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Study of the Impact of Environmental Factors on Vegetation Diversity (Case study: Eshtehard Rangelands)

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Abstract

The effect of environmental factors on vegetation diversity in Eshtehard rangeland was studied in present study. Sampling was done using Minimal Area method. To measure the plant properties in each type, regarding the extent of each type, three 500 meter transects with 50 meter intervals between transects (due to the scarce vegetation cover) were established. In each plot, the number and types of existing species and their percentages were determined. Also, profiles were dug at the beginning and end of each transect and soil specimens were sampled at 0- 20 cm depth. Among soil properties, the percentage of clay, silt, sand, organic matter, lime, acidity, electrical conductivity, calcium, magnesium, sodium and potassium were measured. After collecting data, Shanon-Winer species diversity and Simpson indices were determined using Ecological methodology Software. Finally, the most important factors effecting the species diversity variation were specified using Principle Component Analysis. The results showed that among the studied factors, elevation, slope, soil depth and lime are the most effective ones.

Keywords: species diversity, environmental factors, principal component analysis, Shanon – Winer index, Sympson index.

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Low Flows Trend Assessment in Isfahan Province

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Abstract

Although a number of studies have been carried out around meteorological drought in Isfahan province, there is no specific study about hydrologic drought. In this study, low flows trend was analysed for the first time as the most important indicator of hydrologic drought in Isfahan province watersheds. Mean daily stream flow as a hydrologic indicator and 1-, 7-, 15-, 30- and 90-day low flows were estimated as hydrologic drought indicators for 22 gauging stations with at least 20 years of data record. Results of trend analysis using Mann-Kendall and Spearman correlation indicated that mean daily stream flow and low flows have negative trend at many gauging stations. Apart from *GhalehShahrokh* station, low flow indices in *Zayandehrud* dam basin have negative trend so that *Eskandari* station shows the highest degree of negative trend. Daily stream flow and low flows reduction especially in recent years is kind of warning for water resources management in *Zayandehrud* basin.

Keywords: Hydrologic drought, low flow trend, *Zayandehrud* Dam, Isfahan province, risk, water crisis.

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Evaluating the Efficiency of Empirical Formulae Based on Grain-Size Analysis and Infiltration Equations for Estimating Sediment Hydraulic Conductivity (Case Study: Jarmeh Flood Spreading System, Khuzestan Province)

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Abstract

Hydraulic conductivity is an important parameter for controling water flow through porous media. Hence, accurate estimation of this parameter is important for evaluating flow exchange between surface water and groundwater. In this study, 12 empirical formulae based on grain-size and 4 infiltration equations were used for estimating hydraulic conductivity on 3 sites in *Jarmeh* flood spreading system, Khuzestan Province. Results were evaluated using measured hydraulic conductivity by double rings infiltrometer. The results of the empirical formulae showed that 9 formulae were overestimated or underestimated and 3 formulae were close to measured values. Hazen formula gave the largest overestimation and Slitcher formula gave the largest underestimation and Shepherd formula is the best one. Generally, empirical formulae applicability requires the calibration of C coefficients. The results of the infiltration equations showed that all of 4 equations estimated hydraulic conductivity appropriately and there are no significant differences between them. Among the equations, Kastiakov and Green-Ampt were the best.

Keywords: hydraulic conductivity, empirical formulae, infiltration equations, double Rings, Khuzestan.

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Predication of Sediment Concentration in Rill Flow Using the Adaptive Nero Fuzzy Inference System in Semi-Arid Regions

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Abstract

In many semi-arid regions of Iran, soil erosion has turned into a serious environmental problem affecting land productivity, nutrient loss, water quality, and fresh water ecosystems. Rates of soil loss differ according to erosion type and land degradation processes. Rill erosion is commonly observed when rainstorms occur on steep slopes and sediment transport in rill flows exhibits the characteristics of non-equilibrium transport. In this paper, sediment concentration of rill flow is estimated by adaptive neuro-fuzzy inference system (ANFIS). A series of mathematical equations and parameters affecting rill hydrodynamics and soil detachment were used for well-defined rill sediment concentration. A series of filed experiments were performed to evaluate the model. The stepwise method was used to select the most important and effective input variables from measured input parameters of soil properties, topographic and vegetation attributes affecting sediment concentration of rill flow. Based on the stepwise procedure, the most significant parameters in the model predications were steep slope, vegetation percentage, clay percentage, and shear stress parameters. The values of sediment concentration simulated by the model were in agreement with observed values with Coefficient of Correlation (R^2), Root Mean Square Error (RMSE) and Mean Bias Error (MBE) of 0.697, 30.5 and 1.0, respectively. The results of the investigation shows that the data-driven ANFIS modeling approach can be a powerful alternative technique for correctly estimating rill sediment concentration.

Keywords: Rill erosion, sediment concentration, stepwise method, modeling, ANFIS.

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Investigation of the Efficiency of SINMAP and SHALSTAB Physically-based Models for Landslide Hazard Zonation

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Abstract

Landslide is one of the most important geological phenomena in northern slopes of Iran (Alborz) which causes considerable damages gradually. In the last few years, due to unfavorable changes in land uses and increasing degradation of pastures, forests and farmlands as well as implementation of inappropriate development projects in areas prone to landslides, geology formation prone to landsliding, rainfall rate and steep slopes, the occurance of this destructive phenomenon has constantly increased. In this research, landslides which occurred around *Sari-Kiasar* road were investigated using physically based models i.e. SINMAP and SHALSTAB and the stability map of the region was determined applying these models. First, the physical and mechanical properties of soils in 13 points were measured and evaluated by 56 landslide points. The results of field studies, laboratory samples, running models and data analysis showed that these models (SINMAP and SHALSTAB) have success rate equal to 87.3 % and 69.5%, respectively for predicting the slope instability in ChaharDonge region. This means that the SINMAP model has more efficiency than SHALSTAB model for slope stability analysis.

Keywords: landslide, SINMAP model, SHALSTAB model, hillslope stability map, *ChaharDonge* region.

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Determining the Most Important Geo-Morphometric Parameters in Classification of Desert Plains using Artificial Neural Networks and Sensitivity Analysis

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Abstract

Plains are one of the most important geomorphological units and different parameters have been considered for classification of plain areas. One of most common classifications in natural resources studies in Iran entailing different qualitative and quantitative factors is: bare plains, apandazh plain and covered plain. Such classifications are used to make plains distinguishable from one another. In this study, the geomorphometrical parameters were considered for plain classification by using artificial neural networks and sensitivity analysis. These parameters were extracted by using mathematical equations and applying the corresponding relations on digital elevation models and they are not widely used in Iran. Geomorphometric parameters that were used in this study included Percent of slope, Plan Curvature, Profile Curvature, Minimum Curvature, the Maximum Curvature, Cross sectional Curvature, Longitudinal Curvature and Gaussian Curvature. These parameters were calculated in an area of 125000 hectare and at 1500 points, and the result was compared and calibrated with ground truth map. Sampling method in this study was Latin Hyper cube that is a kind of stratified random sampling. Results of this study show that the most important geomorphometric parameters to classify desert plains include Plan Curvature and Profile Curvature that have the highest sensitivity among different plain types. The more the topography of the area reduced the more the contribution and importance of these factors for separating plain types decreased so that these parameters were most prominent in bare plains but had the lowest efficiency in covered plains.

Keywords: Geomorphometric parameters, classification, plain, artificial neural networks, sensitivity analysis.

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Forecasting and Comparison of Future Climate Change by Using GCM Models under Different Scenarios in Talar Watershed of Mazandaran Province

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Abstract

Present study is aimed at forecasting and comparison of future climate change by using GCM model (General circulation model) under different climate scenarios in *Talar* watershed of Mazandaran province. Regarding the data of existing stations, to study the climate change phenomenon in *Talar* watershed, the LARS-WG5 model and 3 climate scenarios i.e. A1B, A2, B1, each in three emission series i.e. 2011-2026, 2046-2061, and 2080-2095, that were extracted from Gharakhayl regional synoptic stations in Quaemshahr, were used and the base year was considered 1992-2007(for a 15- year duration). Since this model is one of the most authentic statistical downscaling methods and its data is produced in three phases of calibration, evaluation and development of meteorological data, it was applied for research in present study. According to the findings, the most precipitaion changes occurred in May and October and the most severe reductive changes occurred in 2080-2095, the result of which warns about seasonal floods in rainy months and drought or water shortage in dry months in the relevant watershed study area. Besides, in future in June, July, August, and September temperature increase will be experienced but in January and February, the minimum simulated tempreture mean will be observed.

Keywords: Climate change, GCM models, future temperature and precipitation, weather scenarios, Talar watershed.

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Technical Assessment of Watershed Operating Steps in *Sologan* Aquifer's Basin

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Abstract

Although more than 45 years has passed since the first time operating watershed projects were run inside the country and considering the increasing budget that is being allocated to such projects, terrible soil erosion, natural resource degradation and the dazzling and painful consequences of such events are indicative of low efficiency and failure of natural resource protection projects. Therefore, since watershed projects involve many agents and management needs to be as effective as possible, assessment of how suuccessfully the project objectives have been realized is essential. The *sologhan* aquifer's basin with an area of 20571 hectar is one of the basins in which watershed project was carried out in winter 2000. To assess the effectiveness of the above mentioned project, required statics and data was collected and the accuracy of meteorology and hydrology data was examined and the double mass curve, annual hydrograph comparisons, hydrologic analysis, sediment examination in dry and moist periods, sediment graph, studding the amount of sediment in precipitation periods prior and post projects implementation were considered and used. Double mass curve shows the positive effects of this operation on the amount of runoff and sediment. Hydrologic regime curves show as well that watershed operations had positive impacts upon the basins hydrologic reaction to rain so that the amount of runoff as a result of similar amount of precipitation has decreased. Furthermore, the amount of annual suspended load has decreased from 47892.56 to 22365 tons, so did the amount of Debbi and sediment. Above results prove the positive effects of watershed projects.

Keywords: assessment, *Sologan* basin, watershed projects, suspended sediment load.

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Numerical Analysis of Effective Factors in Landslide Occurrence and its Sensitivity Zonation Using Logistic Regression and Multivariate Linear Regression (Case Study: Marbor Watershed)

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Abstract

Present study seeks to identify effective factors in landslide occurrence and landslide sensitivity zonation using logistic regression and multivariate linear regression. Accordingly, through the interpretation of arial photos with scale of 1:40000, geological, topographic maps, and field survey using GPS, landslide hazard map was prepared as dependent variables. For determination of effective factors in landslide occurrence, using Support Vector Machines in Rapid Miner Software, the numerical values of the parameters were analyzed and from 21 selective data layers, 15 data layers were selected and were prepared and digitized for zonation map as the independent variable in ArcGIS 10.1. After weighing the layers, zonation map was prepared using selective method in five classes: very low, low, moderate, high and very high. Result of weighting layers showed that in both methods, land use and aspect have the greatest impact on landslides. The ROC (Receiver operating characteristic) curves and area under the curves (AUC) for landslide susceptibility maps were constructed and the areas under curves was assessed for validation purpose and its values showed that multivariate linear regression model (0.890) has a higher efficiency than the logistic model (0.829) for landslide hazard zonation. According to result of superior model (multivariate linear regression), 16046.1 hectare (20.13%) of the region was found to be located in high risk class and 15671.2 hectare (19.66%) was in very high risk class.

Keywords: numerical analysis, zonation, multivariate linear regression, landslide, logistic regression.

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Investigation of the Quality of Plant Species Partsin at Different Phenological Stages Using NIRs (Case Study: Rangelands of Nodooshan-Yazd)

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Abstract

The most important factor affecting forage quality is phenological stage that if it is recognized correctly, the appropriate grazing time will be determined. In this study, four species including *Artemisia sieberi*, *Salsolakerneri*, *Aelieniasubaphylla*and*Eurotiaceratoides* in different phenological stages (vegetative, flowering and seedling) were sampled. Samples were taken from the rangelands of *Nodooshan-Yazd* in 1389 and 1390. At each stage, five replicates for each plant species were selected and at least five vegetable bases from different locations of vegetation type in the region were selected. Samples were grinded after drying and separating different parts (flower, leaf and stem) and then they were analyzed using infrared spectroscopy in the laboratory. Important indicators of quality such as crude protein (CP), acid detergent fiber (ADF), dry matter digestibility (DMD) and metabolic energy (ME) were determined. Results showed that the highest percentage of crude protein is found in leaves of *A. subaphylla*and in vegetative stage (9.19%), highest percentage of ADF is in shoot and in seedling stage (53.42%) and the highest percentage of DMD (48.13%) and the highest amount of metabolic energy (6.18 *MJ/KgDM*) is in leaves of *A. sieberi* and in vegetative stage, respectively. The end of the vegetative period can be considered the best time for grazing.

Keywords: Quality, plant species parts, different phenological stages, NIR.

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Dynamics of Sediment Hysteresis Patterns during Storm Events

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Abstract

Understanding and quantifying the dynamics of suspended sediment transport is essential to control soil erosion and implement appropriate mitigation practices to reduce stream suspendedsediment and on-site and off-site effects of sediment transport. However, the quantification and the interpretation of sediment hysteresis loops as fluvial and hydrological responses of the watershed to storm events has been less considered. Hence, the present study was conducted in three different regions viz. the Educational and Research Forest Watershed of TarbiatModares University in Mazandaran, the Galazchai Watershed in West Azerbaijan and the Daretefi Watershed in Kurdistan Provinces to investigate the dynamic of sediment hysteresis loops on storm wise basis. The results of analyzing 67 storm event hysteresis loops verified the variety of governing condition of all three study watersheds. According to the results, all of the sediment hysteresis loops showed flushing behavior but with different rotational patterns of clockwise, counterclockwise and 8-typed and complex. Despite of differences and more diversity in precipitation pattern, compared with two other study watersheds, Daretefi Watershed sediment hysteresis loops showed less variety and mainly with 8-typed and complex forms with frequency of 61.29%. Results also revealed a frequency of 44% for both clockwise and complex hysteresis loops in the Galazchai Watershed and frequency of 53.33% for complex hysteresis loops in the Educational and Research Forest Watershed of TarbiatModares University. The results also showed that the sediment sources in the study watersheds were mainly close to the outlet with further emphasis on wash load contribution.

Keywords: Sediment availability, Sediment behavior, Sediment- Discharge Relationship, Sediment flushing, Sediment temporal variation.

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Prioritization of the Problems for Settling Nomads in Northern Khorasan Based on Hierarchical Analytic Process

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Abstract

Current nomad settlement programs seek improving the quality of nomads' life as their ultimate goal. However, it seems some of these programs failed due to some problems such as socio-economic problems that appear after settlement or due to the lack of proper preliminary studies before the implementation. Nomad settlement program in Northern Khorasan is not an exception; therefore, identification and prioritization of problems before implementation of the program in Northern Khorasan is essential for better planning. The required data to identify and prioritize nomad settlement problems and to plan for their proper settlement were gathered through a questionnaire including the criteria and sub-criteria as well as options to solve extant challenges. The questionaire then was completed by experts and analyzed by using the analytic hierarchy process in Expert Choice2000. The results showed that cultural and social management and planning factors with coefficients of (0.433) and (0.314), respectively left the greatest influence on the failure of relevant projects in North Khorasan province. Therefore; the reform of the administrative and planning system as an important solution to problems related to the management and planning criteria and increasing the nomads' participation in planning and management as an important solution to problems related to social and cultural criteria were assessed in present study.

Keywords: Analytical Hierarchy Process, Settlement, nomads of North Khorasan.

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Effects of Salinity Stress on Stomata Variations of *Hedysarumcoronarium* L. and *Hedysarumcriniferum* Boiss

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Abstract

Effect of salt stress on the stomata variations was studied in *Hedysarumcoronarium* L. and *Hedysarumcriniferum*Boiss., using optical microscope. The experimental design was a two factorial (species treatments and salt concentrations including 0, 100, 200, 250 mMNaCl) which arranged in a completely randomized design with four replicates and 50 seeds per replicate. Seeds were grown in plastic pots with sterile sand. All pots were irrigated by distilled water until germination stage. Then the pots were irrigated uniformly every other day with modified Hoagland's nutrient solution during 40 days and finally stomata traits were measured. The data was analyzed using SPSS software. The difference between the means was compared using Duncan test ($P<0.05$). Results showed that the lowest amount of the stomata length, stomata width and area of stomata were observed at 300 Mm salinity stress. Length and width of stomata were reduced by increasing salinity stress. The length stomata decreased 22.33 and 23.76 (µm) for *H. coronarium* and *H. criniferum* respectively, while width stomata decreased by 17.13 and 18.62 (µm) respectively. The area of stomata decreased 397.11 and 442.83 (µm²) for *H. coronarium* and *H. criniferum* respectively. Salinity stress had positive effect on stomata density (mm²). The highest density of stomata was found in *H. criniferum*in 250 and 300 mM salinity levels.

Keywords: Salinity stress, Stomata, density, *Hedysarumcoronarium*, *Hedysarumcriniferum*.

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Simulation of Daily Stream Flows in Semi-Arid Mountainous Watersheds Using FORTRAN Hydrological Simulation Program (HSPF)

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Abstract

Hydrological Simulation FORTRAN Program (HSPF) has long been used in modeling watersheds and many studies have been carried out around the world in this regard. *Hablerood* watershed is located in Semnan province with an area of 3200 km^2 which suppies the required water, especially for farming, in Garmsar plain. Previous studies on daily step and related to hydrology and water resources in this watershed were limited to computation of statistics summaries of daily stream flows. Therefore, simulation of daily stream flows is very important. In this research, the parameters of HSPF model were estimated and the results of model in current conditions with minimum data availability are discussed. In general, it was found out that since the model performance using WinHSPF has high errors in metric system, English system must be used in stead. Also, due to the model's need to hourly time series data, more detailed information about Hydrological components, and other terrestrial data as well as due to low accuracy of these data and model's objection in some cases such as using the mean of infiltration parameter for a given land use segment and the lack of certain criteria in watershed delineation, high errors occurred in daily stream flow simulation with the Nash-Sutcliffe model efficiency coefficient of 0.77 and 0.18 as well as 0.468 and 0.49 for R^2 in calibration and validation period, respectively. Also, simulated flows in late spring are higher than observed value, while in late summer through fall are lower than observed value. Finally, at the end of the paper we discuss the solution to obtain better results.

Keywords: Daily stream flow simulation, Hydrological Simulation FORTRAN Program, (HSPF), Hablerood watershed.

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Assessment of Social Capital of Beneficiaries' Network in Line with Local Sustainable Development (Case study: South Khorasan Province, RFLDL Project)

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Abstract

Social capital is one of the main factors for local sustainable development and social empowerment. The objective of present research is social capital assessment to achieve local sustainable development in *Se-Qaleh* city, *Sarayan* district in South Khorasan province, where the international RFLDL project was implemented. In this research, the level of trust and cooperation ties in the stakeholder's network was assessed in two stages i.e. before and after implementing the RFLDL project using network analysis questionnaires based on observation and interview with all stakeholders and also through the measurement of network analysis indicators including; density, reciprocity, transitivity and average of geodesic distance. The results of this study show the amount of trust and cooperation or social capital before implanting the RFLDL project was in moderate status but it increased post project implementation. The rate of trust and cooperation exchanges among people after implementing the project grew higher than before. Implementing this project as well enhanced the unity among the people.

Keywords: Social capital, network analysis, local sustainable development, RFLDL project, Se-Qaleh.

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Suspended Sediment Fingerprinting and Uncertainty Estimation (Case study: *Zidasht-Fashandak sub-watershed, Taleghan*)

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Abstract

In order to manage and implement conservational activities in watershed successfully, it is necessary to determine the sediment sources. In recent years, sediment fingerpering techniques have been used for estimating sediment sources contribution. With respect to small source samples, having many answer as a result of over fitting, there are some uncertainties in estimated sources contribution. In this study, the uncertainty associated with the multivariate mixing model was estimated using Monte Carlo simulation and GLUE approach in Zidasht-Fashandak sub- watershed. The sediment and source samples were taken in the study area and then, 54 geochemistry and three organic characteristics were measured. 17 elements were also selected as optimum tracer composition using Kruskal–Wallis H-test and multivariate discriminate analysis. Meanwhile, sources contribution were estimated using multivariate mixing models. Results showed higher contribution of sub-surface sources than the surface resources. Also, the distance between lower and upper limits for all sources and resolutely uncertainty bands were high.

Keywords: Ṡuspended sediment, uncertainty, GLUE, sediment fingerprint and Monte Carlo.

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Effect of Fire Severity on Soil Seed Bank Density of Plant Functional Groups (Case Study: Golestan National Park)

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Abstract

In the current study, the variation of soil seed bank density was evaluated in two different fire severities, i.e. low and high. Soil sampling was done in *Sharlegh* site, Golestan national park. Therefore, 5 soil samples for both grass patches and shrub patches in each burnt and control sites were selected. In burnt sites, grass and shrub patches were considered as low and high fire severities, respectively. For data analysis, GLMM and T test were applied.The seed germination method was used in green house to identify soil seeds. Altough, the results of statistical R software indicated that avrage soil seed bank density in burnt-site (74.5) had no significant difference compared with unburnt-site (132.3); however, fire had significant effect on plant functional groups. The results showed that soil seed bank density of different plant functional groups were affected differently by fire severities,. Total seedlings of annual forb was increased (1785 to 3543)and decreased (5000 to 1471) in low and high fire severities, respectively. Total seedlings of pernnial grasses were significantly decreased (7114 to 842.9) in low fire severity while high fire severity had no significant effect on perennial grasses seed bank density. Fire severity had no significant influence on soil seed bank richness. Our results indicated that the surface and severity of fire should be included and interpreted in the future studies.

Keywords: Germination ecology, Soil seed bank, fire intensity, plant functional groups, Golestan national park.

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An Analysis of the Factors Affecting The Use of Information Resources and Communication Channels by Ranchers To Participate in Rangeland Rehabilitation and Restoration Projects (Case Study: Dehgolan County)

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Abstract

The purpose of this research was to investigate the factors affecting the use of information resources and communication channels by the *Dehgoln* Township ranchers to participate in rangelands rehabilitation and restoration projects. The study consisted of all ranchers (N=80) in the *Dehgolan* county, located in Kurdistan Province, among whom 68 ranchers were selected through random sampling technique. A questionnaire was designed and employed to gather the required data. A panel of selected experts verified the questionnaire's content validity. The scale of the use of information resources and communication channels was proved to be reliable since Cronbach Alpha coefficient was estimated as equal to 0.7. Data analysis was done through SPSS software version 22. The results of descriptive statistics revealed that majority of the ranchers were illiterate. In addition, it revealed that majority of the ranchers have utilized information resources and communication channels at a low level. The results of regression analysis finally revealed that three variables of income, educational level and family size, explained about 54% of the variances of the dependent variable.

Keywords: communication channels; Information resources, rehabilitation and restoration, ranchers, rangeland Projects, *Dehgolan* County.

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Effect of Sampling Group and Life-Form on Estimation of Forage Production and Canopy Cover

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Abstract

Canopy cover and forage production have always been two important indicators in rangeland assessment, which sometimes are applied as surrogates of each other. These two indicators are widely used in rangeland studies and have a vital role in evaluation of rangeland structure and functions. Occasionally, different sampling groups (estimators) evaluate forage production and canopy cover of different spaces and times. This research was aimed at investigation of different sampling groups and life-forms' effects on relationship between canopy cover and forage yield estimation. To do so, the impact of three sampling groups and five life forms (Fixed factors) on estimation of relationship between canopy cover (covariate) and forage yield (dependent variable) in a full factorial model in rangeland of Chahrtagh of Naghan, Chahrmhal-va-Bakhtiari Province, was estimated. Results shows that predictor variable of canopy cover is a god surrogate for forage production ($P\leq0.05$) of different life-forms, but different sampling groups significantly ($P\leq0.05$) effects on relationship between canopy cover and forage production estimation. Nevertheless, different life-forms do not significantly ($P\leq0.05$) influence estimation of canopy cover and forage production relationship. By the way, interaction between sampling group and life forms considerably ($P\leq0.05$) affects the relation. Therefore, we conclude that, although, the canopy cover is a good predictor of forage production, nonetheless, different sampling groups should not be engaged in sampling and monitoring vegetation cover and forage production estimation, specifically, if estimation of different life-forms' production is intended.

Keywords: Rangeland; Rangeland assessment and evaluation; Canopy cover; Forage production; Surveying.

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Landslide Hazard Zonation Using SMCE Method and AHP Technic (Case Study: Hafshejan Watershed, Chaharmahal-o-Bakhtiari)

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Abstract

One kind of the mass wasting which takes much toll and leaves much damage in the world and many locations in Iran is landslide. Landslide susceptibility mapping allows recognizing susceptible areas to be considered in environmental programs. Present research is aimed at Landslide susceptibility mapping in *Hafshejan* watershed in Chaharmahal-o-Bakhtiari province using Spatial Multi Criteria Evaluation (SMCE) method via geographic information system (GIS) and ILWIS software and AHP technic. Therefore, regarding the sites where landslides occurred, comparative studies, and the findings of other scholars, eight informational layers were identified for this research. Then, the tree of factors and restrictions was designed in ILWIS software. All layers were standardized and were evaluated and weighted applying AHP model. Last but not least, upshot model and landslide hazard zonation map were prepared and presented for the relevant study area. It was found out that from among effective factors, distance from road, distance from fault and distance from stream of 0.4047, 0.2239 and 0.1302 weight respectively are the most important factors triggering landslide in study area. According to the presented model, about 1.32 percent of watershed area (1013900 square meters) is extremely high risk and 9 percent (6909800 square meters) is high risk. The results of accuracy evaluation of the presented model are indicative of ascendantal trend of landslide index from very low hazard zone to very high hazard zone and they are indicative of sufficient precision of this model.

Keywords: GIS, *Hafshejan* watershed, landslide, Spatial Multi Criteria Evaluation, zonation.

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