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Identifying the susceptible area of Malikan plain aquifer to contamination using Fuzzy methods

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Expanded Abstract

Introduction

contamination in these resources, and these resources may not be used. Groundwater management, especially in dry regions such as Iran, is essential and this concern becomes further with development of agriculture, industry, population growth and climate changes affecting the quality and quantity of groundwater resources. Hence, groundwater contamination can treat the human health. One of the ways to prevent of groundwater contamination is identifying the vulnerable area of aquifers and management of land use. The assessment of groundwater vulnerability maps requires the application of methods and techniques, based on the hydrogeological knowledge of the region under. Several methods have been devised to vulnerability mapping. Groundwater resources in the Malikan region strongly affected by nitrate fertilizers leachates, due to the presence of grape gardens and intensive agriculture. So in this area, identifying the vulnerable area with the proper method is very important. In this study, improved DRASTIC methods using fuzzy logic and catastrophe theory were used to vulnerability assessment of Malikan plain aquifer.

Materials and Methods

Malekan plain is located in East Azarbaijan Province and northwest of Iran, with an area of approximately 450 km^2 (Fig. 1). This region is one of the very active agricultural cultivated areas with water demands supply by groundwater resources. In recent years, groundwater quality of this area is encountered with degradation problem. According to farming and existing of grape farms in this region and intensive use of fertilizers and manure, the groundwater nitrate concentration of the aquifer is high. The aquifer of this plain is unconfined and formed by old and recent alluvial terraces, alluvial fans, and fluvial sediments. The maximum thickness of the alluvia has been reported to be in the central and urban area of Malikan. To evaluate the quality of groundwater resources, especially the assessment of nitrate anomalies in groundwater of the Malekan plain, 27 samples were collected from groundwater resources, and hydrochemical analysis was carried out in Hydrology Laboratory of Tabriz University.

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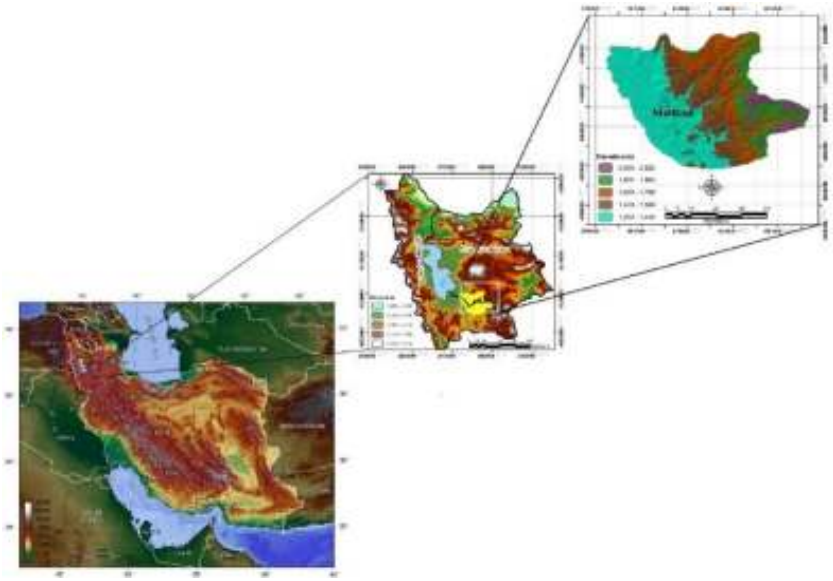

Fig. 1. Study area and sampling points

DRASTIC model has been used to map the groundwater vulnerability to pollution in many areas. Since this method is used in different places without any changes, it cannot consider the effects of pollution type and characteristics. Therefore, the method needs to be calibrate and correcte for a specific aquifer and pollution. DRASTIC model was improved with several methods such as artificial neural network and catastrophe theory (Sadeghfam et al., 2016; Baghapour et al., 2016). In this study the catastrophe theory and fuzzy logic is proposed for groundwater vulnerability.

Results and Discussions

To identify the groundwater vulnerability, the maps of depth to water table, net recharge, aquifer media, soil media, topography, impact of the vadose zone, and hydraulic conductivity are prepared in ArcGIS. The groundwater depth map are prepared by interpolating monthly groundwater depth average of 27 observation wells by kriging method. Catastrophe theory based multi-objective decision-making evaluation system is applied to groundwater vulnerability assessing. Butterfly, swallowtail, cusp, dovetail catastrophe, hyperbolic umbilical, parabola umbilical and fold are seven types of catastrophe models (Wang et al., 2012). The catastrophe theory is applied to assess groundwater vulnerability map using following steps: (i) processing of data layers, (ii) normalization of data layers, (iii) computation for groundwater vulnerability assessment, and (iv) performing the weighted overlay analysis. After selecting the catastrophe fuzzy membership functions for each layer, the weights of data layer should be estimated. In this step, the DRASTIC parameters are weighted with respect to complementary principle and mean value of normalized control parameters, which in the complementary principles, the mean value of control parameters shows the state of system. In the fuzzy logic method, the vulnerability values were corrected in the training stage and then, by training the fuzzy models, validation was performed using vulnerability and nitrate values. Based on the results of fuzzy logic models, in the study area, Sagno method, with lowest error and the highest correlation index with nitrate, have a high ability to optimization of DRASTIC method. Figure 2 shows the vulnerability map of the Malikan plain, using general DRASTIC, fuzzy logic and catastrophe theory.

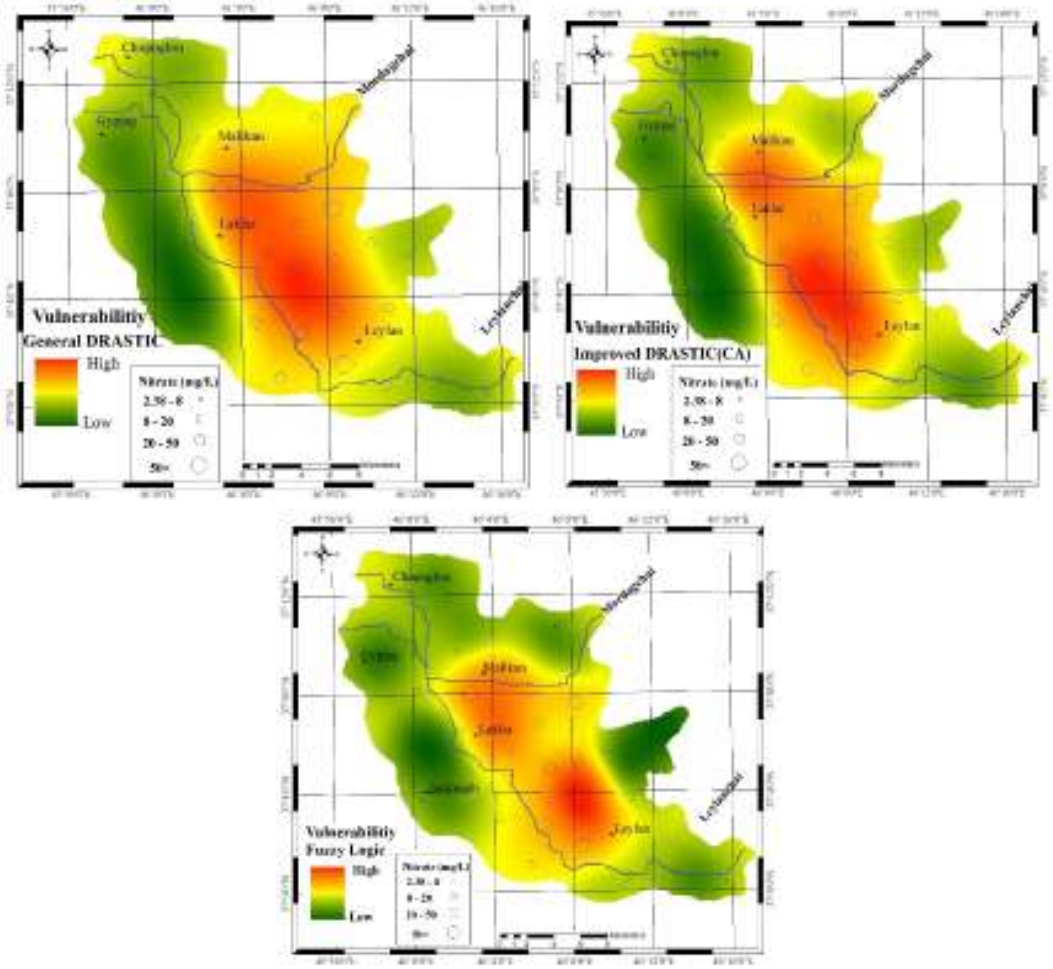

Fig. 2. Vulnerability map using general DRASTIC, fuzzy logic and catastrophe theory

Conclusion

In this study, Fuzzy logic and Catastrophe theory methods using geographic information system (GIS) was applied to evaluate groundwater vulnerability in study area. For optimization, DRASTIC parameters including seven hydrogeological parameters and the value of the vulnerability index respectively are defined as the input and output of the models. Validation of the models was performed using nitrate concentration data and correlation coefficient with the vulnerability index in the region. The results of models showed that the improved DRASTIC model using catastrophe theory with higher correlation index (CI) with nitrate concentration has provided a better result than the fuzzy logic for the aquifer vulnerability assessments. Based on catastrophe theory, the 56%, 23%, 21% of aquifer respectively located in low, medium and high vulnerability area, and central parts of plain was identified as a high vulnerable zones.

Keywords: aquifer, Catastrophe theory, Fuzzy logic, Malikan plain, vulnerability.

Evaluation of temperature sensitivity of soil organic matter decomposition in relation to rangeland management, element stoichiometry and soil depth

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Expanded Abstract

Introduction

Soils are considered as the largest carbon sink in terrestrial ecosystems. Rangelands are the largest terrestrial biomass in world, and contain about 30% of terrestrial carbon stocks. The temperature sensitivity of soil organic matter decomposition (expressed with Q_{10}) is widely used to show the response soil organic matter decomposition to temperature changes. Some biotic and abiotic factors such as land management, soil nutrient contents and stoichiometry as well as soil depth can alter Q_{10}. Since soil carbon content is association with organic matter from vegetation and root turnover, over gazing or destruction can reduces inputs organic matter and leads to surface erosion and increased emission of carbon dioxide. Therefore, sustainable grazing management is effective for protection of soil carbon. It has been determined that fraction of stable and recalcitrant organic matter increases with increasing soil depth. Therefore, studying the Q_{10} in relation to soil depth, especially in natural ecosystems, will improve our understanding of carbon dioxide efflux.
Stoichiometry (for example, carbon/ nitrogen ratio) has an important effect on soil organic matter decomposition by changing the relative availability of carbon and nitrogen to soil decomposer. However, knowledge on stoichiometric relationship between soil nutrition and its effect on the Q_{10} is still limited. The main aim of this study was to investigate Q_{10} in relation to rangeland ecosystem management (grazed, protected and destroyed) and stoichiometry of elements and soil depth. Also, changes in carbon, nitrogen and phosphorus in relation to the rangeland management and depth of soil were considered in this study.

Material & Methods

Three adjacent rangelands ecosystems, located in Fandoghlo of Namin, Ardebil province, with different management (grazed, protected and destroyed) were selected.
Soil samples (0-10, 10–20 and 20-30 cm depth layer) were randomly collected from three rangelands during the mid-growing period. Soil Samples were sieved (<2 mm) and placed in a refrigerator at 5ºC before incubation. Homogeneous soil samples (50 g) from all three rangeland ecosystems in three depths of 0-10, 10-20 and 20-30 cm of soil separately were incubated in half-liter Mason jars at three temperature levels (10, 20 and 30°C).
Control samples, with no soil, were incubated at the same time. An alkali trap containing 15 M ml NaOH 0.1 N was placed in each Mason jar to absorb the respired carbon dioxide. The moisture of each soil sample was adjusted to 60% water holding capacity. Soil moisture content was monitoring by weighing the jars every seven days. The carbon dioxide traps were removed 1, 4, 7, 14, 21 and 28 days after incubation and carbon dioxide emission was determined by the titration method. After determining the heterotrophic soil respiration, the Q_{10} was calculated as follows:

$$Q_{10} = R_{T_0+10}/R_{T_0}{}^{10/(T_0+10-T_0)}$$

where, R_{T_0} and R_{T_0+10} are the heterotrophic respiration at basic temperatures T_0 and $T_0 + 10$, respectively.
Analysis of variance were used separately to test the difference between the Q_{10} in three rangeland ecosystems (protected, grazed and degraded) at three depth levels, as well as changes in carbon, nitrogen and phosphorus

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nutrients in soil depths in three rangeland ecosystems. Regressions analysis were used to identify the trend of Q_{10} changes in related to carbon, nitrogen and phosphorus stoichiometry.

Discussion of Results

According to the results, the type of ecosystem had a significant effect on Q_{10} value. The highest and lowest Q_{10} with 1.21 and 0.87 value obtained from grazed and destroyed rangeland ecosystems, respectively. The value of Q_{10} in the protected rangeland was 0.97. Similar to this result, some studies have shown that the Q_{10} value in grazed rangeland was higher than in protected rangeland. These differences may contribute to differences in SOC quality or soil enzyme activity. The low Q_{10} found in grazed rangeland may be explained by the low labile carbon content of this ecosystem. The Q_{10} value was significantly higher in the bottom soil depth of grazed rangeland (1.373) and protected rangeland (1.149) compared to other depths. Generally, in this study, except degraded rangeland, the Q_{10} value increased with soil depth. The decreasing labile carbon content (carbon quality) with soil depth may be one of the contributors to the increased Q_{10} with depth. Similar to the present study, others have found that decreased carbon quality with increasing depth, may cause of decrease Q_{10} in the soil profile of forest and rangeland ecosystems. In the destroyed rangeland, a significant decrease in the organic carbon content of the soil due to the destruction of vegetation and erosion may decrease microbial population, thus leading to decrease of Q_{10} value.

In this study, the decreasing trend in Q_{10} value was observed with increasing carbon content in all three ecosystems. However, the relationship between Q_{10} and SOC was not significant in destroyed rangeland but was significant in protected and grazed rangeland.

The Q_{10} value in grazed rangeland decreased logarithmically with SOC. However, protected rangeland decreased linearly with SOC. Optimal incubation conditions in the lab can lead to an increase in labile carbon concentration. Hence, the high amount of organic carbon incubation releases high amount labile carbon content and thus decreases the Q_{10} value. The logarithmic and second-order polynomial model (U shaped) was the best fitted models for Q_{10} changes in association to soil nitrogen in grazed and protected rangelands, respectively. It seems that the decrease in Q_{10} with increasing nitrogen content is consistent with carbon quality. Nitrogen increase may lead to smaller C:N ratios (higher substrate quality) in soil, which consequently resulted in deceased Q_{10}.

The Q_{10} depicted a significant logarithmic decrease with increasing soil phosphorus content in both grazed and protected rangelands. The phosphorus, because of importance role of in cellular pathways, may cause increased soil microbial biomass carbon which probably induced efficiency of increasing carbon consumption, resulting in a decrease in the Q_{10} value. The Q_{10} was linear related to increasing the C:N ratio in grazed rangeland. This finding is also explained by carbon quality theory. Several studies have pointed to a positive relationship between the ratio of C:N and Q_{10}. in the protected rangeland. Q_{10} showed second-order polynomial (U shape) model with C:N ratios. Given the similar U shape model between Q_{10} with nitrogen and C:N ratios in this ecosystem, it can be realized the important effect of nitrogen on the carbon use efficiency (CUE) by microorganisms. In destroyed rangeland, the Q_{10} showed an exponential decrease with increasing C:N ratios. The variation pattern of Q_{10} in relation to the P:N ratio was similar to the C:N ratio. It seems that phosphorus availability in soils is also influenced by soil nitrogen changes. The power model was the best model fitted to data between Q_{10} changes and C:P ratio in destroyed rangeland, although this model did not reach statistical significance ($P<0.05$). Although studies on the stoichiometry P: N and C:P in soils are very limited, a study showed that the low C:P ratio leads to an increase carbon dioxide release per unit area. Thus, considering the principle of direct relationship between Q_{10} and carbon dioxide release per unit area.

Conclusions

This study showed that the management and conservation of rangeland ecosystems can be effective on the loss of carbon from the soil. It seems that increasing the quality of organic carbon in the protected rangeland has led to a decreases Q_{10} value. The low amount of organic matter due to loss of carbon during the degradation period may result in a decreased value of Q_{10} in the destroyed rangeland. In general, decreasing trend in Q_{10} value with increasing carbon, nitrogen and phosphorus content was observed in this study. This is consistent with q-theory model. The results obtained from nitrogen, carbon and phosphorus stoichiometry in this study indicated that nitrogen played a more important role in increasing the carbon use efficiency (CUE) and decrease Q_{10} which resulting in a decrease of greenhouse gas carbon dioxide emissions.

Keywords: carbon dioxide emissions, incubation, q-theory, rangeland.

Use of ecological services as an ecological indicators to propose appropriate tourism type "Case study: Sorkhankol wetland wildlife refuge"

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Extended Abstract

Introduction

The extensive presence of tourists around the wetlands not only has caused serious issues for these sensitive and vulnerable ecosystems, but the local communities and their settlements have experienced various effects of tourism in different degrees and forms. In case of uncontrolled tourism, the identity and cultural fundamentals of the local communities could face threats in addition to the destruction of the natural resources in touristic destinations; i.e. systematic instability is created in the region. After the Second World War, the economic and social consequences of the war drew attentions to tourism as a path toward economic development and meanwhile and various ideas emerged from their comprehensive growth to sustainable development.

The wetlands and aquatic ecosystems of the country are counted as valuable assets regulating the underground waters of the surrounding environment, microclimate adjustment, hunting, hunting birds and fishing, supplying feeding sources for the livestock, weaving, etc. Preserving theses complex ecological systems and benefiting from numerous economic, resor, and genetic resources, etc. require an accurate study and recognition of each wetland. Unfortunately, in developing countries, the policy-makers, planners on one hand, and the citizens and the villagers themselves on the other hand do not significantly value the protection of these wetland. Finding a proper type of tourism through ecosystem services of the wetland and using ecological indices for the recognition and examination of the changes of the ecosystem, which is one of the main objectives of this study, have always been a great interest by the planners in the field of environment.

The changes of an index in response to facing stressors are counted as valuable information resources for the planners in the field of environment to prepare different scenarios for the future of an ecosystem which has faced man-made disturbances. The indices are counted as perquisites to prepare the strategies. Employing the indices reflect the pressure and states of the key factors which are used as tools in the analysis of the system. From evaluators' points of view, in the evaluation of the states and the systems procedure, humans' and environment's objectives are the indices for environmental and ecologic programs which use factors or dimensions of the phenomena associated with the environment to illustrate and evaluate the environmental conditions or for setting environmental goals.

Ecosystem services could also be construed as direct and indirect sectors of ecosystem and functional structures besides other factors in human's welfare (objective). Employing indices estimations require using them toward the specified objectives and spatial sensitivities. Each type of tourism and each touristic place has its specific priorities. The priorities in rural tourism are different than natural, urban, etc. tourism. In this study, the effort was to find the indices which determine the suitable touristic type of the region after describing the pressure, thresholds, system state and its impact on sustainable tourism while evaluating them leads to the monitoring of variations threshold, in the form of using ecosystem services as ecologic indices.

Among the available methods for the evaluation and conceptual modeling in this field, DPSIR model is counted as one of the most comprehensive models. This model was proposed by UNEP (United Nations Environment Program) and it is sued in the European environment agency assessments. DPSIR model is the acronym for five words including Driving forces, Pressures, State, Impact, Responses which state the causal relationship. Driving

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forces are the forces which lead to environmental issues. Pressures are the human activities which lead to the destructions and responses are the activities by the human community with the objective of reducing the environmental pressure and improving the quality of the environment

Material and Methods

In this research, DPSIR model abilities are used to analyze the relationships of environmental and human systems of the wetland with a focus on ecosystem services and the functions affected by the driving forces and a focus on tourism.
Sorkhankol wildlife refuge is part of Anzali international wetland. Finding the proper type of tourism through the wetland ecosystem services and using them as ecological indices through DPSIR model is defined as the objective of this research.
In general, the following steps were performed in this research:

- Introducing different possible types of tourism in the region
- Finding the indices associated with the most important environmental issues of the region for each type of tourism based on DPSIR model
- Classifying the identified indices in categories including driving force, pressure, state, etc. according to the conceptual model
- Introducing the index associated with each component of the developed conceptual model
- Finding the relationship among different components based on DPSIR model
- Weighting the effect of driving forces according to an experts' point of view
- Analytic hierarchy process on the driving forces in a geographical data system environment
- Calculating the incompatibility coefficients for the effect components in different types of tourism
- Suggestions for reducing the negative impacts in the form of possible reactions.

Discussion of results

In rural tourism, rural houses, rice cultivation and cow husbandry, and fish farming pools, as the main attractions of rural tourism, lead to the increased visit of tourists to the agricultural lands, development of rice farms around SusarRuga, and the consumption of agricultural inputs, particularly water and pesticides in the vicinity of the wetland, specifically Siah Darvishan. The presence of attractions such as natural and pristine landscapes, flora specific to the region (Indian lotus), terns' nests, pharmaceutical plants and handicrafts lead to pressures such as increased visit of tourists in the region of Nahang Ruga to Susar Ruga. Rural road constructions are performed by machinery in Hendkhaleh and Siah Darvishan and reed beds in Siah Darvishan are cut.
In urban tourism, traditional and historical buildings and markets, malls and shopping centers, cinemas, and hotel and in cultural and historical tourism, traditional and historical buildings and markets, festivals and performances, hotels, and accommodations are considered as the most important attraction for the tourists which have led to pressures such as the tourists visiting traditional and natural regions and change of land use of the wetland. In ecotourism, natural zonings with a focus on the protection of plants and animals species, protective measurements for the terns' nests, designing paths for boats, interest in learning from nature, the presence of piers, accommodations, infrastructures, besides the conflictions of interests with the local beneficiaries (21 unions of tourism and boating) with trustee offices of the environment and water affairs were identified as the driving forces which provided the basis for the focus of the tourists to visit the protected species zones, increased number of motor boats, leakage of hydrocarbon spots from motor boats, smoke exhaustion from these boats, noise, disturbances in the safety and social tensions.
In order to find the more suitable tourism in the protected region of Sorkhankol wetland based on four common types of tourism including urban tourism, rural tourism, cultural-historical tourism, and ecotourism, the driving forces were identified. These driving forces are counted as the main tourism attractions in any type of tourism. Certain pressures are applied to the system which induces certain condition in each type of tourism that affects ecosystem services in terms of the values and benefits for the humans. These effects were determined in analytic hierarchy process with the coefficients among which the minimum value was 0.070 which implies the minimum compatibility and the highest compatibility of 0.29 was obtained. The services or functions which are affected in each type of tourism are as follows: in rural tourism: decreased production, reduced hydrological balance (water consumption for agriculture), change of land use of protected areas to agricultural areas, destruction of habitats and compromising the safety of the habitat, less aesthetic aspects, reduced genetic resources; in urban and cultural-historical tourism: enhancing and regulating the air, self-purification, less aesthetic aspects and sense of belong to ecotourism, destruction of habitats and compromising the safety of the habitat, less aesthetics aspects, enhancing and regulating the air, self-purification, aesthetics and sense of belonging, destruction of the habitat (through the concentration of tourists on visiting protected zones and the presence of motor bats and consequently, noise generation, smoke and hydrocarbon spots due to motor boats which affects the self-

purification and the absorption of pollutions and less social and political safety and reduced ability to exploit resources for educational and bird watching tours). Each of these items is classified in one group of ecosystem services including productive, regulatory, supportive, and cultural. Regardless of which value or function or ecosystem service is found to be more compatible by each resultant coefficient, it is verified in which type of tourism, the resultant drives have applied certain pressures on the ecosystem such that higher compatibility is obtained between the effect and the function. The obtained coefficients were 0.26, 0.24, 0.23, 0.23, 0.24, and 0.13 for rural tourism, 0.23, 0.23, 0.23, 0.07, 0.21, 0.23, 0.23, 0.23, and 0.14 for urban tourism, 0.23, 0.25, 0.23, 0.20, and 0.21 for cultural-historical tourism, and 0.29, 0.28, 0.26, 0.29, 0.29, 0.25, and 0.23 for eco-tourism.

Conclusions

The resultant driving forces due to the function of ecotourism and rural tourism in Sorkhankol wetland includes the zoning of protected plant and animal species, protection of terns' nests, designing paths for boats, building 12 piers, developing service infrastructures, building accommodations, the conflictions of interests with the local beneficiaries (21 unions of tourism and boating) with trustee offices of the environment. Water affairs have led to pressures such as the entrance of tourists to private grounds owned by the locals, development of rice farms around Susar Ruga, consumption of more agricultural inputs, particularly water and pesticides in the vicinity of the wetland, rural road construction, excavation and extracting rocks and materials using machineries in Hendkhaleh and Siah Darvishan regions, increased visit of the tourists in the region of Nahang Ruga to Susar Ruga, the immethodical cutting of the plants in Siah Darvishan, increased number of row boats instead of motor boats in bird watching educational tours (the only positive pressure), noises, dense number of tourists for visiting the protected species zones, increased number of motor boats, leakage of hydrocarbon spots from motor boats, exhaustion of smoke from the boats, increased number of foreign and domestic tours, inability to exploit the resources for the tourists.

Given what is stated, preparing and implementing ecotourism services standards, preparing comprehensive educational documents and organizing ecotourists in smaller groups in Sorkhankol wildlife refuge are necessary, particularly in the water body of the wetland such that one could reduce the pressure on the environment through designing the paths for motor boats and changing them from motor boat type to row boats as much as possible. It is worth noting that due to the volume of the sediments entering Sorkhankol wetland and shrunk aquatic area of the wetland on one hand, and considerably reduced depth of the wetland on the other hand, such that the depth of Sorkhankol wetland was measured to be 30-50 ml in a field observation, the movement of the boats faces serious technical issues which is considered as a technical issue for visiting the Indian lotus as the main attraction of Sorkhankol wetland beside being an environmental damage. However, the Indian lotus currently acts as a sediment trap which intensifies the choking phenomenon of the wetland which is a serious conflict among the attractions of Sorkhankol wetland and its health which requires the urgent and strategic actions of the experts.

Keywords: DPSIR model, ecological criteria, recreation, Sorkhankol wetland.

Analysis of environmental sustainability in rural communities around wetland ecosystem based on ecological model village "Case study: villages in the margin of Zarivar Wetland"

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Expanded Abstract

Introduction

Creating a healthy environment in rural areas is one of the most important environmental issues that not only plays a role in rural politics, but also in land politics. Today, the concept of sustainability in community policy has become a model that leads to the sustainability of a city or village, conservation, protection and recycling of the natural environment. The decision in the village should be such that the increase in environmental benefits is reduced or eliminated negative environmental impacts. In such cities or villages, groups and businesses must be aware of the impacts on their natural environment, and they must be held accountable to reduce or eliminate these negative impacts.

In order to achieve sustainability, communities need cultural, institutional, structural and technological changes. Todays, the most of the problems come from inertia in life. The consumption-oriented life and the excessive accumulation of wealth, power and land have led to the ecological hazards that human beings face today. With regard to human actions on the planet, the slowdown in the destruction of nature and the use of limited resources should be considered. To overcome these problems, scientists and policymakers have come up with solutions that have not had much impact on eliminating them, unless individual people in a city or village change their lifestyle.

Following the environmental problems arising from the unsustainable pattern, the need for alternative lifestyles and the creation of habitats with environmentally-friendly economic and social life have been considered to minimize environmental impacts during the twentieth century. In this regard, the canvas model of the village has been considered in planning and planning for the sustainability of the communities since the 1980s and is in the process of becoming responsive to the environmental, social and economic challenges posed by unsustainable patterns. Environmental rehabilitation in rural areas today is one of the most important environmental issues not only in rural policy but also in national land-use planning. Also, the regeneration of natural ecosystems and the reestablishment of natural currents and rural design constitute the most important fields of research and enforcement in many countries. The wetland ecosystem has been one of the most important ecosystems in the earth, which has played an important role in the development of its peripheral, environmental, social and social dimensions, but the biodegradable pattern and neglect of environmental issues from wetland communities of this natural ecosystem has a problem. To eliminate this problem, the canvas pattern of the village can be a model for sustainable bioticism and the elimination of environmental, social and economic instability by implementing sustainable structures and methods. An ecosystem is in fact a way of describing the function of nature, and incorporates a complex and dynamic mix of all plant communities, animals and living microorganisms, and interactions with the components and the environment.

Materials & Methods

The present study is an applied and descriptive-analytical method. In order to collect information in the theoretical part, the documentary method and in the field of the field have been used for interviewing method and questionnaire. This research seeks to analyze the sustainable pattern in rural communities of the margin of the wetland ecosystem based on the ecovillage pattern in the villages of the margin of Zarivar wetland located in

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Marivan city. The statistical population of the study is 3389 households, of which 355 households were selected as sample size. The studied villages were selected based on the criteria of distance from the lake by stratified random sampling. Accordingly, the studied villages were divided into three categories: the first group was the villages near the lake, located 0-0 km from the lake (6 villages were selected randomly), the second group was the average distance from the lake, at a distance of 2-4 km from the border (6 villages were selected randomly) and finally, villages far from the lake that were located at a distance of 6-4 km from the border (6 villages were selected randomly). In all villages studied included 18 villages Is. In field studies, to collect the required data, a questionnaire was prepared and completed among the villages with interview and observation, which is the most important part of field studies. For this purpose, a household questionnaire including closed questions was designed using Likert spectrum. The content validity of the questionnaire was confirmed by a set of academic professors and the validity of the questionnaires was 0.93% by Cronbach's alpha test. In order to analyze the data, one-sample t-test and ANOVA test were used in SPSS software, non-statistical barometric techniques and radar method (to calculate the stability level). Also, for spatial analysis and production of maps based on statistical data, low/ high clustering/ spatial self-correlation methods, hot spots analysis and IDW method were used in GIS software.

Results and Discussion

According to the Prescott Allen sustainability classes, the stability level of the ecovillage pattern in the villages of the study area with a score of 0.476 is at a moderate level (0.6-0.4). The dimensional stability dimension was also evaluated. Based on the results obtained in Table 5 and Chart 1, the socio-cultural dimension is at an average level of sustainability. In other words, the socio-cultural dimension with the score of 0.518 has the highest score of sustainability, and the two ecological and environmental aspects are 0.387 and 0.421, respectively, at a low level of sustainability.

According to the results of T-test, in Table 9, the numerical mean of the eco-elite dimensions in the studied villages was lower than the favorable and the moderate conditions, namely, the number 3. This difference is significant at alpha level of 0.05 (meaningful level = 0.000). Of the three dimensions of the ecovillage, the highest average of 2.01 is allocated to the socio-cultural dimension, followed by the economic dimension with an average of 1.84 and the least of which is ecological ecological dimension with an average of 1.77 Is.

The results of one-way analysis of variance in the analysis of environmental sustainability in rural communities of the margin of the wetland ecosystem based on the Ecuadorian model in the distance from Zarivar Lake, is according to the amount of sig in ecological, economic, and socio-cultural variables. The zero hypothesis is rejected. The average of these indices is significantly different in villages with different distances.

Conclusion

According to the results of statistical analysis (T-test, ANOVA) and non-statistical analyzes (barometric and radar methods for determining the stability level) as well as spatial analysis in ARCGIS software (interpolation and stains), the contribution and importance of environmental sustainability indices in the studied villages is that social-cultural indicators have the largest share in this regard which is the result of lris Kunze in 2015, Soonk wan Hong in 2016, and also with Andy Kirby in 2003. On the other hand, contradicts the results of Honorary and colleagues in 2012. According to the results of his research, ecological indicators have had the largest share in the sustainability of rural communities and wetland ecosystems. On the other hand, according to the analysis of variance and spatial analysis in the villages of the study area, the villages near Zarivar lake have the most stability in the three ecological, ecological, economic and social-cultural dimensions of the village compared to other villages at other distances (2-4 and 4-6 km from Lake Zarivar).

Keywords: ecological sustainability, eco-village, wetland ecosystem, Zarivar wetland.

The urban landscape systems' ecological networks "Case study: The city of Tehran"

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Expanded Abstract

Introduction

To improve the ecological condition of landscape system and preventing its destruction in the process of urban development, it is essential to optimize its ecological-sociological functions. We utilize ecological services of the landscape system as well as providing our socio-economic needs. For this reason, we should use the principles of landscape ecology for examining and analyzing the structure of the urban landscape and process changing of it and then use the obtained information in development plans and moving to sustaining ecological networks and development of the environment.

Materials & Methods

Conceptual framework

The human scale landscape is generally well adapted to geographic units such as watersheds and urban areas as well as the spatial domain of human consciousness. Many ecologists consider the landscape as a multi-dimensional and hierarchical concept that means a landscape is a spatial heterogeneous area that its size depends on the subject of the study and the research questions. In this research, the scale of study is 22 municipality zones of Tehran.

For examining the ecological-sociological function, we need to study the horizontal and vertical aspects of the landscape and its elements, therefore, we examine the content composition and spatial configuration pattern of landscape's elements:

Measuring the urban landscape of Tehran's ecological-sociological function (ecological networks sustainability)

- Studying the quality of urban landscape of Tehran's elements content composition. Each element of the urban landscape has a different level of ecological-sociological function that depends on several factors. One of the determinants is landscape content (land cover). The ecological function of these structures from up to down is vegetative, aquatic, open (uncovered) and building.

-Studying the urban landscape of Tehran's elements spatial configuration pattern.

Landscape ecology planners considered structural features and patterns related to the ecological function of landscape and ecological network stability, these features including spatial heterogeneity of landscape, ecological and structural connectivity (opposite of fragmentation) between the same type of elements, and the ecological and structural connectivity between all elements of the landscape. Connectivity between all elements is relative because the increase in connectivity would be useful for one function also it would be detrimental to one another. In the following, we explain our conceptual framework briefly.

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Structural patterns and features for: 1. Ecological-sociological sustainable development of urban landscape 2. Sustainability of ecological networks of the urban landscape	Metrics	Metric's units
1. Spatial heterogeneity of landscape's elements	PR (patch richness) PLAND (percentage of each patch) CA (total area)	1. Landscape 2. Patches and corridors resulting from the classification of the considered ecological function (in this project, classification based on land cover)
2. Connectivity between same type patches or same type landscape's function	AREA-MN PN (patch number) PROX (proximity)	Same type patches or corridors
3. Connection between all landscape's elements	CONTAG IJI	All elements of landscape

- Required Metrics for the study of landscape

To examining the current situation and the process changing of mentioned features (heterogeneity, connectivity and isolation) in recent years, we use the landscape ecology metrics.

- Heterogeneity: CA, PLAND, PR

Connectivity between same type patches: AREA-MN, PN and PROX
Connection between all elements: CONTAG, IJI
It should be noted that the use of statistical data, field studies, and visual interpretation help us to understand and evaluate the results. The results show the process changing of ecological elements, likewise the quantitative and qualitative changes of the functions.

Methode

To achieve objectives of the project, we followed below steps:

1. Studying of the ecological elements process changing (including the green patch, open patch, blue patch, building patch, building corridor) by software
2. Dividing the region into two parts to reduce the amount of the large-scale error, or accumulation of valuable ecological elements in one area and study the process of change as well as determining the location of changes make more accurate (after the initial study of the landscape, because of natural and important ecological elements accumulate in the northern half, the landscape was divided into two parts, north and south alongside the Enghelab Street)
3. Studying of the ecological elements process changing (including the green patch, open patch, blue patch, building patch and building corridor) in each of the northern and southern halves by software
4. A more qualitative studying of the ecological elements process changing (including different types of green patch, types of the open patch, natural corridors (river-valleys)) by reviewing the latest detailed and comprehensive plans, the Atlas of Tehran metropolis and prepared maps of the Tehran by the municipality and relevant projects.

We used satellite imagery to obtain information about the structural change of patches. We obtain our satellite imagery from the site (glovis.com). In this project, we get satellite images of LANDSAT in 1984, 2000, and 2016. Then, the captured images were processed by envi 5/1 software. In this process, we perform geometric and radiometric corrections and supervised classification then, with Fragstat analyze them.

Discussion of Results

As you can see, the process changing of metrics for studying and planning within the scope of the study does not appropriate. The inappropriate process changing of the metrics (the quality of the landscape elements, the spatial heterogeneity of the landscape, the connectivity of the same type patches and the connection- isolation of all landscape elements), causes to reduce the ecological function of the landscape, imbalance ecological-sociological landscape function and the reduction of ecological networks sustainability. This trend is more important in the northern half because of important ecological elements and the newer development accumulates there. Some of these ecological functions include hydrological, meteorological and biological functions, which we explain a brief analysis about their process changing.

Hydrological function. Due to the expansion of impermeable surfaces, reduction connectivity of green patches (especially natural green patches) and change of the bed and around stream from natural to man-made materials, water is transferred to the urban landscape more rapidly that caused increased soil erosion at the end of the flow path. Moreover, a large amount of organic and non-organic pollutants enter into these flows reducing the water quality and human health. In addition, the drainage of underground aquifers is one of the effects of these structural changes that would lead to catastrophic consequences such as the soil and earth settlement. These factors all reduce the aquatic function of the landscape, therefore, it does not requiring for aquatic needs of humans. So, human beings must pay more for their needs and add more ecological footprints effects to the regional landscape. Additionally, human responses create secondary contamination as well as increase fuel consumption.

Meteorological function. The rising population and vehicles in the city, building patch, reduced permeable surfaces, especially green patches, lack of concentration and ecological design of different land use patterns, smoothing the city's natural highlands and destroying important elements in air filtering (such as the river-valleys), lead us to face the production of pollutants and the expansion of the city's thermal islands. Simultaneously, the ecological capacity of the land surface has diminished to absorb and reduce these meteorological abnormalities. All of these factors contribute to the spread and distribution of air pollution and affecting human health. By increasing the height of building to the width of the streets ratio, also the non-ecological design of the building patches, we are facing the blocked air corridors, which eliminate the movement of pollutants and mix the city's thermal islands.

Biological function. By reducing the habitat patches and replacing them with building patches, the capacity of the landscape to control and sustain different species is reduced. This problem intensifies by reducing the habitat patch connectivity (non-building patches) as well as imbalance connection-isolation with building elements and human effects. In addition, the elimination of natural green patches and replacing natural green patches with low-quality green patches are effective in this function because structural variation reduced.
After all, for confronting to the destruction of the high-quality ecological elements and the reduction of the landscape ecological functions, we must use this information for landscape ecological planning and ecological networks planning in order to optimize ecological-sociological function and stabling the ecological networks.

Conclusions

Based on the literature review, landscape ecology can help landscape planners and managers to reduce landscape destruction and achieve sustainable urban development. One of the ecological tools is the ecological networks. In order to balance urban landscape structure and function, we must consider ecological planning beside to economic and social planning. Based on the principles of the landscape, for the urban landscape ecological planning, we must study the current situation and process changing of the elements and their functions which in turn, lead us to do protective, developmental and corrective planning. The function of landscape and ecological networks depends on the content composition and configuration pattern of landscape elements. Accordingly, a conceptual framework consist of content composition and configuration pattern elements was established to study the ecological networks of Tehran's landscape, and the metrics were evaluated at different times (1984, 2000 and 2016). The process changing of the urban landscape structure and function is not desirable and did not respond to the ecological needs of urban sustainable development. To solve this issue, plans should be moving toward increasing the ecological quality of the elements, increasing the urban landscape heterogeneity, increasing the connectivity of the same type elements and balancing the connection-isolation between all elements.

Keywords: environmental development, ecological process, landscape ecology.

Relationship between the effect of intermittent ultra-sonication and specific energy on degree of disintegration of secondary sludge

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Expended Abstract

Introduction

Disintegration of excess sludge from activated sludge units for production of a carbon source in post-anoxic processes in order to remove nutrients from wastewater streams has been widely used in recent years. For this purpose, ultra-sonication is one of the most applicable methods for disintegration of cell membranes to provide carbon, the source from disruption of microorganisms. Such substances extracted from disintegrated sludge can be used as readily bio-degradable sources of carbon to be used by other microorganisms in following process units. The amount of power (P) per volume (V) applied to the samples in specific durations (t) as well as the concentration of sludge is the most dominant factors in determination of the disintegration process. The main hypothesis of this research is that if the sonication of samples is intermittent during the total time of ultrasonic radiation, the defensive mechanism of cells will be weakened due to irregular forces applied to the cell membrane. This will lead to degradation of microorganisms at lower Specific Energy (Es) while the energy consumption in the whole process will be reduced accordingly. The effect of this parameter has been investigated through this research, whilst no research has been focused upon this issue earlier in previous studies. In this research, samples of secondary sludge have been disintegrated at the frequency of 24 kHz while the applied power, time of sonication and sludge concentration were changed for each set of experiment. As an extra independent variable, intermittent sonication was altered from 0.3 to 0.9 second. Degree of Disintegration (DD) was monitored as a dependent variable to evaluate the efficiency of the sludge disintegration process.

Materials and Methods

The sludge for disintegration was sampled at the outlet of an anaerobic tank fed by a continuous stream of wastewater. Prior to anaerobic phase, the sludge was aerated in an aerobic tank at a retention time of 12 hours. Raw wastewater with the average COD content of 358 mg/lit was daily supplied from a municipal wastewater treatment plant named Mahalati and located at north-east of Tehran, Iran. The type ultrasonic set was Sonotrode with a 5 mm diameter probe manufactured by FAPAN (Iran). The generated frequency and maximum power generated by the set were 24 kHz and 300 watt, respectively. The degree of disintegration has been calculated by the method introduced by Muller (2000) and one Molar NaOH was used to determine the total COD of the sludge. To separate the supernatant of the sludge from its solid contents, a centrifuge set (SDN- United Kingdom) was used along with and ultra-filtration by a 0.45 micron glass filter (CHMlab, Spain). For experiment design, a Response Surface Method and Central Composite Design were developed using Design Expert software. The power, sonication duration, solid content of the sludge samples and intermittent sonication were independent variables and degree of disintegration was considered as dependent parameters. For standardizing the independent variables, Specific Energy (Es) was calculated at each stage. Determinations of

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COD and solid concentration were performed in accordance with Standard Methods for Water and Wastewater Experiments. For COD measurement, a colorimetric method was used by Hach DR 1900 (Germany) as Spectrophotometer.

Discussion of Results

Considering aforementioned independent parameters, a relationship between these variables has been proposed as Equation (1). The desirability of the model has been evaluated through ANNOVA variance analyzes for proposed logarithmic model. The R^2 parameter for this model was calculated as 0.9797.

$$\text{Log}_{10}(\text{DDCOD}) = -3.27179 + 1.78725\text{E-}003 \times \text{Watt} + 5.28686 \times \text{Seq} + 0.16406 \times \text{Time} - 0.098290 \times \text{Density} - 3.82414 \times \text{Seq}^2 - 8.14053\text{E-}003 \times \text{Time}^2 \quad (1)$$

Considering response surfaces generated by the software for interactions of parameters and their effects on DD, it was figured out that when the power increases, the DD rises up to the maximum of 38% too (under circumstances of this study). Moreover, decreasing sonication sequence from 1 to 0.6 second, leads to increasing the DD and afterwards, this parameter decreases significantly when sequence reaches to 0.4 second. Emitted energy from the probe of the ultrasound generator produces little bubbles of water due to acoustic cavitation. When such bubbles collapse, some radicals such as OH^-, OOH and H^- are formed, which attack the cells in their vicinity. By increasing the power and sonication time, production of such bubbles increases and consequently, the efficiency of disintegration process significantly improves. Additionally, in higher concentration of sludge solid contents, a portion of applied energy to the aqueous systems transfers to the solids instead of making cavitation. In the other words, parts of ultrasound waves are damped by the microorganisms' body. As a result, the number of collisions between radicals and cells are declined, which leads to decrease in the DD parameter. Hence the more sludge is concentrated the less sludge disintegration occurs.
In order to comprehensive understanding of the parameters, Specific Energy (Es) was calculated and a relationship between Es and intermittent sonication with the degree of disintegration has been developed as Equation (2).

$$\text{DDCOD} = -0.30799 + 8.59092\text{E-}006 \times \text{Es} + 1.21280 \times \text{Seq} - 1.00445 \times \text{Seq}^2 \quad (2)$$

The desirability of the model has been verified by ANNOVA analyzes with a R^2=0.9633. According to the respond surface, increase in Es leads to higher efficiency of sludge disintegration, while reduction of sonication sequences from 1 to 0.5 second, affects the DD parameter in such a way that the maximum DD takes place in sequences between 0.6 to 0.7 second. In such circumstances, it can be argued that little bobbles of acoustic cavitation thoroughly dispersed in the sample during the sonication period. These bubbles cause breaking of sludge flocs at the first stage and collapsing of cell tissues in next step. If the radiation is continuous, the resistance of cell walls is strengthened because of uniform collision of bubbles to biomass and its defensive mechanism toward external forces. Such conditions will lead to decrease in degree of disintegration. On the other hand, if the bubbles are not produced in an extremely short period of time (a portion of a second), cell's discipline of defensive mechanism will be devastated and accordingly, they will be more vulnerable to external forces. This will lead to higher values of sludge disintegration.
Another phenomenon that was observed in experimental phase is that when the specific energy increases the optimum point for intermittent sonication approaches from 0.6 to 0.7 second. The reason is that in higher Es values, applied energy to the sludge is high enough to destroy cell tissue. Thus, as soon as sonication starts, the cell membrane disrupts and the theory of alteration in defensive mechanism of microorganisms takes place in smaller scale.

Conclusion

Through a comprehensive literature review associated with ultrasonic sludge disintegration, it was found that no study puts its emphasis on intermittent sonication and its effects on microorganisms. While it is stated that precise microscopic survey is needed to understand the exact mechanism, which has not been performed in this research, macroscopic observations confirm that intermittent sonication can improve the efficiency of the disintegration process. Accordingly, a hypothesis of destructive resonance in cells' structure due to irregular emission of waves is proposed in this study, which should be verified with other extensive microscopic observations. Assuming this theory, when radiation of waves is cut off for a very short period of time, defensive mechanism of microorganisms suddenly interrupts and the cells show a less resistance against external forces. This will lead to disruption of cells in rather lower energy levels.

Based on this research's findings, it is recommended that intermittent sonication is applied instead of continuous radiation for sludge disintegration. This will lead to much more energy savings due to lower sonication time as well as higher degree of disintegration.

Keywords: degree of disintegration, intermittent sonication, respond surface method, sludge disintegration, specific energy, ultrasonic.

Time evaluating of dust phenomenon in Alborz and Qazvin provinces

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Expanded Abstract

Introduction

Dust is a phenomenon that mainly occurs on arid and semiarid regions due to the high wind speed and its turbulence on soil surface without any cover and talent to erosion (Khoshhal Dastjerdi et al., 2012). In recent years, dust of deserts has increasingly grown and has played an important role in climate change in the world (Yarahmadi & Khoshkish, 2013). Today pollution from dust particles has converted to one of the environmental problems, especially in developing countries (Aliabadi et al., 2015). Dust, as a phenomenon of desert areas, disrupts human activities, agriculture, social infrastructure, transportation, and industry (Takemi & Seino, 2005). Goudie et al. (2009) mentioned that Sahara Desert is the strongest sources of global dust in West Africa and western China. Kumar et al. (2015) investigated three major dust events that occurred in northern India during the monsoon season in 2010, by land measurements, satellite, and model estimation. The results showed that all dust storms originated from the desert or transported from it and they were created due to favorable conditions. In this paper, the annual and monthly frequency of dust phenomena in Qazvin and Alborz provinces has been studied during the statistical period in order to minimize the damage caused by this phenomenon using its results.

Material & Methods

Alborz province is located in the middle part of the Alborz Mountains that is adjacent to Mazandaran province from north, to Markazi province from south, to Tehran province from east and to Qazvin province from west. Qazvin province with 15821 km^2 located between 48°, 45` to 50°, 50` of east longitude and 35°, 37` to 36°, 45` of north latitude that are limited to Mazandaran and Gilan provinces from north, Hamedan and Zanjan provinces from west, Markazi province from south and Alborz province from the east.
Dust daily data in special codes for period of 15 years (2000-2014) was collected from seven selected stations in study area with suitable statistical period from meteorological organization that were processed using statistical methods for statistical study of dust. The extraction of days with dust was carried out using weather codes of 06 and 07 using MATLAB software. Code of 06 means the dust suspended in the air that is caused by soil and sand storm from distant points to the station and code of 07 means the dust or sands that are risen by wind at station or near it in observation time. In this research, monthly and annual frequency of days with dust was investigated and separated with regard to codes of 06 and 07.

Discussion of result

The annual survey of dust phenomena

The annual frequency of occurrence of days with dust showed that it has occurred 557 days with dust according to codes of 06 and 07 for selected station in Alborz and Qazvin provinces. Karaj and Qazvin stations with 173

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and 117 days had the most day with dust respectively. Karaj station had high dust with 25 days in 2012 and 24 days in 2014 and there not have been dust in 2001 that annual average of dust was 11 days. Qazvin station had the high dust day with 23 days in 2011 and there was no dust in 2002 and 2007 and the annual average of dust was seven days. In 2008 to 2012, the high dust occurrences have been occurred and in 2012 and 2011 were recognize with 109 and 99 days as the high day with dust in whole statistical period respectively.
The frequency of days with dust with breakdown of 06 and 07 codes showed that the high days with dust according to 06 code has been occurred with 104 days at Karaj station and the lowest dust events have occurred with 36 days at Avaj station. Karaj station has been the most dust events with 22 days in 2014 and the annual average of dust days was seven days. Totally, Qazvin station had 91 days dust events that occurred the most dust occurrence with 22 days in 2011 and there was no dust in 2002, 2004 and 2007. Taleghan station had the most dust events with frequency of 19 days in 2012 and the lowest dust events with six days in 2014. Also, the average of days with dust was 11 days at Taleghan station that was higher than other stations. Karaj and Qazvin stations had the most frequency of dust events with 69 days and 27 days, respectively. Takestan, Buin Zahra and Avaj stations had the lowest dust occurrence with 7, 6 and 1 days, respectively; and Taleghan and Moalem Kelaye stations had no dust based on 07 code.

The monthly survey of dust phenomena

The monthly dust survey showed the most frequency of dust events have been occurred in May with 116 and June with 115 days in selected stations in the statistical period of 2000 to 2014. In May, the most dust with 32 days at Qazvin stations and in June the most dust with 30 days at Karaj station were recorded. Then, in April with 79 days and in July with 70 days have been the most dust respectively. In April, Qazvin station had the most dust with 18 days and Karaj station had the most dust with 23 days. In November and December, the lowest dust with 9 days have been registered. The monthly survey of dust phenomenon according to 06 code showed that in May 90 events of dust and in June 85 events of dust have been occurred the most frequency of dust events at selected stations in the study period, respectively. In May, Qazvin station with 30 events, Avaj and Taleghan stations with 14 events had the highest frequency of dust occurrence among all stations according to 06 code, respectively. In June, Qazvin station with 19 incidences and Karaj station with 15 incidences had the highest frequency of dust. In November, five events had the lowest occurrence of dust compare to the other months during the statistical period. Five events were at Karaj station and the other stations had no dust in this month. The monthly survey according to 07 code showed that in June and October 15 incidences had the most dust that with regard to it Karaj station with frequency of 13 days in June and seven days in October had the most dust. In December and November with 1 and 2 days, the lowest frequency of dust were occurred, respectively, and in January according to 07 code, no dust has been during statistical period.

Conclusion

According to the results, it has been known that in the past, this phenomenon has a lot of abundance, but in 2008–2012 occurred the highest dust incidences that 2012 and 2011 with 109 and 99 days is known as the most dust years in the whole statistical period, respectively. The annual dust survey also showed that Karaj, Qazvin, Takestan, Moalem Kelaye and Avaj stations had ascending trend during statistical period, but Taleghan and Buin Zahra stations had descending trend. The remarkable point is that dust occurrence from beginning of study period to the end of it has almost been ascending trend at Karaj, so that in the last years it reached the highest rate, but in other stations, after 2011 and 2012, the incidence of this phenomenon has reduced. The study of annual frequency of days with dust according to 06 code showed that the high days with dust occurred at Karaj station and the lowest dust events occurred at Avaj station that Karaj station had the most dust incidence with 22 days in 2014. Furthermore, according to 07 code, Karaj and Qazvin stations had the most events of dust and Buin Zahra and Avaj had the lowest events of dust, respectively. Therefore, according to the results, it was found that the most of dust incidence entered from distant regions to studied stations. At Taleghan and Moalem Kelaye, all of the recorded events had external origin and these stations had no dust based on 07 code during study period. The monthly study of dust event showed that the highest frequency of dust occurred in May and Jun. In May, Qazvin station with 32 days and in June, Karaj station with 30 days had the most days with dust and in November and December also had the lowest incident of dust. Monthly investigation of dust based on 06 code showd that in May and June, the most frequency of dust event had been registered. Regarding to this, Qazvin station had the highest events in May with 30 days and in June with 19 days. According to 07 code, in June and October, the highest incidence of dust had been registered. Regarding to this, Karaj station had the most dust with 13 days frequency in June and seven days in October. In general, based on the results, it was found that in the study area, with the onset of the spring season and the warm period followed by the summer season, the frequency of days with dust has increased, which it can be due to increased hours of daily sunlight, thermal

surface, and also there are some local instabilities. Another important factor is the passage of waves of the western masses from the deserts of neighboring countries, which, due to the dryness of the air flow and desert environment in those regions, causes dust and its penetration into the central parts of Iran. Movahedi et al. (2014) monitored the climate phenomena related to dust according to weather codes for Iranian cities, and concluded that the dust phenomenon with the 06-meteorological code in western Iran has a maximum incidence, and in the summer is the highest and, in the fall, is the lowest amount of dust. Also, incidence of dust occurred according to 07 code in the before afternoon in the east of the Iran and occurred in the southeast and the coastal area of Oman sea in the late afternoon. Therefore, the findings of this study are consistent with some of the results of our study. According to the results obtained, it can be concluded that by examining the time and place of the occurrence of dust phenomena, it is possible to reduce the many damage caused by this phenomenon that threatens the environment and human health. It is very difficult to control dusts of external origin, mainly from the countries of Iraq and Syria. So, it is suggested that, for the accurate analysis of internal dust, factors such as drought and use change of the factors affecting the occurrence of dust should be determined.

Keywords: annual frequency, annual trend, dust, meteorology codes, monthly frequency.

Prioritize the various aspects of the producing transgenic plants

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Extended abstract

Introduction

Rapid population growth, food shortages and environmental hazards have caused serious global challenges. The world's population is growing rapidly and it is forecasted to reach 8.5 billion by 2025. Providing food for people is difficult due to lack of natural resources, so malnutrition has become a serious health problem for humans. Today, genetic engineering can increase the quantity and quality of food (Ashraf & Akram, 2009). Transgenic plants are from this category.

So far, in a comprehensive study, there has been no prioritization of the various aspects (economic, social, environmental, health and management-policy) of transgenic plants production in Iran. Therefore, the comprehensive study of these plants seems necessary to plan for production. Therefore, in this study, transgenic plants have been investigated from five economic, social, environmental, health, and management-policy aspects.

Materials and Methods

In this research, an Analytical Hierarchy Process (AHP) has been used to prioritize criteria and sub-criteria. The first level of hierarchy structure includes the main goal of prioritizing the various aspects of the production of transgenic plants. The second level covers the major criteria of the production of transgenic plants, including economic, social, environmental, health, and management-policy and the final level includes sub-criteria of each of the main criteria. Data and statistics were collected through field survey and questionnaire collection from experts. Due to the lack of information from all experts in the field of genetically modified plants, 27 questionnaires were completed by experts in this field (environmental, agricultural and biotechnology experts).

Discussion of Results and Conclusions

After creating the decision tree in Expert Choice software and entering the data collected from the questionnaires in the form of pairwise comparisons, weights of each of the five criteria (economic, social, environmental, health, and management-policy) and their sub-criteria for plant production Transgenic was identified (Tables 1-6).

Table 1. Weight of different criteria for the production of transgenic plants

Criteria	Weight
Health	0.456
Environmental	0.217
Economic	0.184
Management-policy	0.073
social	0.071
Inconsistency Rate	0.08

Source: Research results

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Table 2. Relative weight of sub-criteria of economic criteria for the production of transgenic plants

Criteria	Weight
Increase of yield	0.418
Increase of productivity	0.271
Resistance to tensions	0.188
Increased foreign exchange earnings	0.087
Persistence	0.036
Inconsistency rate	0.08

Source: Research results

Table 3. Relative weight of sub-criteria of environmental criteria for the production of transgenic plants

Criteria	Weight
Health of the plants and the environment	0.491
Reduce the use of pesticides and fertilizers	0.275
Avoid waste of resources	0.123
Avoid the pollution	0.111
Inconsistency rate	0.05

Source: Research results

Table 4. Relative weight of sub-criteria of social criteria for the production of transgenic plants

Criteria	Weight
Helping to eliminate malnutrition	0.515
Reducing food prices	0.321
Increasing product quality	0.120
Unwillingness of traditional farmer	0.044
Inconsistency rate	0.09

Source: Research results

Table 5. Relative weight of sub-criteria of health criteria for the production of transgenic plants

Criteria	Weight
Human health	0.509
Promoting nutritional value	0.251
Promoting environmental health	0.171
Reduce food toxicity	0.069
Inconsistency rate	0.06

Source: Research results

Table 6. Relative weight of sub-criteria of management-policy criteria for the production of transgenic plants

Criteria	Weight
Expanding research centers	0.545
Aligning the programs of relevant institutions	0.241
Create strong management programs and systems	0.108
Awareness and support of farmers	0.066
Rules and policy barriers	0.066
Inconsistency rate	0.08

Source: Research results

The results showed that health criteria is the most important in the production of these plants, and environmental, economic, management-policy and social criteria are in the top priority for experts, respectively. Among the health sub-criteria, improving human health and promoting nutritional value are the most important alternatives in terms of experts. The prioritization of environmental criteria has shown that the health of plants and the environment and the reduction the use of pesticides and fertilizers are the top priority. The results of the prioritization of the economic sub-criteria indicate that the increase of yield and increase of productivity have the highest priority in terms of experts. In addition, the results showed that the expansion of research centers and aligning the programs of relevant institutions are the most important management-policy options. Based on the

results of the social criteria prioritization, helping to eliminate malnutrition and reducing food prices were the highest priority in terms of experts. Therefore, we can recommend that research and investment in the field of production of these plants primarily lead to health and then to the environmental and other aspects.

Keywords: analytical hierarchy process, experts, transgenic plants.

Movement ecology of Asiatic cheetah and Persian leopard in Bafq protected area using environmental variables

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Extended abstract

Introduction

The movement of predators with respect to prey, and of prey with respect to predators, is fundamental to the respective success of both predator and prey. Simultaneous and sympatric data on movements of predator and prey are rare, and the tools to analyze dependent movement are still a work in progress. Here, we analyze and compare the home range, behavior and the interaction of three rare, highly endangered big cats in the Bafq desert of Iran; a coalition of two male Asiatic cheetah Acinonyx jubatus venaticus and a Persian leopard Panthera pardus saxicolor. The animals were GPS tracked for several months at a relatively low temporal resolution of eight hours.

The Asiatic cheetah Acinonyx jubatus venaticus is restricted to central Iran, with a population of only 50-70 individuals in the wild, making it the most critically endangered member of the cat family Felidae. Their home ranges are large, around 4000 km^2, typically larger than the network of existing protected habitat reserves. Their habitat has ungulates, hares, and other mammals as prey, plus competitors, such as Persian leopards, jackals, and wolves. The Persian leopard Panthera pardus saxicolor, also known as the Caucasian leopard or Central Asian leopard, is the largest leopard subspecies. It is native to Iran, the Caucasus region, southern Turkmenistan, parts of western Afghanistan, and northern Iraq. The subspecies are listed as Endangered on the IUCN Red List, with a population of 871-1290 mature individuals. Of these, the majority of Persian leopards (estimated 550-850) live in Iran, mainly in the northern parts. In tandem with a decline in numbers, recent studies indicate that the Persian leopard distribution may be splitting into a northern and a southern range. The geographic range of the Persian leopards overlaps extensively with that of the Asiatic cheetah, both of which are solitary stalk and ambush predators, although the male cheetahs often form coalitions. However, little is known about the home range, movement behavior and spatial interaction of these cats.

Materials & Methods

This study took place in Bafgh desert. The Bafgh PA is characterized by desert with scant rainfall (average annual rainfall less than 1 mm), high temperature and degraded landscape. Bafq is identified as one of five important protected areas for the conservation of Asiatic cheetah by the Conservation of Cheetah Project (CACP). In Bafgh, the presence of human infrastructure such as highways, cities, villages and pathways has made dispersal more difficult for the cats. The transportation network around the animals' home ranges has increased the risk of mortality through road accidents; at least 7 out of 50-70 cheetahs have died due to vehicle collisions in this region.

We excluded the outliers in the movement data and computed the animals' home range using the 100% minimum convex polygon (MCP) of the tracks. We then computed the spatial intersection of the two MCPs and the area of all resulting polygons to obtain an estimate of the animals' home range and overlapping area.

We defined two behavioral states: a moving behavior, explained by a more transitional movement and an encamped behavior, characterized by greatly reduced or zero movement during an observation interval. We fitted a hidden Markov chain model to estimate these two behaviors at the animals' observed locations and computed the proportion of the observations being classified as moving state.

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To analyze the interaction dynamically using a distance-based approach, we used linear regression with the C1-C2 distance as the response and C1-leopard distance as a predictor to see if the major separation of the cheetahs coalition was correlated by the proximity of the leopard.

Discussion of Results & Conclusions

After 512 trap nights, one leopard (age 7-10) and two male cheetahs (C1-C2, age 3-5) were captured using foot snares, under permits from the Iran Department of Environment (DOE), in the Bafq PA, Yazd Province. They were instrumented with GPS collars (Vectronics, Germany) and the collars were programmed to transmit locations every eight hours (at 00:00, 08:00 and 16:00). The data were retrieved periodically by uploading to a hand-held receiver via UHF radio link. The C2, C1 and leopard were collared on 26, 27 and 28 of February 2007 and their collars transmitted for 130, 137 and 282 days respectively. There were relatively few missing points for C1 and C2 (4.5% and 7% respectively) and the gaps were mainly one-step (16 h interval) with very few two-step gaps (24 h interval). For the leopard, 34% of the observations were missing, with 153 one-step and 47 two-step gaps; the numerous gaps could have been due to the leopard residing and ambushing under the bushes and rocks that block the visibility of GPS satellites or the more moving state of the animal preventing its GPS receiver to orient and obtain a fixed position. The leopard, C1 and C2 tracks had 846, 443 and 410 observations respectively after the linear interpolation of missing points.

The two cheetahs were members of a likely sibling coalition, a typical social grouping among cheetah brothers born in the same litter who stay together after weaning. The home ranges of the cheetahs were identical. C1's home range was three times bigger (1137.15 km^2) than that of the leopard (407.85 km^2) using MCP and the cheetahs' home range overlapped with 95% of the leopard home range in the intersecting time-frame. As identified by their GPS tracks, the movements of the two cheetahs were almost identical with median, mean and maximum distance of 12 m, 560 m and 13 km, respectively.

Approximately 68% of location fixes for the C1 were classified as moving compared to 71% of fixes for the leopard in the overlapping time-frame (Fisher test p.value < 0.001). Total displacement of both animals varied linearly with their stay duration in the behavioral bouts (i.e. moving or encamped bouts; c). The estimated speed (displacement/ duration) of C1 in the moving bouts was 0.46 km/h, slightly higher than the 0.35 km/h for the leopard when encamped, the C1 was again more mobile than the leopard (0.09 km/h versus 0.03 km/h).

In early June, the leopard started to exhibit a periodic attraction to C1, as emphasized by the linear regression analysis. Consequently, this attraction, among other habitat elements including elevation and distance to water, may have contributed to the separation of the two cheetahs. Looking for mates to breed or being influenced by the presence of other male cheetahs are possible catalysts of their separation yet very unlikely, as the number of cheetahs in the region is very limited.

Studying extremely rare animals in the wild is a challenge, and observing inter-species interactions among rare species is that much more difficult. Without the benefit of direct observations of chasing, harassing, attacking and killing, researchers are left by extracting as much as possible from remotely sensed data coupled with advanced statistical methods. The dataset of a coalition of two cheetahs and one leopard obtained in this study is unique, as it documents the movements and interactions of one very rare and two extremely rare felid predators, one of which falls prey to the other. However, the data were limited by a relatively short time span of a few months and relatively coarse (8 h) temporal resolution. Thus, a comprehensive and rigorous quantitative analysis relies on a densely integrated suite of GIS, habitat, and movement analysis tools.

Keywords: computational movement analysis, data mining, GIS, spatial ecology.

Formation of urban heat island and its effect over temperature variability in Babol

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Extended abstract

Introduction

Urbanization and cities have a great impact on human life. Today, more than half of the world's population living in cities. One of the important impacts of the city is the change in environmental characteristics. Changes due to urbanization have negative consequences on environmental, social and economic characteristics. Cities reduce the amount of albedo and emissivity of the ground.

Due to changes in the radiation balance in cities, one of the consequences of their development is the change in temperature characteristics of environment. The most famous city's impact on the climate is the urban heat island (UHI).

Mostly, cities have higher minimum temperatures from suburbs. In addition to the temperature differences between the city and the suburbs, some studies have shown that the behavior of urban areas is also different. UHI is one of the most important factors in increasing energy demand for cooling in buildings. The effect of UHI was observed in London in the 1830s first, and then this phenomenon was studied in other European cities and large American cities such as Chicago and New York.

UHI can be detected better at a minimum temperature. In addition to the temperature differences between the city and the suburbs, some studies have shown that the temperature behavior of urban areas varies with other environments.

Because of harmful effects of UHI, humans have always sought a solution to reduce urban heat island intensity. Major researches about urban heat island have been done in the metropolises of developed and developing countries.

Babol is the second largest city in Mazandaran province. This city has rapid population growth since 1956. With its rapid expansion, it is considered an intermediate or medium size city now, and the creation of UHI in this city is expected. The purpose of this study is to investigate the formation of UHI and its effect over day to day changes in temperature of Babol. This work try to understand the best time of UHI formation in Babol every day, as well as looking this at the best time between different months of the year.

Materials & Methods

This study was conducted on Babol city in Mazandaran province. The increase in population from 36,194 people in 1956 to 356,781 in 2015 indicates the high physical development of Babol, in recent decades. This increase in population over the past decades has led to an increase in unplanned construction, change in the physical model of the city and its expansion in various directions. During the last three decades, after Sari, Babol has had the largest physical development.

There are several methods of identifying UHI, which typically include the use of climatological data from the environment, satellite imagery, or mathematical modeling. Due to the lack of professional urban meteorological station in Babol, two sets of data logger (MIC 98583 USB-Data Logger, Taiwan) with the ability to record temperature and relative humidity data at different times in the city and suburbs were installed.

The first place in the city center, which has high population density and high traffic per day, was selected as urban station. The second place was located as a suburban space in the southern part of the city. The sensors were placed in wooden boxes. These boxes were placed at an altitude of about 2 m from the ground. These devices were calibrated by the manufacturer and tested at the meteorological station before starting up the devices in the environments.

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The conventional method was used to illustrate the urban heat island intensity. The temperature difference between urban center and surrounding rural areas (ΔTu-r) indicates the intensity of urban heat island. According to references, sometimes the urban heat island intensity in some cities will reach more than 10°C.
Also, this research investigated day-to-day temperature variations in both urban and suburb locations to show spatial differences. For this purpose, the two following integrated methods were used: 1) The day to day temperature variation (DTD), 2) the difference between day to day variability of daily maximum temperature (DTD_{max}) and day to day variability of daily minimum temperature (DTD_{min}) (Tam et al., 2015).
The day to day temperature variation is based on Equations (1).

$$DTD = \sum|t_i - t_{i-1}|/(n-1) \quad (1)$$

where Σ is the sum over all n data elements, t is daily temperature, i is the counter that marches through the days in a time period (e.g. a month), | | is the absolute value, and n is the number of days elements.

$$\Delta DTD = DTD(tmax) - DTD(tmin) \quad (2)$$

ΔDTD is the difference between day to day variability of daily T_{max} ($DTDt_{max}$) and day to day variability of daily T_{min} ($DTDt_{min}$). Its positive values indicate more changes in temperature for days, and negative values indicate higher temperature variations for nights. In rural areas, minimum temperature day to day variability is higher than the maximum temperature day to day variability.
Mostly, in urban areas, the ΔDTD is more than rural area.

Results & Discussion

To understand the temperature behavior of the city and suburb, hourly temperature data were extracted for two environments. The survey showed that from 9 to 13, the intensity of the UHI has lowest amount. The lowest temperature difference is around 11 am. In other words, the city's impact on temperature is at its lowest amount at this time. In general, the average temperature in the urban environment is about 19.5°C and in the suburb it is 18.5°C.
In addition, during December, January and February the temperature difference between the city and the suburbs, which is more than other months. In these months, the difference between two urban and suburbs minimum means temperature reaches more than 2.5°C. While the difference of maximum temperatures of the two points isn't high, and in some months these indicators are in the suburbs more than the city.
The UHI intensity according to minimum temperature is 1.7°C throughout the entire survey period. In addition, temperature difference between the city and the suburbs was more pronounced during December, January and February. The survey showed that DTD for mean daily temperature and minimum temperature in city is more than the suburbs, but this index for the maximum temperature is not much different in the two environments. The city's ΔDTD is higher than the suburbs. The study of the urban and suburb humidity showed that the urban average is about 70% and the suburbs also have about 73% relative humidity. There is the highest humidity difference between the urban and the suburbs in the morning, because at this time suburbs having a lower temperature than the city.

Conclusion

The present study, based on observed data in two urban and suburban areas in Babol, has been studying the temperature differences for urban heat island behavior.
According to the findings of the discussion, it seems the temperature difference between the city and the countryside observed in Babol is due to the effect of the city on the temperature. In other words, the UHI is formed in the city, and this phenomenon is clear in minimum temperatures. The results of the temperature study in Babol showed that the minimum temperature in every month was higher than suburbs, while the maximum temperature of urban in many cases was less than the suburbs. In the urban station during the period under review, the minimum temperature has not fallen below 2°C, and in the suburbs the lowest recorded temperature is -0.8°C. The study of the daily variability of temperatures also showed that the ΔDTD index, which is a new and alternative indicator for identifying the UHI phenomenon, is lower in the suburbs. Since the built up environment reduces the amount of albedo and emissivity from the ground, and it is generally less moisture and the heat and energy reaches a higher level, more Tangible heat will be stored within the built-up space.
According to the findings of the discussion, it can be said that the temperature difference between the city and the suburbs is as a result of the city's effects on the temperature. In other words, the thermal island in Babol has been formed and this mode has been shown more clearly in its minimum temperatures.

Keywords: Babol, heat island, minimum temperature, urban, variability.

Persistent geotop, an original example of landscape and natural environment (Case study: "Koohrig" of Mehriz in Yazd Province)

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Extended abstract

Introduction

Natural resources are valuable and important parts of environment. The nature of landscape elements of Koohrig along with mentality and beliefs of the people is the determining factor of interactions between people and with these places. Study on extraterrestrial landscapes and geotop is important from many different aspects, because these landscapes in the world are diverse and their various scientific dimensions have a wide range. Considering these phenomena, planning to understand the behavior of tourists in order to have a better understanding and beginning the tourism organizing in the site, and entering of it to the landscape science is essential for high quality exploitation and perfecting the environment, while preserving and maintaining them. The lack of general understanding, and specialized, applied and case studies on unique natural landscapes and mismanagement has led to harmful interventions and alternations in these landscapes. In the present study, Koohrig geotope located in Mehriz city, Yazd province was selected as a case study. This landscape is one of the natural legacies that has been subjected to improper human alternations due to lack of knowledge and mismanagement. This has led to an inefficient exploitation and in accordance with the capacities of the environment, which has led to a destruction. According to the discussed issues, this article seeks to answer the following questions:
1. What is the relationship between the natural features of Mehriz Koohrig and human interactions?
2. What are the landscape features of the existence of a ritualistic-cultural perspective in Mehriz Koohrig?
3. What are the criteria for the interventions methods and quality improvement of Mehriz Koohrig Landscape?

Matherials & Methods

This research is a qualitative investigation that analyzes the phenomenon of Koohrig in various aspects of phenomenology. The researcher implemented the method of interviewing with experts in the field. On the other hand, the research was carried out by looking at the historical and cultural aspects, and behavioral changes of people at different times, and the method and cause of motivations in people's interactions with the landscape and the relationship between them. Most of the research was done by field research and hermeneutics phenomenology method, and parts of the research information has been gathered in documentary and library form.

Conclusion

Findings on the first question:
1. Holiness and spirituality of Mehriz Koohrig. Apart from the sanctity of certain mountains, the mountains have a special spiritual solitude and have certain forces that in some cases (such as Koohrig) these positive forces are more powerful because of certain reasons (such as sand bedding). Therefore, they lead to inner peace and developing mental and spiritual growth.
2. Exclusive natural and extraterrestrial attraction of Mehriz. The distinctive contrast of sands from the background, and other wind erosion landscapes such as mount Oshtorkhorma stimulate the imaginations and dreams of the people and their beliefs.

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3. Geographical situation of Mehriz Koohrig bedding. This natural phenomenon is facing the city, and it is surrounded by other natural features at the same time, consisting of mountain and a small plain. This natural plain bedding is also visible at the top of the mountain, giving an extra mental and ritual power to the visitors.
4. The unique features of Mehriz Koohrig for health and the opportunity for cultivating the soul. Moving through the natural hard passable paths is basically a kind of mystical cultivation. The reason for this is the formation of body harmony and comprehensive physical, mental and emotional health state of the body as a result of hiking the sand mount.
5. The presence of relaxing and refining environment of Mehriz sand mount and enhancing the intuitive perception of human kind. Seeing Mehriz sand mount and being in the place is an expression of the almighty and a sign of his existence and power.
6. The tendencies, attitudes and beliefs of the people. Religions such as Islam has highly respected the nature. They also invite people to thinking, recognition, and progressing in that.
7. The proper condition for attendance and interacting with the Mehriz Koohrig. Despite the environment of the sand mount, this phenomenon has the potential for people attendance in its hot environment. As a result, the position of the sand mount and nearby mountain places the sand concentration in a shadow and favorable conditions more quickly.
Findings about the second question:
1. The existence of heroes, fictional stories and holy beliefs to the Koohrig with physical signs
2. The femininity of the environment in the mounts milestone
3. Illuminating a candle in sand mount
4. The proximity of lower stream gardens and farms to the chapel
5. Sacrificing and vowing in the mountains
6. Conducting religious and ritual acts all together
Findings about the third question:
1. There have been some damaging interventions and alternations in the landscape of the Koohrig. These organizational and developmental changes were not helpful, and they have brought more serious damages to identity, environment quality and the landscape. The lack of planning, correct investigation without understanding the identity and potentials of this geotop, and consequently not performing any interventions, inappropriate designing and mismanagement is the reason of these alternations and damages.
2. Objective and separated perspective of the body from its meaning and its non-terrestrial aspect, or sudden changes to the body and meaning.
3. The fragmentation of quantitative and qualitative factors in the landscape of the Koohrig. The consequences of the landscape fragmentation include reducing the scale and disturbance in the visual, functional and perceptual dimensions, which, eventually have adverse effects on the identity of the environment.
Four main criteria should be considered to design and organiz the sand mount. These criteria include:
1. Conservation of the sand mount, the core of the landscape and opportunities, while exploiting and responding to different human needs;
2. Understanding the capacities, talents, and natural features of the sand mount in order to exploit them;
3. The development of acquired qualities (such as the cultural aspect of sand mount) and natural alterations by the organic process, and elimination of inappropriate interventions, barriers to discontinuity and peripheral disruption;
4. Expansion and connection of body, meaning and identity with the context;
In the interventions and the present planning, a vast majority of these factors are ignored. Furthermore, the function is the opposite of these criteria.

Discussion of Result

The interactions of people with the sand mount and their attendance was unified with the religious perception and beliefs of the society, but today they are justified by scientific explanations or personal perceptions of being positive. Furthermore, they are adapted to their inner needs and their pleasant feelings and they find meaning in it. Eventually, these unique geotop and landscapes, together with the interactions of people, will become persistent perspectives in their minds. It will make sense of the identity of that landscape for the inhabitants, and it is a mirror reflecting the culture of the ancient people of that nation. The need to preserve, these heroes and myths, which is the first cultural consequence of the interaction with these particular sights, is also very important and precious in terms of interpretation, better understanding of the subject, the growing recognition of the effects and decoding most scientific issues and cultural-identity roots in these phenomena. The unique identity of sand mount landscape, combined with the religious-cultural interactions of the people, has made it a lasting perspective. The sustainability of a landscape has direct relationship with the effectiveness of certain intrinsic (physical and non-physical) properties of the landscape, as well as the type and amount of people's

mental-objective interactions with it. The sand mount has some criteria that led it to be a lasting and unique geotope. Today, this natural landscape and its area are subjects to damage by human intervention, which threatens the sustainability of it. As a result, to preserve these landscapes from human factors, its physical and non-physical sustainability components must be survived.

Keywords: Koohrig, persistent geotops, qualitative development, unique natural landscapes.

Investigating the changes of ecological network and its role in the ecological resilience of Mashhad city

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Extended abstract

Introduction

Today, the urban ecological network is considered as an approach to enhance the ecological values of urbanizing areas. Indeed, the concept of urban ecological network in relation to overcoming the natural environment and its fragmentation due to the human environment development is appeared. This concept as a suggestion to protect the ecological elements of the urban structure in response to the disruption and destruction of its components was proposed. Ecological network structure based on the principles of landscape ecology includes a combination of the landscape basic elements such as patches, corridors, and matrix. These elements in urban areas consist of natural and artificial ecological layers so that the adjustment and how these layers adopt with each other are very important. Supporting the urban ecological networks is a factor to protect natural processes and biophysical functions in the cities, and promotes the system capability to cope with environmental pressures by balancing human and ecosystem services. However, ecological networks are destroyed, damaged or fragmented in many urban development plans instead of using them as natural potentials. This issue leads to serious negative consequences in urban areas.

In addition, maintaining the natural context and biodiversity in cities in order to create a connection with nature due to the environmental degradation and disruption of the urban ecological foundation, requires integration of ecology knowledge with the process of urban planning and design. The emergence of ecology as a distinct discipline has occurred in the late nineteenth and early twentieth century in Europe and North America. The introduction of different paradigms over a time led to the ecology development and provided the context for changes of the urban ecology approaches. Thus, according to the evolution of urban ecological science and based on recent approaches, cities are presented as social-ecological systems that the resilience of these systems are affected by both socio-economic and biophysical patterns and functions. In fact, the relationship between natural and human functions is the most important determinant of urban ecological resilience. So, creation and restoration of the ecological network in the cities are considered as the practical application of urban ecology science in urban planning and design. This action is an important step toward achieving the goals such as maintaining natural context in urbanizing area, consolidating the relation between city and nature, providing the better utilization of natural ecosystem services and increasing urban ecological resilience.

Side effects of unplanned urban developments are visible in Mashhad as a second most populous city in Iran. The elimination of greenways, fragmentation of gardens and green areas, burial of the natural streams and urban air pollution increment have all led to cripple natural systems, descend the quality of life and consequently decreased the ecological resilience of this city. With regard to the above issues, illustrating the position and importance of attention to urban ecological networks in urban development plans towards achieving ecological resilience is the main purpose of this research. Other objectives that pursue the main purpose, are explained as follows:

- Identifying the ecological structure of the Mashhad city and its forgotten and burial ecological values in the current situation, and determining the relationship between natural and man-made elements in Mashhad.
- Illustrating the qualitative and quantitative changes of the ecological networks in the processes of Mashhad development over the past half-century, and analyzing the impacts of these changes on the ecological resilience of the city.
- Suggesting the strategies to improve the structure and function of the Mashhad ecological network and similar urbanizing areas.

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Materials & Methods

The research method of this paper is a mixed method and both qualitative and quantitative methods to gathering and analyzing data are used according to different parts of the paper. Output data like qualitative maps and quantitative tables are created using ArcGIS 10.2 software. Period 1956 (the time of the first aerial photographs of Mashhad) up to 2015 is selected in order to investigate the evolution of ecological structure components of Mashhad city in its development processes and analyzes the impact of these changes on the ecological resilience of the city. Based on Forman mosaic model, the ecological structure of the Mashhad city according to the spatial distribution of patches, corridors and matrix in 60 years period and times of 1956, 1987 and 2015 is analyzed and its quantitative and qualitative changes are studied. In order to extract the structural elements of the ecological network in the three listed times, the satellite images of Landsat OLI/8 (15 August 2015), Landsat TM/5 (20 July 1987), historical aerial photos of the years 1956 and 1987 for the study area of Mashhad and historical documents are used. Data of the past and current situation of the Mashhad city for a mentioned period which were gathered by studying historical and pictorial documents are interpreted through content analysis and comparative methods.

The pre-processing of the satellite image to extract data mainly includes radiance calibration and atmospheric correction is done. In addition, pan-sharpening is applied in order to increase the resolution of the 2015 image from 30 m of multispectral bands to 15 m of panchromatic on. The aerial photos of the years 1956 and 1987 are georeferenced and image mosaics are integrated using ArcGIS. Natural and man-made layers including hydrological maps, green space, and accessibility network as the components of the ecological structure are identified by using aerial and satellite images and also historical documents. These layers along with other land cover classes such as arid lands, highlands, and built areas are mapped in ArcGIS as classified shapefiles. Finally, the GIS maps of the Mashhad city in the three mentioned times are created, and qualitative and quantitative comparing of the components of the ecological structure through maps, statistic data and attribute tables are provided. Comparing these components in the three times of 1956, 1987 and 2015 indicates the changes and evolution of them in the processes of Mashhad urban development and growth.

Discussion of Results

The components of ecological networks based on the patch-corridor-matrix model as classified layers are extracted to determine the situation of ecological networks in Mashhad city. These layers are overlaid to analysis the ecological structure and urban function.

- Natural and built green patches layer has an important role in an urban ecological structure which effects directly on the ecological activities of the city.
- Hydrological network layer as the most important natural and built ecological corridors of urban landscape includes surface and subsurface streams.
- Accessibility network layer as built ecological corridors in urban fabric includes main roads which connect the ecological patches in dense urban areas.

Finally, the ecological structure of the Mashhad city in each considered period are created as union map by integration of natural and man-made layers above-mentioned.

The survey of the aerial photos and satellite images of the Mashhad city in the three periods and comparison of the quantities data obtained from the shapefiles of land cover layers as well as analysis the overlaying maps of these layers with GIS software techniques show that about 1743 hectares of agricultural lands and about 630 hectares of green spaces in the year 1956 have been changed to build areas in the processes of urban development. Moreover, 2478 hectare of agricultural lands and about 513 hectares of green spaces in the year 1987 have been destroyed. The investigation of the water corridors during the 60 years of evolution shows their structural and functional changes. Mashhad city physical development was led to enclosure, blockage, redirection or removal of some of the corridors. The enclosure of Naderi and Gharekhan streams as two of the most important western-eastern water corridors of Mashhad, the disappearance of the end section of the Gonabad stream as a vital transporter of the Gilas fountains' water into the city, and burial of many northwest streams are the main impacts of unplanned urban development. In fact, these corridors must be preserved as the ecological elements which have main roles such as linking the city and nature, conveying water and air flow throughout the city and as respiratory organs of the city.

Conclusion

In this paper, based on landscape ecology principles, the position and importance of urban ecological networks in urban development plans towards enhancing urban ecological resilience are discussed. Investigation the evolution and changes of the ecological networks during the 60 years period in the Mashhad city indicates that about 2373 hectares of green and agricultural lands in the year 1956, as well as 2991 hectares of these lands in

the year 1987 were destroyed in the processes of urban development. So that there is no trace of them in the ecological network in the year 2015. Thus, more than 5300 hectares of green patches were destroyed while these areas should be preserved for main reasons such as preventing the formation of urban heat islands, contributing to the penetration of runoff into underground aquifers in order to maintain natural water cycle, prevention of climate change and natural air filtration. As a result, the ecological resilience of Mashhad city has been decreased in the face of environmental hazards like climate change, air pollution, drought and flood. Today, in this city the most important ecological elements of the past are streams and water corridors which are considered as a key factor to preserve nature in the Mashhad urban landscape. By recognizing and revitalizing these corridors that strengthen the ecological values of the city and link the open and green spaces to each other, the ecological structure of the city can be increased. The loss of network integrity, disruption of the network elements connection, negligence in maintaining the ecological corridors, unbalance distribution of natural elements and low ecological quality of patches and corridors are the main problems related to Mashhad ecological network.

Finally, the corresponding strategies to these important problems are proposed by considering the different methods of intervention. Some of these strategies include maintaining buffers among the green patches and water corridors, increasing the diversity of green spaces by using indigenous plant species, increasing the number of green patches and corridors in the network, paying attention to proximity principles of ecological land use, improving the pattern of man-made elements in accordance with natural pattern, keeping balance between natural and artificial elements and considering ecological elements as a key factor in the process of urban planning and design. Generally, the ecological structure of Mashhad city can be improved through strategies in protection, reclamation, restoration, rehabilitation, and creation phases.

Keywords: ecological network, landscape ecology, resilience, urban landscape.