastoralists varied depending on the place pastoralists live. At suburban pasture where is close to cities or major roads, a smaller number of livestock is required. There are two major reasons for it; they can sell dairy products in addition to livestock and cashmere which are traditional commodity for sale, and costs for transportation are cheaper, comparing to remote pasture where mobile phone, which is necessary for selling dairy products, is generally out of service.

As a result, pastoralists who migrated into suburban pasture increased, where density of pastoralists had not been dense at socialistic era. On the other hand, not a little number of pastoralists decide to remain in remote pasture for some reason; large number of livestock is more suitable for sparse remote pasture, for instance.

This dichotomy is not only true to Northern Mongolia, but also to Southern Mongolia. Because the number of livestock which pastoralists can keep is controlled rather strictly according to carrying capacity set by local government, pastoralists in remote area who generally own wider pasture keep larger number. On the other hand, pastoralists in suburban area often started to get cash income by new way; tourist camps or fermented mare's milk for instance. This phenomenon in Southern Mongolia also emerged after 2000s, when the central government recognized environmental problem in pastoral area and attributed it to overgrazing of pastoralists which was caused by privatization of livestock and pasture after 1980s.

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Combating desertification through innovations in arid zone: Case study from Pali, India

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New approaches and technologies involving application of blended modern agroecological science and indigenous knowledge systems have shown to enhance food security while conserving natural resources and soil and water under stress conditions. Under hot arid zone of Thar desert Mr Rambharti a farmer of Pali India, decided to go for multifunctional agriculture and convert his barren area into an integrated farm, utilizing innovative approaches. Every year the farmer prepares his field in summer by deep ploughing and making deep ridges so that he can trap maximum rain water in his field for the upcoming crops. Crop rotation forms the basis of the farming system as crops are grown naturally without external inorganic inputs. The crops are grown in a unique rotation, which means that the same crop is grown in the same field only once every three years. Besides field crops incorporation of spice crops mainly cumin, fenugreek, fennel and ajwain plays a very important role in farm sustainability as spices are disease resistant, hardy and requires less water. Animal integrated farming forms the backbone of his agriculture providing him with milk, fibres and valuable organic waste rejuvenating his soils and increasing moisture retention. Under rainfed conditions he practice intercropping of green gram with sorghum and sesame which reduces the climate-driven crop failure as variety of crops have different climatic adaptability. Intercrops efficiently utilize the natural resources such as land, light, water and nutrient and increase biodiversity, productivity, resilience and stability of agroecosystem. In addition, crops facing threats from the same or similar pests are not grown in bordering fields or in a sequential season in the same field. Also crops requiring high nutrient inputs are not grown in sequence in the same field. The main crops are pulses, spices, barley, oats and wheat. Leguminous crops have less water requirement and fix nitrogen which the other nonlegume crops need. Hardy grasses planted at margins prevent run-off of minerals from the field into bordering ditches. In addition, they attract natural enemies for pests in the crops, provide habitat for pollinators and have an esthetical value as well. These practices have built soil organic matter and the soils are now self-enriched. Acacia trees planted on farm boundary acts as biological fence and as sink for carbon dioxide and exploit the ecological and economic interactions of the different components. Thus alternative agriculture in the form of multifunctional model integrating different components with farming produce sufficient yields by maintaining crop-fodder-livestock -forest plant diversities and manage equitable socio-economic access outcome to the poorest section of the society.

Keywords: arid zone, deep ploughing, crop rotation, soil organic matter, sustainability

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Embroidery production system in current Palestinian Territories

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Palestinian peasant and bedouin women started embroidery to reinforce their cloth for heavy labor, then embroidery spread all region in Palestine. Palestine War had begun in 1948, women had no longer been able to make embroidery. Palestinian women re-produce embroidery under occupation by Israel with the support of NGOs for economical independence and the cultural identity as Palestinian. Nowadays not only NGOs but also cooperatives are established to produce embroidery. We investigated fieldwork research in West Bank how they produce embroidery and it became clear that production system differs among NGOs and cooperatives. However, research on embroidery and economical independence has not been done enough.

The Society of Inash al Usra, Palestinian local NGO in Ramallah, West Bank, was established in 1965 and support village women in Ramallah and about 5000 women register as embroider. UNRWA Embroidery Project Sulafa is NGO and was established in 1950 in Gaza city by UNRWA(United Nations Relief and Works Agency for Palestinian Refugees) as a part of social service program, and support refugee women in 8 refugee camps in Gaza district. About 300 refugee women register as embroider. Both of NGOs provide embroidery work for village women or refugee women and pay wage according to their work. NGO staff finish as final products, pricing and selling to sales-supporting NGOs and retail shops. On the other hand, women in Al-Amari refugee camp near the city of Ramallah, established cooperatives by themselves with about 30 embroidery group members in 1993. Cooperative members produce embroidery, finishing as final products, pricing and selling to sales-supporting NGOs and retail shops.

The 1995 Oslo II Accord established the administrative division of the West Bank into areas A, B, and C. Area A is administered by the Palestinian National Authority; Area B: by both the Palestinian Authority and Israel; and Area C is administered by Israel. 61% of the land of West Bank is Area C and most of this land is agricultural land. Especially farmers in area C have to be cope with severe restrictions by Israeli government and suffer from low income. We researched if there is a difference between the area they live and the income they get from embroidery work. Results show that women who works with the support of NGO can earn income regardless of the area they live.

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Water Resources Modeling of Ali Faren Catchment in Ambouli Watershed, Djibouti

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The water resource utilized for social activities in Djibouti is almost exclusively groundwater which is abstracted by shallow wells from the porous sediments in wadis with estimated thickness of several meters to around 20 meters, and by deeper wells from the fractured zone of basaltic base rock. Because of small annual precipitation and high geological ambiguity associated with wadis and fractures, to find out new good groundwater locations is not an easy task in Djibouti.

In this project, utilizing collected various field data, we try to construct numerical hydrologic models for estimating groundwater movement through wadis and fractures. A terrestrial fluid flow simulator GETFLOWS is used for this purpose, in which surface/subsurface coupled flows under precipitation/evapotranspiration are dealt. It might be able to reproduce and visualize occasional flooding through wadis at rainfalls, infiltration into the wadi sediments, and flow/retention of groundwater in wadi networks.

For the first modeling site, we deal Ali Faren catchment, a small part of large Ambouli watershed which spreads in the south-west of Djibouti City.

Using the satellite image of Google Earth and high-resolution DSM (AW3D supplied by RESTEC), the target area including wadi networks and base rock surface were discretized three-dimensionally into around 35,000 horizontally and 15 vertically, with corner-pointed structured grid system.

In the symposium, we will present the modeling procedures, settings of geological conditions and hydraulic parameters, and results of simulation including model equilibration, calibration and prospecting case studies.

Keywords: groundwater resource, wadi network, integration of field information, numerical modeling and simulation

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Food insecurity is expecting in upcoming decades in the Zarafshan River Basin of Uzbekistan

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Uzbekistan is recognized as one of the world's most vulnerable regions to the impact of long-term climate change process. The potential threats in the food insecurity is related to the period 2003-2100 are based on ensemble projections of global climate models provided by the Tyndall Centre for Climate Change Research and updated for Zarafshan River Basins areas (*Samarkand, Bukhara, partly Navoi*). The extended period 1901-2100 presents to depict global trends in observed climate and projected climate change scenarios for Zarafshan River Basins in the side of Uzbekistan. The main results comprise an estimation of the shifts of climate zones within the 21st century by considering different IPCC scenarios. In upcoming decades, the water shortages could severely limit irrigation water availability in almost all river basins of Uzbekistan, and are taken into account in Zarafshan river basin areas will influenced a negative effects on almost all crops (*cotton, wheat, vineyards*), with reductions of 10–25 percent in yields through 2050. Increased temperatures can lengthen growing seasons; and as well as a higher carbon dioxide (CO₂) concentration can enhance plant growth. Also, the Köppen-Geiger climate classification projected with Tyndall temperature and precipitation data for the period 2076-2100, A1FI emission scenario, multi model mean, on a regular 0.5 degree latitude/longitude grid and estimated changes around the selected area. The four scenarios are designed to reflect a range of global circulation model (GCM) outcomes for agriculture that include a low-impact, medium-, and high-impact outcome in the Zerafshan River Basin.

Keywords:

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