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Environmental investigation of heavy metals concentration in Ahvaz city street dust, by using Geographical Information Systems (GIS)

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Received: August 2, 2016 Accepted: December 3, 2018

Expanded Abstract

Introduction

Rapid urbanization and continuous demand of land for infrastructural development in urban areas have placed great stress on the local environment. Consequently, varieties of environmental problems have emerged, which among them toxic metal pollution is a major issue, especially in urban soil and street's dust. Street's dust receives varying inputs of heavy metals, mineral constituents, organic matter (humus), living organism, air, and water; the anthropogenic materials are vehicle exhaust particles, lubricating oil residues, tire wear particles etc; and the natural biogenic materials are tree leaves and other plant matters. To certain degree, street's dust is a more pertinent indicator to urban environ-mental quality than single compartmental monitoring of air, water and soil, because it reflects pollutants from the different sources. Heavy metals may come from many different sources in urbanized areas, including vehicle emissions, industrial discharges and other activities. It is important to identify the origin and distribution of heavy metals in street dust, and estimate population from heavy metal exposure via street's dust in smelting district. There were many recent investigations on heavy metals from many different sources in urbanized areas, including vehicle emissions, industrial discharges and other activities. Ahvaz, a metropolis city located in Southwest Iran, with a population of over 1.2 million, has experienced a rapid urbanization and industrialization in the last few decades. Industrial growth along with expansion of population and increase in number of vehicles in Ahvaz caused increase of heavy metals accumulation in airborne particles and urban soils. Ahvaz city is considered as one of the heavily polluted cities in the world. However, the spatial distribution patterns and contamination levels of heavy metals in road dust in the area is still not clear .

The aim of this paper is to: 1) identify the patterns of spatial distribution of Cd, Cr, Cu, Pb, As and Zn; 2) assess contamination levels of these metals by integrated pollution index (IPI) and Nemerow integrated pollution index (NIPI). Multivariate statistical methods and spatial analyses were used to achieve these goals. Geographic Information System (GIS) mapping was applied to evaluate the results by visualizing the spatial patterns.

Material and Methods

Soil sampling and analytical methods

A total of 115 street's dust samples were collected form urban area in July 2014 when it was dry season. The sampling comp again was chosen in driest month of the year to avoid rain-washing out the heavy metals. The weather condition was stable during the sampling period and no rain had occurred during one month prior to sample collection. The street dust samples were mainly collected by sweeping an area of about 1×1 m^2 from road pavement using a clean plastic dustpan and brushes for each sampling site. The sampling points and background of samples locations are marked in Figure 1. Geographical coordinates of samples collection locations were

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recorded at each sampling point with a GPS device. The streets' dust samples were analyzed for toxic metals by Atomic Absorption Spectrophotometer (AAS).

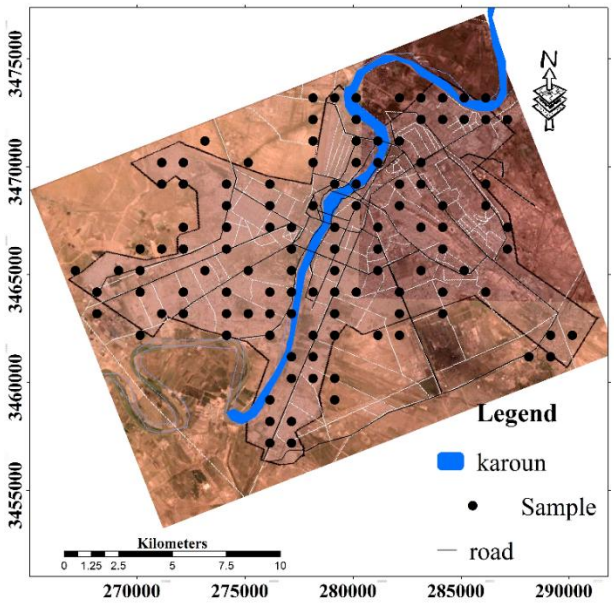

Fig. 1. Location of samples sites in Ahvaz city

Metal pollution index

PI was calculated for all the six elements under study. The minimum, maximum, and mean values of PI are given in Table 4. The pollution index IPI is defined as the mean value of the pollution index PI of an element. It is classified as non-pollution (PI≤1), low level pollution (1<PI≤2), moderate level of pollution (2<PI≤3) and high level of pollution (PI>3). The NIPI of the six metals for each sampling site was defined as follows:

$$NIPI = \sqrt{\frac{PI_{i\max}{}^2 + PI_{iave}{}^2}{2}}$$

The NIPI was classified as non-pollution (NIPI<0.7), non pollution (NIPI≤0.7), warning line of pollution (0.7<NIPI≤1), low level pollution (1<NIPI≤2), moderate level of pollution (2<NIPI≤3) and high level of pollution (NIPI>3).

Results and Discussion

The mean concentration of Pb, Cu, Zn, Cr, As and Cd concentrations in the street dust samples were 179.75, 179.60, 150.15, 101, 67.27 and 5.60 mg/kg respectively which were 5.4, 12.7, 5.3, 1.1, 21.6 and 62.2 times as high as the background values in street dust samples. Table 1 compares the concentration of heavy metals measured in road dusts of metropolis city of Ahvaz with other metropolitan cities in the world. Concentrations of heavy metals in street dust particles vary considerably among cities depending on the density of industrial activities in the area and technologies employed. As summarized in Table 1, the mean concentration of Cu in Ahvaz street dust (present work) is lower than mean concentration of Guangzhou, Baoji, Ottawa, Calcutta, Luanda, Oslo and Nanjing cities and higher than Tehran city. Pb concentration in Ahvaz street dust is higher than Oslo and Nanjing and lower than Guangzhou, Baoji, Ottawa, Calcutta, and Tehran. The mean concentration of Zn in Ahvaz is higher than Tehran, Ottawa, Calcutta, Baoji and lower than Oslo, Guangzhou and Nanjing. The mean concentration of Cr is lower than Baoji and Nanjing higher than Tehran, Guangzhou, Ottawa, Calcutta, and Oslo. The mean concentration of As in street dust of Ahvaz is higher than other metropolitan cities. The mean concentration of Cd in street dust of Ahvaz is higher than other metropolitan cities except Tehran. The range of PI values for all the elements under consideration was determined, and their behavior was found to be as follows 0.31 to 17.32 for Pb, 1.3 to 15.29 for Zn, 0.28 to 7.69 for Cu, 0.2 to 22.5 for As, 0.7 to 2.06 for Cr and 0.05 to 9.45 for Cd.

Spatial distribution map of PI indicated that there are several clear trends in the distribution of the PI values in the studied area. In the old urban area, most of the street dust samples collected were from the areas with high levels of pollution, which can significantly attributed to traffic emission and long-term accumulation of heavy metals. On the contrary, most of the streets dust samples collected with low levels of pollution were from the

new urban areas and city suburban areas. Moreover, the areas closed to manufacturing companies were with high levels of pollution. These trends can be attributed to urbanization, distribution of industrial and commercial areas. The NIPI of all of the Samples collected varied between 0.71 to 59.01 with an average of 9.66. Assessment of geochemical data indicates that there were 24 soil samples collected (20.8% of samples) with an NIPI<0.7, while 26 soil samples collected (22.6%) of all soil samples had a NIPI between 0.7 and 1. About 16.5% of samples had a NIPI between 1 and 2 and about 16.5 of all samples had a NIPI between 2 and 3. Finally, 28 soil samples (24.3%) had NIPI>3 with high level of pollution. Figure 2 shows the spatial distribution of NIPIs in Ahvaz city. Overall, these findings suggest that the street dust of Ahvaz city has been polluted by anthropogenic emission. Soil samples with high and moderate pollutions were located in area with high dense pollution, high traffic volume, manufacturing industries such as smelting, chemical industry, industrial towns, and oil drilling activities.

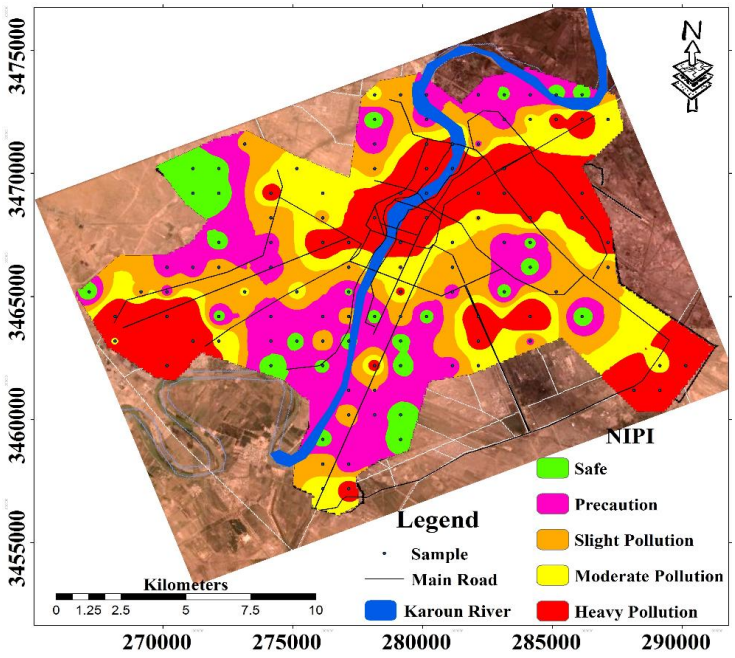

Figure 2. Spatial distribution of NIPI in the study area

Conclusion

The present study examines the content of metals in the urban soils in Ahvaz city. The mean concentration of heavy metals were significantly higher than the other cities. The results of spatial distribution reflect the influence of urbanization and industrialization on the areas considered. The PI values indicate that a significant degree of metal pollution exist in some street dusts within the urban area with high population density, high traffic volume and also areas with high industrial activities such as oil drilling. Then NIPI values also indicate that Ahvaz street dusts have high degree of pollution. These findings indicate that more attention should be paid to metal pollution of the urban street dust and urban topsoil's in Ahvaz.

Keywords: Geographical Information System, heavy metals, integrated pollution index, pollution index, street dust.

Application of symbolic regression and Geographic Information System in Kheyroud watershed to provide spatial models that affect on the surface of the landscape

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Received: March 15, 2017 Accepted: December 3, 2018

Extended Abstract

1. Introduction

Hyrcania is a highly productive forest along the southern coast of the Caspian Sea (northern Iran). The forests are mostly uneven-aged, oriental beech (*Fagus orientalis*)-dominated hardwood mixtures. These forests often include the presence of *Carpinus betulus*, *Alnus subcurdate*, *Acer velutinum*, and several other tree species and shrubs. These forests are mostly broadleaved, but *Taxus bacata* and *Cupressus spp*. do appear on some specialized sites. They are home to about 80 different tree species and 50 shrub species. Hyrcanian forests have multiple ecological functions, such as provide for (i) the production of wood fiber and lumber, (ii) the protection of watersheds, including their water and soils, and (iii) the conservation of biodiversity.

2. Materials and Methods

The topic of biodiversity has become a primary focal point in deliberations of sustainability worldwide, as a result of the rampant decline and degradation of natural environments initiated by urbanization, unrestrained resource extraction, and wanton disregard for nature. Furthermore, global climate change broadens our need to incorporate significant amounts of knowledge on biodiversity and functionality in developing contemporary forest management plans, which is not always easy to achieve. We develop a computational framework that relates measures of tree diversity (based on actual field surveys) to modelled physical (abiotic) variables. Here, we calculate tree diversity using the Shannon-Weiner index; an index commonly used to characterize species diversity in plant communities by accounting for both species abundance and evenness. The plot network in the Gorazbon section is designed on a rectangular grid (150 m × 200 m) and consists of 258 fixed-area circular plots of 0.1 ha each .Tree species richness was determined at each plot from basic tree species identification and tallying. Prominent tree species in plots include Fagus orientalis, Carpinus betulus, Acer velutinum, Acer campestre, Alnus subcordata, Quercus castaneifolia, Parrotia persica, Tillia begonifolia, and Ulmus glabra. Total number of plots available for the current analysis was 202; many of the unused plots had missing site information, including GPS (global positioning system) coordinates, preventing their geo-referencing.

3. Results and Discussion

In development of numerical surfaces, fundamental to the spatial calculation of abiotic surfaces or their surrogates at mid-resolution is the DTM of the Gorazbon section. DTM-height data is derived from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) 30-m resolution Global Digital Elevation Model v. 2 (GDEM; http://asterweb.jpl.nasa.gov/gdem.asp, last accessed on June 2014). Descriptions of the various abiotic and associated surfaces, including their proxies and their derivation, can be found in Table 1. Values of abiotic and proxy variables at forest-plot locations were summarised separately as averages of values falling within each individual 0.1-ha plot (Fig. 1b).

Relating plot-estimates of environmental variables, symbolic regression, or symbolic function identification, is used to determine from the list of independent variables in Table 1, which site variables are particularly crucial in explaining spatial variability in. Symbolic regression is a procedure founded on evolutionary computation in searching for algebraic equations, while reducing the difference between target values and values calculated with

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the equations generated with the procedure. Different from conventional regression techniques that determine parameters of known equations, no specific mathematical expression is needed as a starting point to the approach. Rather, primary expressions are formed by randomly combining primitive base functions of input variables (linear or otherwise) with algebraic operators. Equations retained by the procedure are those that replicate the target output data better than others; undesirable solutions are rejected. The procedure stops whenever the desired accuracy in data replication has been reached. In order to balance the relative contribution of each plot-estimate in the development of a generalised expression of values were weighted as a function of the inverse of their occurrence (i.e., number of times it occurs) in the dataset. This was done to ensure that values that are not commonly observed (e.g. 7 species per 0.1 ha plot) contribute as much to the explanation of as values that are more frequently observed (e.g. 2-4 species per 0.1 ha plot). This research examines the possible ecological controls on tree diversity in an unmanaged region of the Hyrcanian forests (i.e. the Kheyrud experimental forest). Key to the study are computer-generated abiotic surfaces and associated plot estimates of (i) growing-season-cumulated cloud-free solar radiation, (ii) seasonal air temperature, (iii) topographic wetness index (TWI) in representing soil water distribution, and (iv) wind velocity generated from simulation of fluid-flow dynamics in complex terrain (Fig. 1).

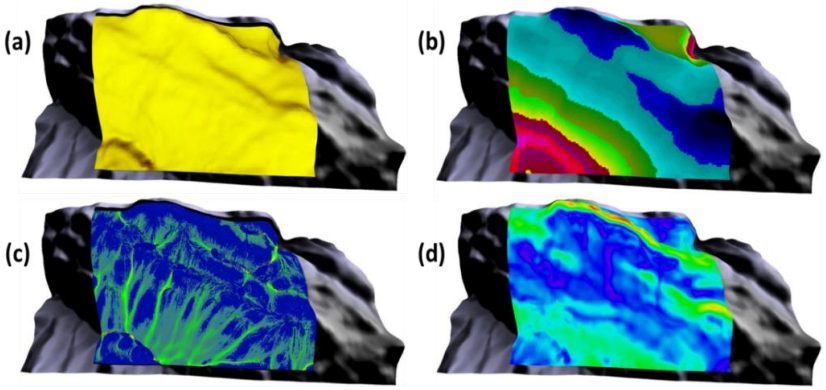

Fig. 1. Model-generated abiotic surfaces of (a) growing-season cumulated cloud-free solar radiation (MJ m-2), (b) mean seasonal air temperature (oC), (c) topographic wetness index (TWI; unitless), and (d) wind velocity within the study area (m s^{-1}).

Plot-level estimates (Fig. 2) are used in the generation of a three-variable equation (Eq. 1) of tree diversity by means of symbolic regression (Schmidt & Lipson, 2009).

$$\text{Diversity} = \left(\frac{1.073 \max\left\langle \sin\left(W^{-9.404} - 5.792W\right), \min\left\{\cos^{-1}\left[\sin\left(0.196 + 27.95W\right)\right], \sin\left(0.001605S\right)\right\rangle}{\sin\left(0.5122T\right)} \right.,$$

(Eq. 1)

where W is the wind velocity (m s^{-1}), S annually-cumulated cloud-free solar radiation (MJ m^{-2}), and T mean annual air temperature near the ground surface (oC). In the regression process, diversity values are weighted according to TWI.

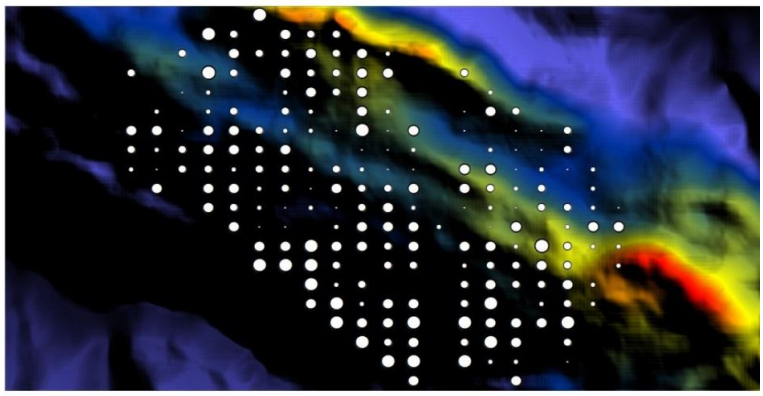

Fig. 2. Spatial variation in plot-level estimates of tree species diversity; size of the circles coincides with level of species diversity based on a calculation of the Shannon-Weiner index; the large circles coincide with high index values (high species diversity with an upper value of 1.6), whereas small circles coincide to low values (low species diversity with a lower value of 0.1).

4. Conclusion

Localised topographic wetness index (TWI) is shown to be unimportant with explaining spatial patterns in tree diversity. The approach shows that plot-level estimates of W, S, and T in combination can explain roughly 70% of the spatial variation in tree diversity in the validation data (Fig. 3).

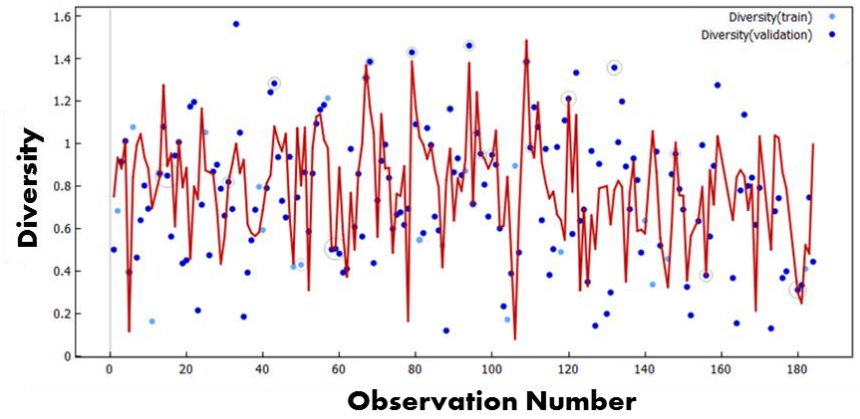

Fig. 3. Plot-level estimates of the Shannon-Weiner index (blue circles) compared to modelled values (red line).

Keywords: abiotic and biotic variables, fixed sample plots, hyrcanian forests, topographic wetness index.

Assessment of the probability of occurence of multiple environmrntal hazards in mangrove habitats using remote sensing and geographic information system

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Received: April 28, 2018 Accepted: December 3, 2018

Expanded Abstract

1. Introduction

In mangroves, assessing the threat of multiple environmental hazards is important to inform effective management decisions to protect these habitats and to mitigate the environmental impacts. In this study, the threat of multiple environmental hazards including drought, reducing surface runoff of upstream catchments, strong winds, extreme temperatures, fishing activities, and loss at seaward edges of mangroves in the northern coast of the Persian Gulf and Oman Sea in Iran are assessed and mapped.

2. Materials and Methods

2.1. Study area

The study area comprises 10025.55 ha and is located on the northern coast of the Persian Gulf and the Oman Sea. Natural mangrove forests on the coastal areas of Hormozgan range between 25° 34′ 13″ N in Gabrig (Jask town) to 27° 10′ 54″ in Koulaghan (Bandar Abbas town) and 58° 34′ 07″ E in Himan (Jask town) to 55° 22′ 06″ E in Bandar Lenge town. Mangroves on the northern coast of the Persian Gulf and the Oman Sea are classified according to geographical location, habitat structure, and geomorphology of the coast and are found in four areas: Khamir, Tiab, Sirik and Jask.

2.2. Mapping environmental hazards

2.2.1. Drought

In this study a Mann-Kendall (MK) test was performed within the MAKESENSE 1.0 software to detect trends in standardized precipitation index (SPI) values at a confidence level of 95% and 99%. Based on changes in Z values and implementation of the natural break command in ArcGIS, a map of drought was produced and categorized into four classes of low (code 1), moderate (code 2), high (code 3) and very high (code 4), based on the values of $Z| \geq 1.96$ (increasing trend of drought severity). This was used to assess the threat to mangroves.

2.2.2. Reduction of surface runoff of upstream catchments

To map changes in surface runoff from upstream catchments during the 30-year period (1986-2016), the time series of changes in runoff coefficient values were evaluated. A 30-year time series of land use/ land cover changes (LULC) in upstream catchments of mangroves was also prepared using data from 210 Landsat images. Using the LULC map, the Runoff coefficient of the catchment is calculated from the runoff coefficient for permeable areas (Cper). Cper was calculated from a weighted sum of land use, soil type and slope factors, respectively, the first, second, and third term in the right-hand side of Equation (1).

$$C_{per} = w1\left(\frac{0.02}{n}\right) + w2\left(\frac{\theta_w}{1-\theta_w}\right) + w3\left(\frac{s}{10+s}\right) \quad (1$$

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Eq. 1)

where *n* is the Manning's roughness coefficient dependent on the LULC, θ_w is the volumetric soil water content at wilting point, and *S* is the land surface slope in percentage land surface slope in percentage. The value of $\left(\frac{\theta_w}{1-\theta_w}\right)$ was calculated using the soil texture map of upstream catchments of mangroves obtained from Iranian Forests, Range and Watershed Management Organization (FRWMO). The values of the coefficients W1, W2 and W3 were considered as 0.4, 0.3 and 0.3, respectively. Using a 30-year time series of runoff coefficients and annual precipitation values, a 30-year time series of surface runoff changes in catchments was prepared. The time series of the changes in surface runoff values was used to create a map of the reduction of catchments using four classes of low (code 1), moderate (code 2), high (code 3) and very high (code 4) to assess the threat to mangroves. Classification was undertaken using the natural break command in ArcGIS.

2.2.3. Fishing activity

Changes in the intensity of fishing activities in mangrove habitats were mapped using the location of the fishing ports and the number of active launches and boats, determined using the satellite imagery of Google Earth Pro (© DigitalGlobe Inc., © GeoEye Inc.) and field surveys. The coastal waters area was divided into 4×4 km GIS grid cells (598 cells) and in each of the grid cells, the intensity of the fishing activity was calculated and finally a map of the intensity of the fishing activity in coastal waters was prepared.
Finally, using the Fishing Index (FI) map, fishing activity intensity was classified using the natural break command in ArcGIS as low (code 1), moderate (code 2), high (code 3) and very high (code 4). This was used to assess the threat to the mangroves.

2.2.4. Wind

In this study, the threat from wind speeds greater than 8 m/s was mapped .This cut off was used as this velocity considered as potentially damaging to the structure and function of these mangroves. A 30-year time series (1986-2016) of daily wind speed data from synoptic stations adjacent to the mangroves was used. In this study, the Weibull function was used to calculate the probability of wind speeds greater than 8 m/s. Wind speeds greater than 8 m/s were extracted and their average was calculated and multiplied by the probability of occurrence for each of stations during the thirty-year period. A risk map of winds speeds greater than 8 m/s was prepared and classified using the natural break command in ArcGIS, the four classes were low (code 1), moderate (code 2), high (code 3) and very high (code 4). These were used to assess the threat to mangroves.

2.2.5. Extreme temperature

Based on previous studies and for the analysis of spatial variations in the occurrence of extreme temperatures, a temperature of 38° C was selected as the threshold temperature for mangrove damage. All daily temperatures equal to and greater than 38° C were extracted from the long-term dataset of daily temperatures for the 30-year period (1986-2016). By dividing the number of days with a temperature equal to and greater than 38° C by the total number of daily temperature records in the 30-year period, the probability of occurrence of temperatures above this threshold was calculated for each of the synoptic stations. At each synoptic station, the mean value of all temperatures equal to and greater than 38°C was calculated and multiplied by the probability of occurrence calculated for that station. Finally, using ArcGIS, a risk map of temperatures equal to and greater than 38 °C was prepared within the coastal areas and classified using the natural breaks command as low (code 1), moderate (code 2), high (code 3) and very high (code 4) to assess the threat to the mangroves.

2.2.6. Loss of seaward edges of mangroves

In this study, Landsat images of 1986, 2000, and 2016 were used to analyse the rates of changes in the seaward edges of mangroves over the 30-year period (1986-2016). To separate mangroves from surrounding water and coastal land areas and to identify the final borders of the study sites, an NDVI vegetation index was used. In this study, 2701 transects 30 m apart were mapped using the DSAS software to calculate the rate of changes in the seaward edges of mangroves. As with previous studies, the linear regression rate (LRR) method was used to

measure the rates of changes in the seaward edges of mangroves. These were used to create a map of rates of regression of mangroves classified as no regression (code 1), low rate of regression (code 2), moderate rate of regression (code 3) and high rate of regression (code 4) using the natural break command in ArcGIS, to assess the threat to the mangroves.

2.3. Calculation of Threat Index (TI) and its classification in Mangrove habitats

At this stage, classified hazard maps were combined using ArcGIS and Equation 4.

$$TI = \sqrt{\frac{a \times b \times c \times d \times e \times f}{6}} \quad \text{(Eq. 4)}$$

where TI= Threat Index, a= drought, b= surface runoff, C= wind, d= air temperature, e= fishing activity and f= loss of seaward edges of mangroves. The TI was used to create a threat map for the mangroves at all four sites classified as: low, medium and high using the natural break command in ArcGIS.

3. Results and Discussion

The results of this study showed that considering the severity and probability of occurrence of the hazards, Khamir and Jask mangrove habitats are highly threatened by environmental hazards (Fig. 1). Investigating the severity of occurrence of environmental hazards in mangrove habitats shows that Khamir and Jask habitats are considered to have a high to very high threat level from drought, reduced runoff from the catchments and extent of loss, significantly higher than the Tiab and Sirik sites. It is likely the increase in the severity and risk from these hazards has had adverse effects on the structure and functions of these mangrove habitats as found in other studies conducted in other regions of the world showing that reducing rainfall and increasing the risk of drought reduces the extent of mangrove area and increases their vulnerability to other environmental hazards.

Fig. 1. Threat level of mangrove habitats (a. Khamir habitat, b. Tiab habitat, c. Sirik habitat and d. Jask habitat)

4. Conclusion

The results of this study significantly contribute to effective planning for the protection of these ecosystems and reduce their vulnerability to environmental hazards by providing up-to-date and accurate information on the threats to mangrove habitats. The analytical methods used in this study may serve as a basis for assessing environmental threats to other mangrove ecosystems around the world.

Keywords: assessment of the probabilty of occcurence, environmental hazards, Hormozgan province, mangrove.

Application of CPLEX solver to land use optimization in Gorgan township

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Received: March 19, 2016 Accepted: December 3, 2018

Expanded Abstract

Introduction

Inevitably, land use planning is the main clue in the process leading to sustainable development. If we imagine study area as a set of cells (unit) in map, each cell cannot be allocated to more than one land use simultaneously. In this regard, land use planning defines the proportions and locations of special use for each spatial unit of land. With this definition 'place' becomes an important issue when deciding about the most appropriate land use. It is the reason why we call land use planning a place-based decision making. Usually, in this process, the study area is modeled through a raster layer in which the cells act like land units waiting to be allocated their special uses. The important and crucial criterion in this process is suitability map produced from overlaying several thematic maps. However, suitability maps are not sufficient for optimization of land use for a region. Without integration of other constraints, the result may become a fragmented land uses layer. In this study, we attempt to solve a land use planning problem with respect to optimizing four categories including agriculture, forest, rangeland and development areas in Gorgan Township. Here, we incorporate three objectives including minimizing allocating cost, use conversion cost and maximizing compactness in the form of a linear programming problem.

2. Materials and Methods

Decision variables, constraints and objectives are three main and critical elements of linear programming. They are the questions of problems. In this domain, problem can be defined as minimizing or maximizing based on suitability or unsuitability of the considered objectives. This study used minimizing form of linear programming with respect to three objectives including minimizing allocating cost, conversion cost and maximizing compactness. Four decision variables are used for introducing linear equations for every objective. The main decision variable is binary that equals 1 when land use k is allocated to cell (i, j) as representation of special place of land and equals 0 otherwise. By adding this variable, it is clear that the problem is integer linear programming. As linear programming is an exact method that enumerates all solutions to find optimal one, adding integer variables to it makes a huge burden on computational processes and intensively increases the required processing time. This burden nearly makes it impossible to find optimal solutions. Therefore, we relaxed the problem from integrity and changed it to usual and classic linear programming. So, the values obtained for X_{ijk} was ranged at [0 1]. The other difficulty was that one cell could not be allocated to more than one land use simultaneously. Therefore final responses that had been obtained from implementing linear model are ranked then for every cell the maximum value is selected and the other value is equaled with zero. After this selection, there was a solution map of the study area showed land uses with the maximum value in each cell. We found that nearly none of the values were less than 0.5. So, every cell is allocated to land use with the maximum

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value. Although this result could not guarantee optimality, but was very close to responses of the exact method of linear programming.

3. Results and Discussion

In order to have an equal base for comparison, we implemented the problem with the same target area in MOLA algorithm in IDRISI. We selected MOLA because it works on the base of ranking the value of cells related to distance to ideal point which is the highest value possible after standardization of the suitability values. It is necessary to say that compactness and conversion cost objectives have not been considered in MOLA. Table 1 shows the number of cells (area) of every land use before and after implementing the above mentioned model (target area) and Table 2 shows the number of cells for every land uses before and after application of MOLA.

Table 1. Comparison of area of every land use before and after implementing the suggested Model

Land use	Area			
	Target	Result of Model	Final accepted	Violation
Agriculture	12400	12467	12400	0
Forest	13055	13059	13055	0
Development	3263	3225	3225	38
Rangeland	3916	3883	3883	33
Sum				71

Table 2. Comparison of area of every land use before and after implementing MOLA

Land use	Area		
	Target	Result of Model	Violation
Agriculture	12400	12346	54
Forest	13055	13040	15
Development	3263	3263	0
Rangeland	3916	3819	97
Sum			166

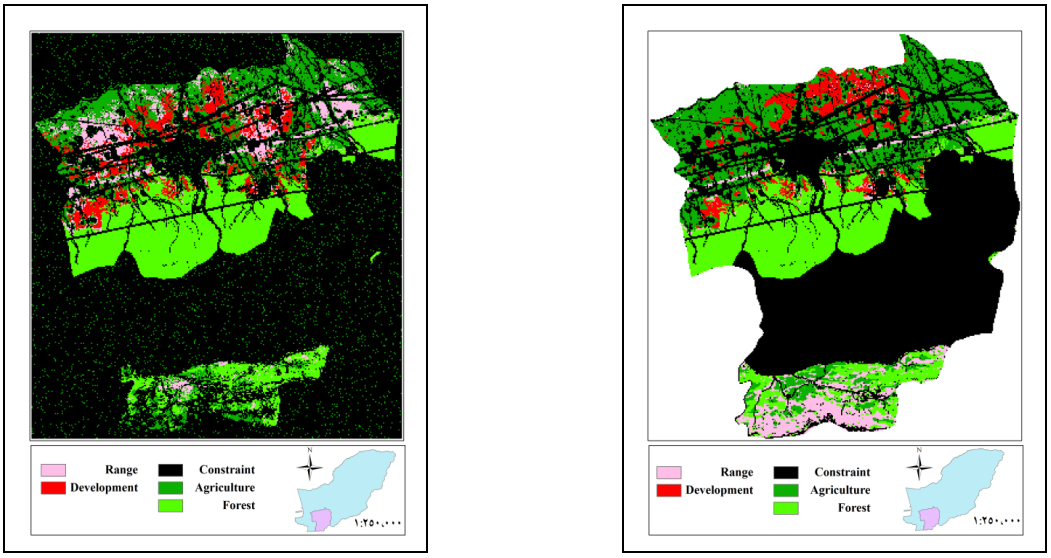

Fig. 1. The results obtained after MOLA (left) and the suggested model in this study (right)

Conclusions

As Figure 1 shows, fragmentation of land use in the suggested model is less than that for MOLA. Also, it is possible to change objectives or some other criterion in the linear programming model but MOLA in IDRISI is a crisp module that cannot accept other objectives like compactness for improving the results. If we accept the fact that land use planning is a main clue through achieving sustainable development, its importance becomes ever clearer. What improves land use planning and makes it more practical and powerful is paying attention to many aspects, stakeholders and sources that are involved and affected by the process which makes even more complex. Use of optimization algorithms is the way to address this complexity. The powerful feature of linear programming is achieving the exact solution which guarantees optimality. This feature besides its simplicity is sufficient to make this algorithm attractive and worthy of more in-depth studies. In this regard, this study attempts to introduce a way for application of linear programming in land use planning and optimization.

Keywords: CPLEX solver, land use planning, linear programming, mathematical programming, optimization.

Assessing the accuracy of MLR, PCR, ARIMA, and MLP in predicting the aerosols optical depth

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Received: May 5, 2018 Accepted: December 3, 2018

Expended Abstract

1. Introduction

Atmospheric aerosols have different sources which can refer to volcanic activities, dust, salt particles in the seas and oceans, or due to human activities, can refer to activities such as industrial activities, transportation, fuel costs ect. Aerosols have very important role in transitive radiation and chemical process which are the earth's climate controller. Among the various type of suspended particles in the air, dust can be found to cover most of the earth including Iran located in the arid and semi-arid area. Dust storm occurrences in Iran is due to its proximity to the major dust creation zone in Iraq, Saudi Arabia, Kuwait and Jordan. Iran has little role in dust storm creation. The aerosols, or the airborne particles, play a very important role in the transitional radiation and the chemical processes controling the climate of the earth. Aerosols are founded in the subordinate layer of atmosphere and are able to go through long-distances by wind. So, their effect on the atmosphere shows variability in the time and locative situation for checking aerosols and atmospheric pollutants like hovering particles. We usually use special parameter called Aerosols Optical Depth (AOD), which show the quantity pass rate of light rays in the atmosphere and expressing the role of aerosols in absorb and separate these light rays, and it is a dimensionless quantity. Since Sanandaj is known as one of the most polluted cities in the country, it is important to predict the types of pollution, especially the suspended particles in the air.

2. Material and Methods

In this study related data to Pyranometer were collected though the Meteorology office in center of Kurdistan province ranged 2005/01/01 until 2016/12/31. Thus, the total number of available data in this period were 4382. Since, there was no solar radiation for some days of the year, the total number of data used for Sanandaj city were reduced to 3956. As well as, data on meteorological variables such as temperature, relative humidity, wind speed, and atmospheric elevation at 850 hPa level in the mentioned period according to the working time Pyranometer instrument were utilized. In order to access these data, a global database called the European Center for Medium-Range Weather Forecasts (ECMWF) was used.

2.1. Study area

Sanandaj is the capital of Kurdistan province, located in 35 degree and 20 minutes north latitude and 47 degree east longitude from Greenwich Hour circle and in 1373.4 m height above sea level.

2.2. Multiple linear regression model

In the Multiple linear Regression turn to check the relation between a dependent variable and several independent by earned relationship for them in the SPSS software, in the Multiple linear Regression the measure of AOD serve as dependent variable and meteorology numeral quantity such as temperature, relative humidity,

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wind speed and also altitude atmosphere were considered as independent variable. The general formula for the MLR model is as follows.

$$Y = \beta_0 + \beta_1 x_1 + \cdots + \beta_n x_n + \varepsilon$$

In this case, y is dependent variable. X1, ..., Xn denote the independent variables, and also nβ0, ..., β report the fixed constants. Ɛ also indicates the remaining values.

2.3. Principal Component Regression Model

Principal Component Regression Model is a combination of Principal Component Analysis (PCA) and Multiple Linear Regression (MLR). These calculations are as follows.

$$Y = \varphi \beta_{PCR} + e$$

where φ is the matrix of base components, which is obtained as n * k, and βPCR represents the first of the components of the K score. The vector of e is a random error defined as n*1. Mark and scores for the components are based on the original version of the OLS method as follows.

$$\beta_{PCR} = (\varphi'\varphi)^{-1}\varphi' y = (L^2)^{-1}\varphi' y$$

In this case, L^2 is the amount of slice of the matrix, which is based on the Kth parameter indicating the slip of the parameter kʎ. Finally, the following equation was reached.

$$\beta_{PCR} = \sum_{K=1}^{K} \frac{v_k u_k'}{d_k} y, \quad K < \min(n,p)$$

In this model, primary variable changed to new components and independent from each. Both of the two components have zero correlation coefficient, finally these used as primary variables.

2.4. Autoregressive integrated moving average model

Autoregressive integrated moving average model is one of the important method in anticipation time series which presented by Box and Jenkins in 1970. ARIMA model is a data- driven model. It means the mentioned model use of the structure of data. This model facet, if data have any meaningful nonlinearities relationships. ARIMA model is able in this way present the forecasts related to the time series. This model is a forecasting method with statistical theory and because of having advantages such as high attention and strong adaptability ability is able to have a good usage in many bases.

2.5. Artificial Neural Networks Model

Multilayer perceptron (MLP) is the most well know and mostly the most used among different kind of neural networks and in most cases act as signals that transfer input to output in the network. These kind of multilayer network layers are joined as outputs of first layer act as second layer inputs, and output from second layer are the third layer inputs and it will be continued till last layer output. They are the main outputs and the certain and real answer.

3. Discussion of Results & Conclusions

In the model of Multiple linear Regression according to the made result for this model, the measure of the AOD in understudied city has a direct connection with temperature and wind speed parameters out the level 850 hectopascal, but also this have an opposite connection with relative moisture. The measure of atmospheric layer altitude also got determination factor by this model allocated itself less numerical value and it is used because of linear structure in the data. The equation presented for it is as follows.

AOD=0.458+0.039T_{850}-0.127RH_{850}+0.021$Speed_{850}$-0.064 BLH

The $R^2 = 0.071$, RMSE=0.1698 and MAE=0.1498 were obtained for training phase and $R^2 = 0.096$, RMSE=0.1703 and MAE=0.1494 were acquired for testing phase. The results of the training and testing phases of the MLR model indicate the low accuracy of this model in predicting the AOD in Sanandaj city. The second used model in this research was Principal Component Regression Model. In this model AOD has direct connection with temperature and wind speed but it has a negative connection with the other parameters such as relative moisture and atmospheric layer altitude. The extracted equation for PCR model is as follows.

AOD=0.457+0.041T_{850}-0.126RH_{850}+0.021$Speed_{850}$-0.065BLH

In this section, $R^2 = 0.071$, RMSE=0.1699 and MAE=0.15 were obtained for training phase and $R^2 = 0.069$,RMSE=0.1694 and MAE=0.1484 were acquired for testing phase. According to the result, got out puts by

MLR and PCR models have a close result to estimate the AOD for stations with no Pyranometer. Autoregressive Integrated Moving Average Model was the third used model. This model had the best function to estimate AOD in the station with no Pyranometer. The obtained equation for ARIMA model is as follows.

AOD=0.0061+0.7084y_{t-1}+0.0572 y_{t-2}+0.2189y_{t-3}

In this section, $R^2 = 0.91$, RMSE=0.0501 and MAE=0.033 were obtained for training phase and $R^2 = 0.89$, RMSE=0.086 and MAE=0.0374 were acquired for testing phase. MLP model was the fourth used model. Two hidden layers were used in this model. The number of optimized neurons for the understudied area was different with available data. The number of optimized neurons determined for Sanandaj city were 24 and 33 neurons to estimate the AOD in the long time (a year) in the station with no Pyranometer. In this section, $R^2 = 0.75$, RMSE=0.1162 and MAE=0.0921 were obtained for training phase and $R^2 = 0.63$, RMSE=0.14 and MAE=0.113 were acquired for testing phase. It can be concluded that for estimate AOD in the area with Pyranometer instrument, it is better to use the autoregressive stage instead follows the training and testing phases of the different models. Because, as it has been showed, the data required for the autoregressive stage is only the data of the AOD at the station. In general, the results of this research showed that use of different and efficient models can be a suitable solution for estimating AOD for regions with Pyranometer, as well as the area without a Pyranometer.

Keywords: aerosol optical depth, artificial neural network, autoregressive integrated moving average, ECMWF data, predicting.

Improving municipal solid waste landfill liners using synthetic fibers and di-calcium phosphate

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Received: July 2, 2018 Accepted: December 3, 2018

Expanded Abstract

1. Introduction

Waste disposal to landfill remains the most common practice for waste management, worldwide (Eskandari et al., 2012). But gas and leachate produced after disposal are two serious threats to various environmental components particularly to water, soil and air. Ideally, a sanitary landfill should be considered for the disposal of waste materials, thus minimizing damage to the environment (Eskandari et al., 2015). However, in many developing countries, organizations that are competent in waste management are not able to pay for the process, and most of the wastes are disposed to the damp sites. As a result, the leachate and the resulting gas will also be released into the environment (Eskandari et al., 2016).

Although in many developing countries, it may not be possible to construct a fully sanitary and engineering landfill site in accordance with what has been done in developed countries, less costly methods can be employed to reduce environmental damages. For instance, expensive geosynthetic clay liners can be replaced with simple clay lining in low-income countries. Then, these simple liners was improved by using low cost and easily used methods. One of the major concerns of clay liners is surface cracking due to the used clay properties. Surface cracking of the liners reduces the useful life of the liners, decreases soil resistance, increases surface infiltration and, as a result, contamination of the environment. Hydraulic conductivity of some clay liners has been reported 500 times as a result of cracking (Safari et al., 2014)

Miller and Rifai (2004) examined the fiber-based landfills and showed that the percentage of fiber suitable for maintaining hydraulic conductivity was in the range of 0.4-0.5% of soil weight. Harianto et al. (2008) investigated the effect of adding polypropylene (C3H6) fibers on a clay soil to prevent the increase of contraction cracks in clay liners. This study showed that the use of fibers in soil is very effective in reducing contraction cracks. Ple and Le (2012) investigated the effect of polypropylene reinforcement fibers on the mechanical behavior of clay and found that reinforced clay exhibits a soft behavior that can reduce cracking potential. Ple et al. (2015) studied the hydraulic conductivity of natural clay and clay modified with bentonite, with and without cracking. In their research, three types of liquid were used to cross the clay. Compared with water, passing artificial leachat did not have much adverse effect on hydraulic conductivity. Based on the results of this study, cracking due to drying and fine grained amounts are two important factors in the hydraulic ability of the liners.

Consequently, it seems that the addition of fibers to clay lining would enhance to two opposite effects. On the one hand, fibers reduce cracking, and on the other hand, in a range of values, increase the permeability of the liners. Therefore, determining the optimal fiber percentage, which is itself a function of the soil and fiber, and its size, is very important, so as to prevent cracking, the permeability can be changed at a laboratory scale within an acceptable range. Some other additives, such as phosphate compounds, can be added to reduce the potential for transmission of contamination to the liners. So far, many studies have been done to show that phosphate compounds are capable of stabilizing various types of contaminants, especially heavy metals and radioactive materials in the soil (Roger & Shi, 2004; Mignardi et al., 2013; Ping et al., 2013; Falamakiet al., 2016).

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Therefore, it can be concluded that by adding phosphate materials to clay loess of landfill, the absorption of different types of contaminants in the leachate and especially heavy metals increases.
The main objective of this study was to produce a dense clay loop with fibers and a combination of phosphate at the same time. For this purpose, the natural clay of municipal waste landfills in Shiraz was used and the optimal fiber percentage for this soil was investigated for its use as clay lining.

2. Materials and Methods

The collected soil sample were transferred to the laboratory, dried and prepared for testing. Based on the unified system of soil classification, the texture of samples was clay loam (CL) and had a plastic and liquid limit of 25 and 10, respectively. The specific gravity of this soil was measured at 2.65 g / cm^3. The fiber used in this research was polypropylene (C3H6) with an approximate length of 2.5 cm. Di-calcium phosphate (DCP) with the chemical formula $CaHPO_4$, $2H_2O$, was used as a phosphate additive. Three different types of samples were prepared and tested in this study. To prepare a simple liner sample, 500 mm of water was added to 3000 g of soil sample, so that the percentage of moisture in the samples was 16.6%. Then the specimens were allowed to reach a uniform paste condition. This sample was transferred into the test cell and loaded for a period of time to prepare the permeability coefficient measurement. Fibrous samples were prepared similar to the simple one, except that before adding water to the soil, the required amount of fiber was randomly added to the soil and mixed well. Polypropylene fibers were used in three levels with 0.5, 0.75 and 1% by weight of soil. Third, in addition to the fibers, DCP was also applied. To prepare these samples, before adding water to the soil, di-calcium phosphate was added to the water and mixed with the mixer to form a gray-colored liquid. The resulting liquid was then added as sample water. The DCP value in all experiments was considered as 0.2% by weight of the soil sample. The prepared samples were then placed in a humidification room for 10 days in order to obtain the chemical equilibrium, and the effect of the additive on the soil behavior was stable. In order to evaluate the performance of improved dense clay liner with polypropylene fibers and di-calcium phosphate, permeability tests, direct cutting and determination of cracking value were performed on seven different samples each with two replicates. Some permeability tests were carried out based on ASTM-D2434 (2006) standard in a cylindrical cell made of Plexiglass with a diameter of 150 mm and a height of 130 mm. Direct cutting test was performed according to ASTM D3080/ D3080M-11 (2011) instructions. After the permeability test, the specimens were removed from the cell and exposed to sunlight for a week to evaluate the potential of cracking.

3. Discussion of Results & Conclusions

The permeability of simple clay liner measured in 24 hours, was a value of about $(0.8\text{-}1)\times10^{-8}$ centimeters per second. The infiltration coefficient was increased by about four times in samples with 0.5% fiber compared to clay without fibers, and was obtained a value between $(3\text{-}3.5)\times10^{-8}$ cm/s. This process was also observed for the application of 0.75 and 0.1% fiber, and the permeability changes acquired in these two states between $(3\text{-}4)\times10^{-8}$ and $(4\text{-}5)\times10^{-8}$ cm/s, respectively. In other words, the hydraulic conductivity after application of these two quantities of fibers, on average, was about 3.5 and 4.5 times than permeability of simple clay, respectively. By adding 0.5% fiber in the presence of DCP, the permeability value was obtained to be about $(2\text{-}3)\times10^{-8}$ cm/s. Similar to the non-DCP samples, adding DCP simultaneously with fibers in the clay linear increase the conductivity by about three times than the simple clay sample. The permeability of the clay sample with 0.75% fiber plus DCP was 3 to 5 times larger than the simple clay sample. In samples with 0.1% fiber plus DCP, the hydraulic conductivity of the clay liner increased about 4 to 6 times than the simple one. Therefore, the fiber increases permeability, but the addition of DCP does not have much effect on penetration changes. The results of the direct shear test showed that the maximum shear strength in the case where DCP was present was not significantly different from that in which the fiber was used alone.
It seems that, by adding 0.5% of the fiber to the soil, the φ of sample increased, but in the following, with increasing fiber content, i.e., 0.75 and 0.1% of the fibers, φ decreased. The reason for this soil behavior is the high volume of fibers compared to its light weight. At each step, increasing fiber, adhesion has also increased. In fact, the increase in fiber has contributed to the increased adhesion of clay linings.
The results indicated that the addition of fibers and DCP can increase the shear strength of the maximum soil. In addition, observing the effect of the fiber on the reduction of surface and inside cracking of clay liners is also a very important factor. Because these cracks have a significant adverse effect on the mechanical condition and the permeability of the lining. It also reduces the longevity and performance of the clay liners. The simple liner specimen, first had hairy cracks, but after passing the time and drying the surface, cracked deep and wide. The samples made in this study show a very small scale of clay liners, and in reality, the dimensions of the liners are much larger. As a result, fractures and cracks will have a lot more size and depth. In samples with 0.75% fibers, the desiccation cracks completely faded and a smooth and uniform sample was obtained. From the integrity of this sample, it can be concluded that this fiber percentage has also been able to greatly eliminate deep cracks. 1%

polypropylene fiber has a lot of volume based on its light weight, which may cause improperly distribution. That's why it cannot completely absorb soil particles and completely prevent desiccation cracks.
The results observed in the fiber samples were also the same in the presence of DCP. That is, in clay sample with 0.5% fiber and in the presence of DCP, cracks behavioral had a similar effect as 0.5% of non-additive fibers. The analysis of the results obtained from the experiments shows that the hydraulic conductivity of the fibrous clay liners were lower than simple one, but the advantage of using the fibers is the reduction of the desiccation cracks, which can be a major factor in the significant increase in the hydraulic conductivity of the liners as a result of the preferential flow. In general, the elimination of contractions with 0.75% fibers was more pronounced than 0.5%, and the appropriate range for using fibers seems to be between 0.5% and 0.75%.
However, the permeability coefficient of samples made from liners with 0.75% fiber plus DCP was 3 to 5 times higher than that of simple clay, its value was within the acceptable range of hydraulic conductivity of dense clay liners, ranging from 1×10^{-7} to 1×10^{-9} cm/s. On the other hand, the shear strength increased to an appropriate degree. Addition of Di-calcium phosphate to clay to reduce and absorb contamination and to stabilize and solidify heavy metals did not have any harmful effect on the lining. Therefore, its application with fiber will not affect the liner permeability coefficient, shear strength and cracking elimination.

Keywords: clay liner, cracking, leachate, polypropylene fiber.

Estimating the value of quality of drinking water using contingent valuation method (Case study: Kermanshah City)

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Received: March 11, 2018 Accepted: December 3, 2018

Extended abstract

1. Introduction

Currently, the international community has recognized the common problems associated with the quantity and quality of water. Many diseases that can be transmitted through unhealthy drinking water occur in developing countries of Asia, Central and South Africa. Therefore, provision of safe water is one of the most effective and permanent technologies to improve the health of the community. According to the World Health Organization's report, the mortality rate associated with water borne diseases was more than 5 million people in 2008. Therefore, information on water quality and pollution of resources is significant for sustainable water management strategies. The analysis of people's economic and social demands helps to anticipate health needs and deficiencies, among which one factor can be the value that people have for drinking water, which can be expressed by the amount of willingness to pay. Measuring the willingness to pay in social projects in developing countries is done by conditional valuation. Given the fact that there is no explicit market to improve some products such as safe drinking water, the use of non-market methods and the trading of such goods in this market is recommended. Contingent valuation is one common method used by economists, policymakers and water organizations to improve water supply. It has also been implemented in many water supply and sanitation projects, especially in the provision of rural water in developed and developing countries. The main advantage of this method is its flexibility.

Another advantage of this method in comparison with other ones is that the respondent keeps both use values and non-use values in his mind, once answering the questions. On the other hand, the willingness to pay is to measure the value of a person to a particular commodity. Since drinking water quality issues plays an important role in human health, the use of methods to estimate the value of drinking water quality in order to carry out economic programs and move towards the development of the study area is considered necessary.

2. Matherials and Methods

The present research was carried out in the north and east of Kermanshah city (Elahiya, Jahad, Nobahar, Cornachi) in November and December, 2016. Data were collected using questionnaires and interviews by random sampling. The Cochran formula was used to calculate the number of samples needed in the sampling method. According to the formula, the number of samples required 384 questionnaires, but to achieve better results and with the probability that some filled in questionnaires were invalid 400 questionnaires distributed among residents of Kermanshah city. 39 of the questionnaires were deleted after completing the study due to mistakes and defects. Finally, 361 questionnaires were used for the final analysis. Face-to-face interviews was conducted at the respondents' place of residence. Socio-economic characteristics, population, water resources, drinking water quality, presence of suspended particles in water, willingness to pay and reasons for unwillingness to pay for respondents were questioned. Respondents were also asked about how to use tap water (boiling, filtering) before drinking it. The contingent valuation method was applied to calculate the average willingness to pay for the improvement of drinking water quality in the residents of Kermanshah. Also, the binary logistic regression method was used to obtain the tendency to pay. In this method, regression analysis is

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based on dependent variables and binary classification variables. McFadden R2 indicators and statistics likelihood ratio were also used for a good fitness estimation. The right-of-proportion ratio statistic compares the right-exponential function statistic in the bound state (all coefficients of zero) and unconstrained, and shows the simultaneous meaning of all the coefficients. If this statistic is meaningful in relation to the probability of stating the right ratio, this shows that the explanatory variables in the model have been able to describe the dependent variables well.
The software packages used in this research are SPSS, Shazam, and Wolfram Alpha.

3. Discussion of Results

In the preliminary study, experts' opinions were used to assess the validity of the questionnaire. After reviewing and correcting, the validity of the questionnaire was assured. To assess the reliability of the questionnaire, a pre-test was performed with 55 questionnaires and the Cronbach's alpha coefficient for the questionnaire was 0.55, which indicates that the questions are highly valid. Table 1 shows the reasons for people's dissatisfaction with drinking water in Kermanshah. As shown in the table, the most reason for people's dissatisfaction with drinking water is related to the remaining salts in the container.

Table 1. Citizens' opinion about the reason for their dissatisfaction with drinking water in Kermanshah

Property	**Bad tasting**	**Malodor**	**Inappropriate color**	**The remaining salts in the container**	**Sediment in the tube**	**None of them**
Number	62	6	15	153	120	5

The results of the willingness to pay of residents show that among 361 samples, 16% of the respondents offered 5000 USD, 51% offered 4000 Rial and 16.4% proposed 2000 Rial to improve water quality. Also, 16.6% were not willing to pay a sum to improve the quality of drinking water. Table 2 shows the results of a lack of willingness to pay or a willingness to pay low in order to improve the quality of drinking water in the city of Kermanshah.

Table 2. Reasons for people not willing to pay or willing to pay for drinking water in Kermanshah

Reason	**The task of water and sewage**	**Lack of confidence in the efficiency of the organs concerned**	**Low income and high living expenses**	**Good water quality**
Number	184	58	81	38

According to the results, among the five main problems (unemployment, high living costs, low water quality, water crisis and environmental pollution), unemployment were the highest and low water quality and the least significant among the respondents. Also, 76.5% of respondents believe that the quality of drinking water is fairly good and 23.5% of respondents believe that the quality of water is poor. In general, 80.2% of respondents did not rely on drinking water (piped water) and Concerned about diseases transmitted through drinking water. Considering piped water was the drinking water source of that 95.8% of the statistical population, therefore, 64.3% of the respondents were willing to pay a fee to improve the quality of tap water so that the water and sewage office assured them that no disease would spread through drinking water.
The results of estimating the Logit model are shown in Table 3. The dependent variable accepts a bid amount of 0 and 1 and variables such as recommendation rate, education, age, water quality concern, assurance of safe water quality and the quality of drinking water quality are independent variables. Also, variables that were not statistically significant were eliminated in the Logit model to help achieve better results.

Table 3. Logit results after removing meaningless variables statistically

Variables	Coefficients	Statistically significant level	Total Weight Tension	The final effect
Education	0.6380	0.0004	0.11245	0.1523
Age	0.0741	0.0039	0.0587	0.06847
Concerns about Water quality	1.881	0.0006	0.325	0.4587
Ensure that the Tubing is healthy	-1.6584	0.0043	-0.124	-0.153
Assessment of Drinking water Quality	-1.2375	0.0092	-0.0124	-0.0144
Proposal	-0.0003	0.0260	-0.212	-0.224
Constant factor	-0.0067	0.5749		
R MC Fadden= 0.87134				
Percentage of Right Predictions=75				
Likelihood Ratio Test= 257.69				
Probability (L. R. Statistic)= 0.0000				

After fitting the model, the numerical integration in the range from zero to the maximum suggested average of the willingness to pay for the value of improving the quality of drinking water was estimated.

E (WTP) = $\int_0^{15000} \frac{1}{1+\exp\{-(\alpha*+\beta A\}} = \int_0^{5000} \frac{1}{1+e^{-3.1658+0.000806x}} dx =$ 4553.3

According to the results of Table 4, the fitting of the model with a maximum accuracy of 25 degrees is 257.69 in degrees of freedom. Considering the probability of stochastic proportions being significant at 1% level and suggests that independent variables describe the dependent variable well. Also, the percentage of correct prediction is 0.75. Given that the acceptable value for the logit model is 70%, then this pattern is believed to be trustworthy. The value of the Mc Faden coefficient is also 0.87%, which is desirable for the logit model, based on the number of observations of the dependent variable. A total of 83.4% of respondents tended to pay for improving the quality of drinking water (pipe water). The average willingness to pay of each person to improve drinking water was 4553.353 Rial a month. Also, variables such as rate of offer, education, age, water quality concern, assurance of safe water quality and the quality of drinking water quality were the most important factors affecting the willingness to pay.

4. Conclusions

Environmental valuation methods have been widely used to value recreational sites, but we must consider that all environmental benefits need to be valued to achieve sustainable development. Therefore, in this study, using the contingent valuation, the willingness to pay of the residents of Kermanshah city was estimated to help improving the quality of drinking water. Public awareness and raising public awareness about the standards of safe water and transmissible diseases through contaminated water would greatly help people's attitudes towards water quality improvement. It is natural for people in the community to be aware of the quality of water, demand to improve drinking water quality and if such a water is not available, they will be willing to pay for it. Regarding the results of the present study, in the logit model, the relationship between income variable and Willingness to pay was not significant. It can be noted that all strata of society, not just high-income people, are demanding safe and safe drinking water, and in order to achieve such a goal, they would financially support the government, and in particular the water and sewage administrations. Considering the importance of drinking water for the residents of Kermanshah and the desire to in order to have a healthy and high quality water, it is clear that people of the community can play an important role in supplying water. Therefore, in the area of management and planning process, conscious efforts must be made to fulfill the community's needs and address their concerns regarding the quality of drinking water. Because these are people who would suffer must meet them when there is a problem

Keywords: Contingent Value Method (CVM), Logit Model, Kermanshah, water quality, Willing To Pay (WTP).

Probabilistic long-term prediction of drinking water demand (Case study: Neyshabur City)

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Received: April 17, 2017 Accepted: December 3, 2018

Extended abstract

1. Introduction

The probabilistic prediction model is obtained by developing a spot prediction model. Unlike definite prediction, probabilistic prediction provides an amplitude of probable amounts for water demand. It is clear that there is more trust in amplitude values in decision making process. The probabilistic prediction of water demand is calculated through the distribution of uncertainty in independent variables by the water demand model and production of a probabilistic distribution function for water demand in the point of interest in the future. Looking for the probabilistic distribution allocation, the Monte Carlo simulation process is used to develop a probabilistic prediction of water demand according to the spot model using the Stone-Geary utility function. For each repeat in the Mont Carlo simulation, a value of allocated distributions to each descriptive variable is used randomly. In this research, both methods of analyzing past information and other experiences are used to determine probability density functions. Normal and uniform distribution functions were used because of their ease in the determination of parameters whenever their real distribution is not clear or it cannot be easily determined.

2. Materials and Methods

To apply uncertainty, the independent variables used in the prediction of domestic water demand consist of per capita real income, the real price of water, the stock prices of goods and services, the average maximum temperature and the literate number, the best distribution of their monthly values, as a result of the probabilistic distribution function, were used as the input of the water demand function and outputs received as monthly water demand. For validation of the water demand forecasting model, the predicted values of water demand were compared with its real values in a few periods. In this research, the LARS-WG micro-scale statistical exponential model was used to predict annual maximum temperature.

Neyshabur city, located in Razavi Khorsan province, was selected as a case study and the statistical society of domestic water branches was investigated. The required information was obtained from its subsidiaries' annual report and the statistics of the meteorological organization.

Independent variables that were used for water demand estimation are real income per capita, real water price, stock prices for goods and services, average maximum temperature and literate numbers. The best distribution was selected by applying distribution functions on the value of variables, considering the results of the Anderson test, selecting the Anderson multiplier and attending to other studies and experiences.

The final model for long-term water demand according to the Ston-Geary utility function is as Equation (1).

$$perc_t = \theta_0 + \theta_1\left(\frac{I_t}{MP_t}\right) + \theta_2\left(\frac{PO_t}{MP_t}\right) + \theta_3 E_t + \theta_4 MT_t + U_t$$

)Eq. 1(t=1,…, 120

MP: the average price of water (Rial)
I: the per capita income of consumer (Rial)
PO: the stock price of goods & services in Razavi khorasan province
P_{erc}: the amount of per capita water consumption (m^3)
E: the number of literates

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MT: the average maximum temperature
U: the disturbing element

Discussion of Results and Conclusions

Calculated elasticity of the price, income, intersection, maximum temperature and number of literates by considering their average values in the investigated time periods for Neyshabur city are presented in Table 1.

Table 1. Calculated elasticity of water demand for Neyshabur city

Price	Income	Intersecting	Maximum temperature	Number of literates
-0.117	0.195	-0.078	0.054	0.402

Table 1 shows if the price of water increases one unit, it will result in a decrease of just 0.117 unit in water demand, which indicates the possibility of using a pricing policy to reduce water consumption. Relatively low income elasticity (0.195) shows the small share of water in the family income. Negative intersecting elasticity indicates that water is a complementary good. Temperature elasticity is positive (0.054) which notes the tendency of using water by temperature rise. In this research, the elasticity for a number of literates obtained is equal to 0.402. So one percent increase in the number of literates will result in a 0.402% increase in water demand.

To estimate the accuracy of the model, the per capita water demand was forecasted using independently observed variables in the period from 1997 to 2008, and the results were compared with the observed information which showed a good match. Also, the results of RMSE and MSE tests for estimating the accuracy of the models were 0.22 and 0.12, respectively, which emphasizes the acceptable accuracy of the model. After finalizing the model, the per capita water demand of Neyshabur was predicted by the spot method and the summary of results is shown in Table 2.

Table 2. Summary of the per capita water demand prediction by spot method

Unit	Year						Percentage changes	Average of yearly changes
	2008	2011	2016	2021	2026	2031		
M^3	51.18	53.35	60.06	66.03	71.93	79.31	48.6%	2%

Finally, the per capita water demand was predicted for Neyshabur through the probabilistic model and the summary of the result is presented in Fig. 1.

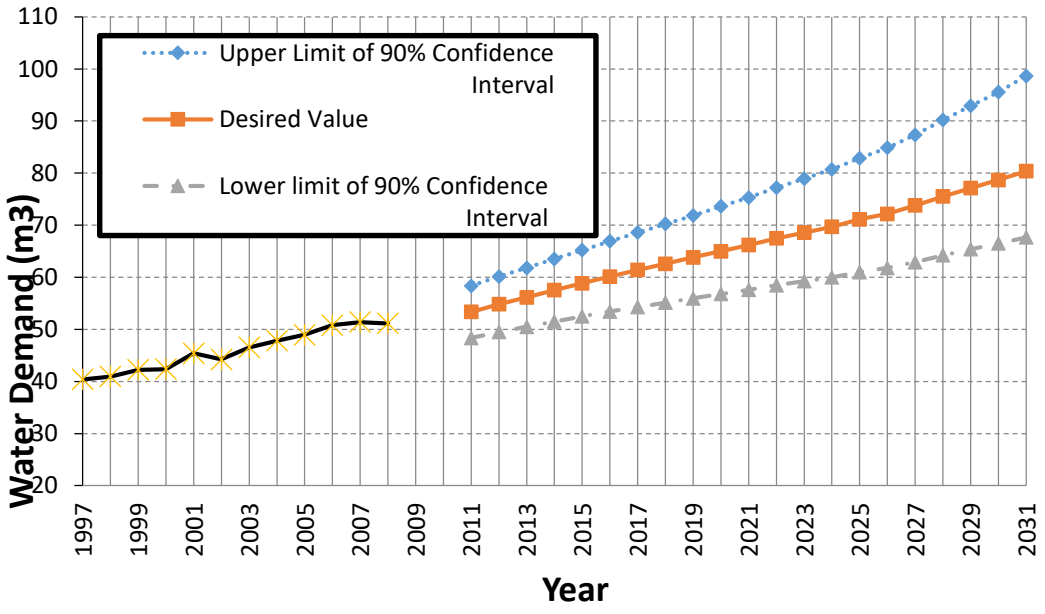

Fig. 1. Comparison of the observed values and 90% confidence interval of the annual per capita water demand forecast

As can be seen in Figure 1, the annual amount of predicted mathematical expectation for the per capita water demand in the year 2031 is calculated equal to 80.36 m^3, which shows a 50% increase compared to 2011. The average annual increase in water demand is about 2%, which is consistent with results of the spot prediction model. For the year 2011, the defined confidence interval for water demand has averaged between 48.34 and 58.36 m^3. While for the year 2031, this range has grown and broadened to 67.66 and 98.64 m^3. Furthermore, probability function shows a 90% confidence interval for all probable predictions with consideration of independent and explanatory variables uncertainty.

Keywords: long-term prediction, Monte Carlo Simulation, probabilistic prediction, Stone-Geary Function, water demand.

Determining total allowable pollution and waste load allocation in rivers regarding seasonal variations, a framework for local multi-parameter water quality standardization and monitoring

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Received: July 25, 2018 Accepted: December 3, 2018

Extended abstract

1. Introduction

There are two approaches for water quality standardization and monitoring the pollution loads discharged into the water bodies, like rivers and estuaries. In the conventional system of command and control, the monitoring organization focuses on limiting the concentrations of physicochemical parameters of water, such as dissolved oxygen (DO), biochemical oxidation demand (BOD), chemical oxidation demand (COD), total nitrogen (TN), total phosphorous (TP), total kjeldahl nitrogen (TKN), etc. in the effluents of point-sources. This framework is easy to monitoring and penalizing, particularly for industrial and domestic polluters with continuous annual discharge flow. However, it has several shortcomings. The main weakness is the inflexibility of water quality standards regarding the environmental conditions of rivers, their self- purification and vulnerability potential, and the seasonal variations of water quality and quantity of rivers. Besides, the conventional approach neglects controlling the discharges of non-point sources (NPS), including agricultural activities, as they may not be continuous or precise in location for sampling. These faults are introduced as a reason of pollution accumulation and Eutrophication in surface waters.

In the second approach termed as controlling ambient discharges, the water quality standards are determined in local scales regarding the environmental potential and conditions of rivers. Here, water quality monitoring is focused on the critical points in the river itself and limiting the pollution loads rather than concentrations in these stations. This approach in monitoring considers other issues like the self-purification potential of river, and the total pollution loads (TPL) discharged by both point and non-point sources upstream. However, there are some challenges that make this framework more complicated: 1) Finding a proper standardization and TPL in a multi-parameter framework, 2) waste load allocation (WLA) and fair sharing of penalties among polluters, and 3) uncertainties regarding the seasonal variations of emissions and the fluctuations in river water quality and quantity.

In this research, a methodology is introduced regarding the ambient discharge framework to calculate an optimal multi-parameter WLA among emission sources. This intends to determine an allowable TPL in a river with high seasonal variations and challenges in the aquatic life. For this purpose, we chose Tajan River in northern Iran as the study area. This river has 51 km length with annual average water volume of 15 million m^3. It ends to the Caspian Sea where the estuary currently encounters DO deficiency in some seasons and endangers the aquatic life. This may be due to the pollutions discharged from point and non-point sources, including paddy fields, pulp and paper industry and municipal effluents of Sari city with the rural areas upstream.

2. Material and Methods

In order to find a proper WLA and TPL, a simulation is carried out on Tajan River with 18 reaches by Qual2kw software with 100 times iteration for calibration. This simulation includes two steps. In the farming season (FS) of the study area, more than 5 m^3/s of water is allocated for paddy fields that reduces one third of river overall flow at headwater. This lessens the remediation potential of river for diluting pollutions discharged particularly the nutrients concentrations exist in the drainage of NPS. Conversely, in non-farming seasons (NFS), DO profile and base-flow of river increases and environmental pollution limits to the point sources. Therefore, simulation is calibrated with respect to the sampling results in the first scenario of FS and later validated by other data in NFS.

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Regarding the fitness function and auto-calibration based on the genetic algorithm, the simulated model with 100 iterations presented 71% accuracy. For that, the water quality data sampled from three stations between 2014 and 2015 in the upper, middle and lower lands of river are used.

3. Results

Figure 1 illustrates DO deficiency of river in two periods. It is obvious that in FS, DO deficiency exceeds 2.5 mg/L (for a DO saturation of 8.5 mg/L) that endangers aquatic life in the last 15 km of river to the terminus point but this is rather normal in NFS. Besides, in FS the concentrations of nutrients like TN and TP respectively increase more than 5 and 1.5 folds in comparison with NFS. It should be noted that about 40% of TN is made of TKN in FS that shows two points. First, chemical fertilizers are the main pollution origins of NPS discharges. Second, it may devour considerable amount of DO in the nitrification process. Therefore, NPS like agricultural activities are introduced as the main reason of seasonal pollutions. In addition, both nutrients and carbonaceous compounds are highlighted as influential parameters on DO reduction. Therefore, DO is assumed as the key factor in multi-parameter WLA and decision-making. Here, it is assumed that 5 mg/L should be met as the minimum limit of DO throughout a year even in the most polluted periods FS, while 6 mg/L must be met annually in average.

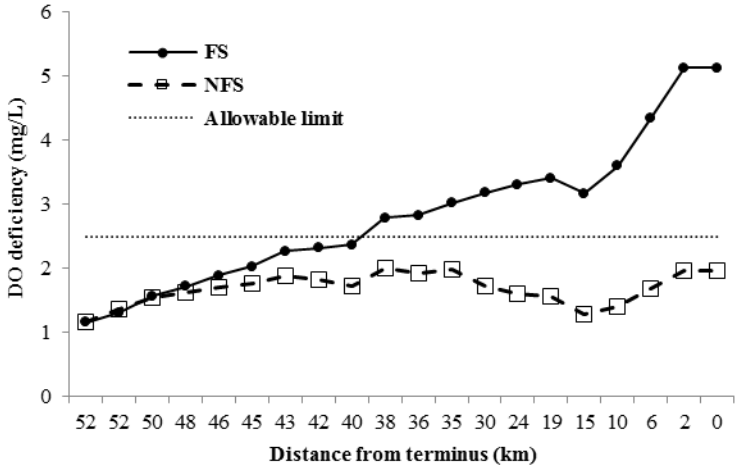

Fig 1. Simulated DO deficiency profile of river in farming (FS) and non-farming seasons (NFS)

The sensitivity analysis on the origins of pollutions showed that the self- purification potential of river for nutrients reduction will not exceed 10%, but it easily reaches 50% for carbonaceous organic loads. This result adds up the significance of NPS pollution control in decision-making for WLA in river. Therefore, regarding the simulated pollution loads of the terminus point in FS and NFS, the annual TPL in WLA is determined in a way that DO profile responds to the assumed limits. As shown in Table 1, the maximum allowable loads of TN and COD are respectively considered 2500 tons/yr and 4500 tons/yr. TPL for other parameters like TKN, nitrate, and TP are respectively 500, 2000, and 250 tons/yr.

Table 1. TPL estimation and set allowable concentrations of pollutants

Water quality parameters	Total pollution load in the terminus point (tons)/current			Annual TPL (tons)/WLA	Abated pollution load (%)	allowable TPL in terminus (tons/yr)	Allowable concentration in terminus (mg/L)
	FS	NFS	Annual				
TKN	639	111	750	446	40.5	500	1
NO_3	1549	329	1878	1281	31.8	2000	4
TN	2188	440	2628	1727	34.3	2500	5
TP	381	16	397	212	46.5	250	0.5
COD	2784	2261	5045	4361	13.6	4500	9

By these limits, the local concentrations of pollutants can be set as the standard level for better monitoring. For TN, TP and COD, the recommended monitoring concentrations are 5, 0.5 and 9 mg/L, respectively. By these conditions, it is expected that DO remains on the assumed standard level as shown in Figure 2. Here, WLA is set

on 45% removal of pollutions discharged by NPS. This value may reduce 34% of TN, 46% of TP and 14% of COD at the terminus point.

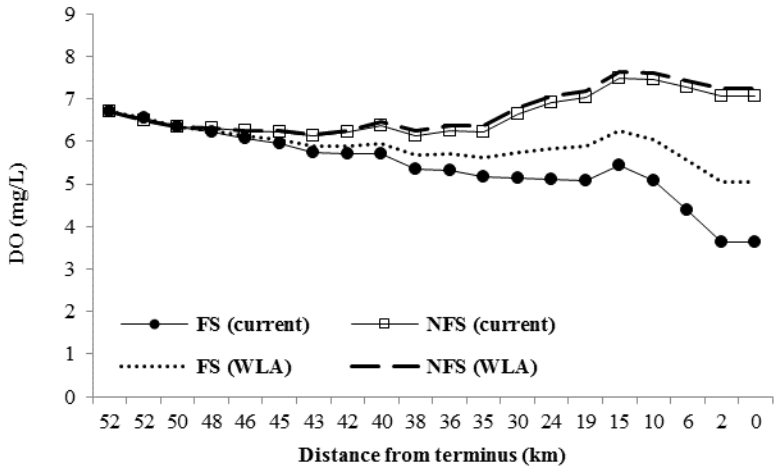

Fig 2. The simulated DO profile of river in the current and after WLA in two scenarios of FS and NFS.

4. Conclusion

In this research, a method in introduced with respect to the ambient-based framework for water quality monitoring to find TPL and consequently the annual average concentrations of main water quality parameters is used. In the case of Tajan River, it is realized that the estuary is highly sensitive to the seasonal variations of water quality and quantity. The main source of these variations is marked as the agricultural activities of paddy fields that recommended to be mainly focused for multi-parameter WLA and decision-making. For this purpose, it is also recommended that DO is selected as the key controlling index because it reflects the effects of both carbonaceous and nitrogenous compounds and is crucial for the aquatic life. Finally, with respect to the self-purification potential of river, TPL and WLA are determined. This approach can be similarly used in other cases to find local standards for water quality monitoring.

Keywords: allowable discharge, maximum pollution load, river self-remediation, simulation, water quality.

Assessment of campus landscape quality experience in higher education institutions from aspect of students (Case study: Campus of Ferdowsi University of Mashhad, Iran)

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Received: April 25, 2017 Accepted: December 3, 2018

Extended abstract

1. Introduction

The campus is the total physical environment, including all buildings and landscape space. This combination of buildings, landscape and space between buildings functions, as an organized whole, has a distinctive identity.
The value of the campus is appreciated for its role in defining a unique sense of place, for its beauty and rich connection to the state and university history. They may further be appreciated as a restorative setting to work and play, or to recruit and retain faculty, staff, students and visitors. However, this urban campus landscape also has a valuable role to play through its contributions to environmental, economic and human health. Trees serve as part of the University's green infrastructure providing unaccounted services that improve air quality, reduce atmospheric pollutants and greenhouse gas emissions, mitigate urban heat islands, conserve energy, filter water, reduce municipal costs for flood control and contribute to offsetting climate changes. In essence, trees serve as a source of natural capital that is the currency fundamental to the ecosystem processes sustaining the health of all life on earth. Therefore, the landscape and buildings hold a key place in the collective memory of the institution. In recent decades, the development of higher education in Iran has always been associated with the development of physical training centers. This process, especially in the last ten years, has been established new fields and increased the capacity of educational institutions and universities in different sections intensified. However, the quality of the centers of higher education institutions has not involved uniform by population growth and other factors. Open and green spaces are factors which have the important role in the evaluation quality of academic centers, usually ignored in the process of physical development centers. Educational spaces, regardless of their buildings and facilities, due to the quality of the environment and your perspective, can impact cognitive, emotional and behavioral users to leave. The quality of a school is judged by its sense of place and by the activities going on across the campus. Prospective students, their parents, and faculty count the overall feel of a campus as part of their decision when selecting a school. It also contributes significantly to a university's ongoing efforts to attract and sustain the best students, faculty and staff, and to reflect its social purpose in a positive way. Few people are happy attending a campus that recognizes the importance of campus landscape spaces; it is no longer the leftover of buildings. Ferdowsi University of Mashhad is the third university in Iran witch due to the diversity of the audience, scope and focus of the units has led the campus landscape and one of the most important and immediate collection of the university. In this research, the main problem is to evaluate the measures affecting the quality of the campus landscape environment from aspect of Ferdowsi University students. To analyze the components of effective strategies to improve quality, planning and development of university provide current perspectives. One of the goals of this study was to identify the components of the quality of the campus landscape environment of Ferdowsi University and providing visual and environmental quality to improve quality of life and education. Other objectives of this study are:
- Strengthening the genius loci on campus landscape environment.
- Assessment and improvement of University open and green spaces.
-Attention to beauty and aesthetics from the perspective of users, and its use in the planning and development of the current landscape.
- Assessment of ecological effects of landscape and green space from aspect of users.

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1. Matherial and Methods

In this study, a standard questionnaire was used to obtain information. For university campus, it is easy to identify the majority end-users of campus landscape spaces who are students. Faculty, staffs, parents, visitors and surrounding community members are also important users. Only the major end-users (college students) were chosen to simplify the process. Among college students, the study population included all male and female students living in hostels are the number about 9,000. According to Morgan table, we selected 367 students as a sample size, with half of them from different genders by random sampling. A reliability analysis of the questionnaires is necessary to test how real they reflect the facts. We use Cronbach's Alpha coefficient to test on the questionnaire items by means of internal reliability consistency. The higher the coefficient is, the more consistent and reliable the factors tested will be Cronbach's Alpha coefficient over 0.7 indicates a rather high reliability; the coefficient less than 0.35 shows a low reliability; and 0.5, the minimum of an acceptable reliability. The statistics shows that the reliability of the questionnaires completed by 30 out of the population of 0.67 was approved by Cranach's alpha coefficient. The analysis by software (SPSS) was performed. Factor analysis to obtain the effect of each variable was used sub-parts on evaluating the quality of campus landscape environment. Also, to obtain the relationship between variables correlation test was used. Pearson correlations and among the parameters has been conducted to build an effective linear regression equation and illustrate whether there is a significant correlation between the items of natural landscape, belonging to the place, visual assessment, health and ecological aspects.

2. Results

The results showed that visual- perception variable, are explained 21.8% of the variance by random sampling and are the highest representation that evaluate by an agent. The highest Pearson's correlation coefficient with the variable quality, related to the visual- perception (0.93), respectively. Genius loci and vitality and mental health nuanced next. Physical aspect of environment has the lowest correlation with the quality of the environment. So, results show the environment quality from aspect of the women (19.98), less than men (47.21), respectively. Due to the significant mean difference in level of more than 99% is significant. The conclusion we can draw is that a significant positive correlation consists in the relation between the visual assessment, belonging to the place, health, ecological aspects and architectural environment.

3. Discussion

Campus landscape space design has been overlooked for years. With many institutions expand and renew their campus, the importance of campus landscape space has gained its rightful due. The current trend in the design of public open space and the healthy active living all indicate the importance of the users' involvement in the design process. How to integrate users' voices into the design becomes an important task in designing professionals. The focus of this research is to investigate the applicability of quality assessment in landscape design, especially on campus landscape space. Results of this study provide a framework that takes user's needs and requirements into account, and the traceability of these needs to design attributes. It also provides other advantages; yet it is not without some tradeoff and limitation.

The testing results of scale reliability demonstrate that all the sub-scales are reliable as a whole. On this condition, through the Pearson correlations analysis among the independent variables and between the independent values and dependent variables, we can see that the visual assessment, belonging to the place, health, ecological aspects and architectural environment correlate positively with environment quality, which accords with the hypothesis test. By the following approach, the multiple regression analysis has been conducted in the article, which verifies that the visual assessment, belonging to the place, health, ecological aspects and architectural environment are the independent variables in the regression equation and that all three factors can well predict environment quality. In addition, the coefficients of visual assessment, belonging to the place and health, are put in a descending order. The relatively highest coefficient of these three factors reveals the fact that students depend more on subjective variables in campus environment.

4. Conclusion

Since entering the 21st century, the research on campus quality has become increasingly important with more and more colleges and universities expanding and redesigning their landscape spaces. The design of campus landscape space has gained more recognition in the recent twenty years. The evaluation system of environment quality keeps pace with the advancement of science. And it is a reforming process to improve and operating system, during which researchers need to transform the traditional ideas, accelerate innovation of systems' form and content, improve the multilevel evaluation system and move forward with constant exploration. Anyway, it

remains to be an important topic, which needs further study, to better the dwelling environment construction in the efforts of developers and estate managers as well as promote the sustainable development of human living.
The results show that the quality of the campus landscape environment directly related to the perception elements. The judicious use of characteristics of landscape elements such as form, color, texture and the like can be used to increase the quality of environmental impact. In addition, visual quality, to create a sense of place and identity formation has a direct effect. These factors led to the formation of students' minds, and it reinforced the university environment. The important note is physical and environmental variables that indicate a lack of attention to the combination of green open spaces and architectural elements. Also, due to the lack of differentiation and function of sex and use of existing spaces, the quality of the environment for the female students to male students is a significant difference in the health. In landscape planning and design, little attention was given to listening to user's needs or concerns in the past. It is not unusual to see design professionals formulate their design ideas solely based on their experience, "insight", creativity and artistic training. Although with this approach, design professional may create great designs, however, faced with a set of complex and occasionally conflicting individual and community issues, resolution of the community and project needs may be limited and incomplete. As an important landscape design, the design of campus landscape spaces affects millions of people. Nowadays university campuses are no longer ignored on the global outcry of taking serious actions to safeguard the environment. Universities should be modeled as centers that can enhance teaching and learning and accommodate the needs of all learners and to serve as center of the community to promote sustainability. These could support the concept that high institutions are important symbols of ''place''. Universities should also be welcoming to all members of their community and promote partnership and collaboration with all stakeholders in policymaking and planning a sustainable environment for learning and research. This can result in problem solving and innovations that support the goals of a sustainable campus.

Keywords: campus landscape, Ferdowsi University, green space, planning, quality assessment.

The effect of dust on the feedback of some climatic factors from Ilam province

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Received: February 23, 2018 Accepted: December 3, 2018

Extended abstract

1. Introduction

Climate factors such as temperature, humidity, and precipitation play an important role on environments and their function can effect on the socio-economic conditions of societies. Aerosol is one of the factors influencing the quality and quantity of climate system. Approximately 40% of aerosols in troposphere are dust which has been happened due to wind erosion. Aerosols and dust particles can affect the radiative equilibrium energy of earth, dynamic clouds, and their microphysics, both directly and indirectly impacts (Nabat et al., 2015). Rosenfel (2000) used some satellite data, examined the processes of rainfall formation in Australian urban and industrial areas. The results indicated that the effective radius of cloud droplets have reduced as result of industrial and anthropogenic aerosols and then, coalescences droplets declined. These leaded to diminishing formation of raindrops and suppressed rainfall. Koehler et al. (2010) applied laboratory studies to give information about effect of temperature changes on several types of dust. Dust activated at less relative humidity for heterogeneous ice nucleus when temperature was higher. Additionally, those particles covered with secondary organic aerosols in lower temperatures require higher relative humidity for ice nucleus. Nabat et al. (2015) studied direct and semi-direct aerosols effect on the Mediterranean climate. They presented that aerosols influenced on radiation budget of earth, which resulted on lowering surface temperature. Also, due to negative surface forced, the sensible heat has changed, resulting in becoming less (increasing) in specific humidity, and alteration in cloud cover and rainfall. Gu et al. (2016) conduct a research on dust and aerosols impacts on regional climate of North Africa and South/East Asia by using an atmospheric general circulation model. They showed that the effect of dust on rainfall varies and can enhance or even suppress it. Absorbtion and scattering of shortwave by dust, cause the air columns to be heat. As a result, the strong vertical updraft movements are being created. On the other hand, forced radiative can dwindle surface temperature and weakens updrafts which lead to constant air. These processes can change rainfalls. Using observations with lidar in a region of China from 2010 to 2013, Wu and Yi (2017) investigated interaction of aerosols and moisture layers in cloud. Their results suggested that ice nucleus is growing with increased relative humidity thus evaluate rainfall. Ilam province is located in the western part of Iran and affected by dust storms. Environmental impacts of dust storms include soil fertility reduction and damage crops, air pollution, and cause respiratory disease. Furthermore, dust storms change the radiative energy budget which effect on the hydrological cycles and climatic system. Hence, dust impacts were studied upon some climate factors such as temperature, humidity, cloudiness, and precipitation of Ilam province by using meteorological data from autumn and winter 2000-2013.

2. Materials & Methods

Ilam province is located in the western part of the Zagros chain mountain at Iran, from 31° 58' to 34° 15' northern latitude and 45° 24' to 48° 10' eastern longitude (Fig. 1). In this work, temperature, humid relatively, cloudiness, and rainfall information gathered from Iran Meteorological Organization in daily scale from 2000 to 2013 for Ilam province. Precipitation data collected from hydrology station of the Ministry of Energy as well. Synoptic weather stations were selected as target stations including Ilam, Eyvan, and Dehloran. Statistical variance analysis in SPSS software was done to study relation among dust, temperature, relative humidity, and

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cloudiness. Because of the high volume of observation, MATLAB software was used to separate variables on scheduled days included dusty days as well as the days before and after. The stations selected as control stations had the highest correlation coefficient of daily precipitation with the target stations (Fig. 1). A regression model is used to forecast the target rainfalls by controlling rainfalls as a function of dust impact. The statistical ratio is used to evaluate climate change projections and operational cloud seeding programs on streamflow or rainfall at target stations (Gabriel, 2002; Silverman, 2010). The effect of aerosols and dust on rainfalls were performed by the statistical ratio for historical regression (Rosenfeld & Nirel, 1996).

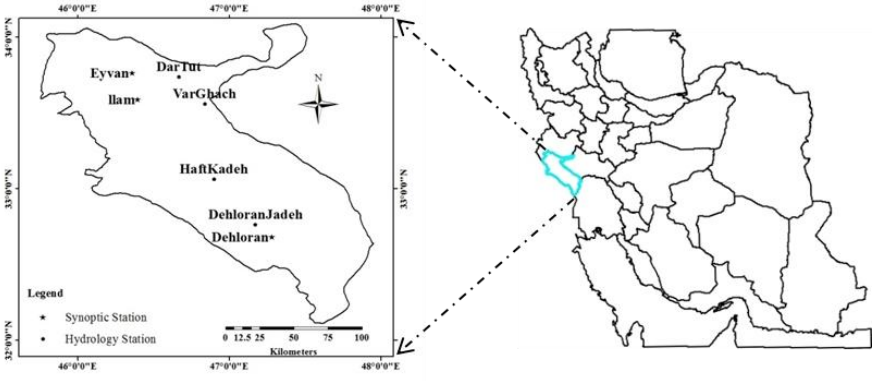

Fig. 1. Location of Ilam province in Iran showing the synoptic and hydrology stations

The statistical ratio for historical regression was calculated target stations with observed and predicted rainfalls.

$$SRHR = SR/SR_{PRED} \quad (1)$$

SRHR: The statistical ratio of historical regression
SR: The ratio of observed rainfall to the observed average for target rainfall during the historical period
SR_{PRED}*:* The ratio of predicted rainfall to the predicted average for target rainfall during the historical period
The Monte Carlo permutation test was conducted for evaluation of dust impacts on rainfalls. This test simulates samples based on dusty and rainy days. Results of permutation test include comparing the observed data with the random samples generated in accordance with the test hypothesis (Griffith et al., 1997; Silverman, 2010).

3. Results

The results of statistical test presented in Fig. 2 include temperature, relative humidity, and cloudiness in dusty days with the days before and after it for Ilam, Eyvan, and Dehloran.

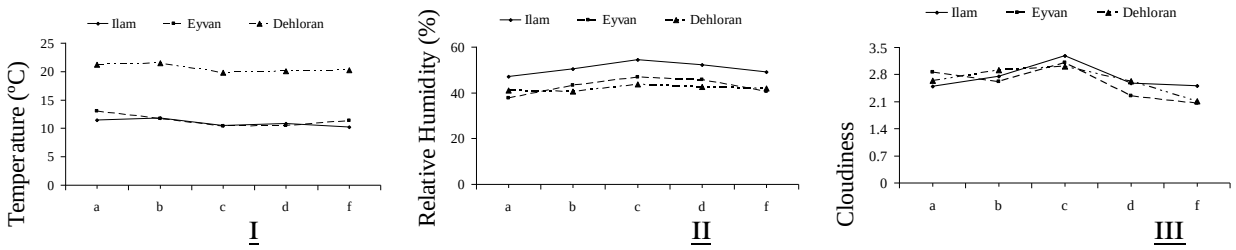

Fig. 2. Comparison of modified temperature (I), humidity (II) and cloudiness (III) on dusty days with days before and after it
a: two days ago b: one day ago c: dusty d: two days later c: on day later

Temperature variations had the lowest records in the dusty days of Ilam, Eyvan, and Dehloran with values of 10.5°C, 10.4°C and 19.8°C, respectively (Fig. 2I).
Statistical comparison of relative humidity values during these days showed that the highest relative humidity of each station was related to the days that dust occurs (Fig. 2II). Average of relative humidity for dusty days were 54.4%, 46.9%, and 43.8%, respectively for Ilam, Eyvan, and Dehloran. Studied cloud cover for stations showed that cloudiness had the highest value for days with dust. Values of cloudiness were 3.4, 3.1, and 3 for Ilam, Eyvan, and Dehloran on dusty days, respectively.

Table 1. Monte-Carlo permutation test for statistical ratio index for historical regression target stations

Station	Statistical ratio	Significant level	Confidence intervals 90%	
			Confidence	Confidence lower
Ila	0.98	0.05	1.28	0.68
Ey	0.8	0.04	1.1	0.5
De	0.7	0.03	1	0.4

Table 1 shows a statistical evaluation of dust impacts on rainfalls by using Monte Carlo Permutation test. The statistical ratios for historical regression were 0.98, 0.8, and 0.7, respectively for Ilam, Eyvan, and Dehloran. Obtained statistical ratios are less than one which shows negative effect of dust on rainfalls. However, the negative effects of dust were difference on rainfalls for studied stations.

3. Conclusion

This study aimed to investigate the effects of dust on some climate variables in Ilam province. Results of temperature variable showed that they decreased on dusty days. Atmospheric aerosols, such as dust, play a significant role on the radiative budget of the earth-atmosphere system. Dust by absorbing and scattering of shortwave and longwave have direct and semi-direct effect on the radiative energy budget balance of the earth surface (Nabat et al., 2015). Temperature declines due to downdraft reduction shortwave flux during dust storm (Wu & Yi, 2017). Stations temperature decreased for Ilam, Eyvan, and Dehloran when dust occurred and is similar to results of Nabat et al. (2015), and Wu and Yi. (2017). Result of variance analysis of studied days showed temperature enhancement on dusty days in all station in this work. The latent heat is altered on earth surface by changing radiative energy under dust effect, which changes specific humidity (Dessens & Bücher, 1995). If temperature become less and specific humidity were constant, saturation humidity is reducing and then relative humidity is increasing. Relative humidity increased in Ilam, Eyvan, and Dehloran that agrees with Gu et al. (2016) and some other studies. Gu et al. (2016) reported that dust and aerosols lowered temperature and then increased relative humidity. Cloudiness comparison of studied stations showed that it increased on dusty days. One of the most important mechanisms for the cloud's formation is sufficient relative humidity (Weare & Mokhov, 1995) which can influence on cloud cover (Wu & Yi, 2017). Changed temperature by dust impacts can be vary in relative humidity. Dust and aerosol effect on solar radiation at the upper atmosphere and earth surface, therefore temperature may change. These processes alter relative humidity and cloud cover. In the present study, cloudiness enhanced on the dusty days. These results match with McFiggans et al. (2006) that showed rising humidity may increase cloud cover due to temperature reduction.

Monte Carlo permutation analysis of statistical ratio conducted for evaluation of dust effect on rainfalls. The results of permutation analysis showed that dust had negative effect on stations rainfalls. Interaction of water vapor and mineral dust can lead to cloud condensation nuclei on warm cloud. Also, some aerosols contribute to the formation of ice particles in cold clouds which are named ice nucleus (Wu & Yi, 2017). The relative humidity can strongly control the surface precipitation rate (Ackerman et al., 2004). Dust storms enhance concentration of cloud condensation nuclei and ice nuclei. If relative humidity isn't enough during dust storm, precipitation reduces or suppresses (Rosenfeld, 2000). In this study, by comparing statistical ratio of each station with its relative humidity, it can come to an end that effect of dust on rainfall variations are under influence of relative humidity. Ilam station had 0.98 statistical ratio which had 54.4% relative humidity. Statistical ratio of Ilam station shows that aerosols' effects have had the lowest negative effect on the rainfalls in the studied stations. Ilam stations have the highest relative humidity in the studied stations. On the other hand, Dehloran station had 0.7 statistical ratio with 43.8% relative humidity. Statistical ratio of Dehloran station shows that aerosols effects have had the highest negative effect on the rainfall in the studied stations. The lowest relative humidity in the studied stations is for Dehloran station. These results accord with some studies that suggest suppression of precipitation on storm dust because of cloud condensation and ice nuclei in insufficient relative humidity (Rosenfel, 2000; Wu & Yi, 2017).

Keywords: dust, humidity, Ilam province, rain, temperature.

A framework for governance assessment and enhancement of public participation in environmental management plans: Application in the integrated coastal zone management of Iran

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Received: March 23, 2018 Accepted: December 3, 2018

Expanded Abstract

1. Introduction

Public participation is a crucial process in environmental management plans. One of the important areas in environmental management plans is the issue of coastal zone management. Over the past three decades, in response to the rising coastal problems, most countries have moved towards adopting integrated coastal zone management. However, most of the approaches were not successful. This was due to the lack of attention to the inadequate institutional and structural capacities of the social system. Management approaches cannot succeed without looking at the local social, cultural, economic, political and environmental contexts.

The governance of natural resources is defined as "interaction among structures, processes and traditions that determine the distribution of power and responsibilities, how decisions are made and how actors or other stakeholders are expressed." One of the main components of governance is the participation between stakeholders. The purpose of this paper is to propose a framework for assessing the governance structure of coastal zones in Iran, with an emphasis on improving the outcomes of integrated coastal zone management. Since the stakeholder participation is an important component in improving governance and resource management, so this study also has a special focus on this component. Therefore, the proposed framework is derived based on the review of the former research and global experiences related to governance and public participation approaches in coastal resources management. Also, this framework was evaluated and used for designing the public participation strategies and its appropriate capacity building program in the coastal zones of Hormozgan province, Iran.

2. Materials and Methods

The economic features of the coasts of Hormozgan province, along with its problems, such as disproportionate population, oil pollution, sediment and erosion, degradation of mangrove forests and water scarcity, require the integrated coastal zone management approach to address the existing problems. For this purpose, two basic steps are taken in this article. Initially, a framework for assessing the structure of coastal governance and the implementation of the public participation approach under integrated coastal zone management for coastal zones of Iran has been developed. In the second step, the public participation strategies of the coastal zones of Hormozgan province along with their capacity building program were derived based on the framework proposed in the first step.

In the first step, the objective was to propose a Coastal Governance Assessment Framework with an emphasis on implementation of the public participation. The basic stages of the ICZM were considered as five main stages including: identification of issues, analysis of stakeholders, planning and decision making, policy implementation, and monitoring and evaluation. The main focus of this framework is on the three pillars of governance assessment, the use of public participation and the providing capacity building (training) program. The assessment of the governance structure is presented by defining and adopting 26 indicators under 7 categories of components and dimensions. These seven dimensions include capability and resources, adaptation, transparency and accountability, social capacity, participation, legitimacy and integration. In the framework of the public participation, based on the analysis and classification of the stakeholders using the indexes of interest, power and knowledge and awareness, the level and strategy of the stakeholder participation under ICZM plan

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was developed. The level of participation in this framework is considered as five levels of informing, consultation, Shared Decisions, Shared Working and empowerment. The third pillar, which is related to the designing of the capacity building program, was carried out in five main stages of setting the goals, defining courses, identification of audiences, determining the most effective tools, and setting out the authorities in charge of the capacity building process. The focus of the capacity building program is to train stakeholders. Also, for evaluation public participation at the final stage of the ICZM approach, which is monitoring and evaluation, indicators of information and informing, open space, agreement, accountability, participatory methods, trust and interaction, learning and capacity building, and level of participation were developed. Figure 1 illustrates the proposed framework.

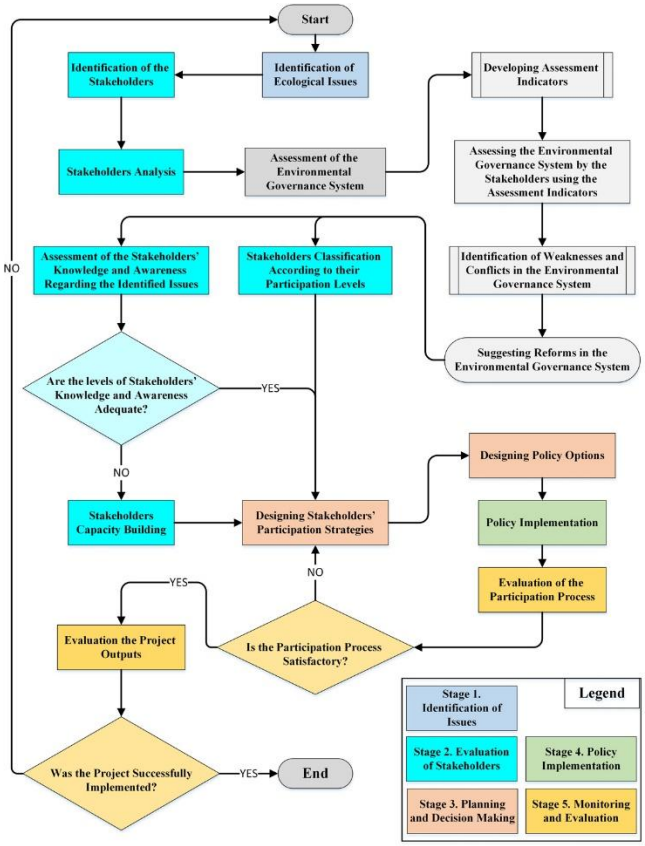

Fig. 1. The proposed framework for assessment of governance based on using Public Participation in Integrated Coastal Zone Management

In the second step, with the aim of proposing a public participation strategy for integrated coastal zone management of Hormozgan province, the framework presented in the first step was used. First, the related stakeholders were identified by snowball sampling method. Then they were evaluated and classified by indicators introduced in the framework (interest/ power/ information, knowledge and awareness), and their level of participation was determined. Based on the level of knowledge and awareness of the stakeholders, the capacity building program was also determined. The process of collecting the data required for this assessment was carried out by holding several workshops with experts related to coastline management project of Hormozgan province. Therefore, qualitative methods for collection and analysis were used.

3. Discussion of Results & Conclusions

The Integrated Coastal Zone Management (ICZM) approach aims to exploit and sustainably develop natural resources in coastal zones along with solving socio-ecological problems in those areas. From this perspective, regardless of the social context of coastal zones and the problems encountered in it, the adoption of practical and emergent solutions to solve issues face with difficulty and failure. In addition to pay attention to the governance structure, the necessity of public participation between stakeholders with the aim of adopting solutions, implementation of plans and projects, and monitoring and evaluating their outcomes have been recognized. However, there was no specific, integrated and clear framework for these goals and gaps, and on this basis, the

purpose of this paper was to provide a framework for assessing governance and public participation with respect to the coastal zones of Iran. It was also attempted to provide a clear methodology for designing the capacity-building program for stakeholders. Considering the importance of public participation and capacity building of stakeholders to prepare for ICZM projects, the second goal of this paper was to design the public participation strategies and capacity building program of the stakeholders of Hormozgan province by using the proposed framework. The public participation strategy is, in fact, a way for stakeholders to engage in ICZM's planning and implementation. Therefore, the list of stakeholders involved in the issue and the actors involved in the ICZM process (problem identification, decision making and planning, implementation, monitoring and evaluation) were first provided. In the next step, according to the analysis and assessment of the identified stakeholders, the level of participation was determined. Participation levels showed a wide range of participation from awareness to implementation, but none of stakeholders in the current situation has the capacity to initiate local governance and fully participate in ICZM programs. This weakness has been identified especially at the level of knowledge and awareness of the stakeholders. Therefore, the capacity building and training program for those stakeholders was designed. In this respect, various capacity-building programs were developed for the purpose of achieving their ability to participate. The main objectives and goals of the Capacity Building Program were explained in the seven groups as of creating a common knowledge, creating common concerns, improving adaptability, improving the level of stakeholders' expectations, improving insights on coastal issues, improving the level of participation between all stakeholders, and creating and improving professional skills. Finally, it can be concluded that, based on the categorization and the determined capacity building packages, the process of implementation and participation in the ICZM project should be started by the stakeholders, and according to the level of Participation, participants in different stages and processes will be involved. Based on the above framework, the roadmap of implementation of the public participation with regard to the different levels of stakeholders will be designed in two basic steps. In the first step, the main priorities of capacity building should be those who are at the current level of participation in decision making and implementation. In this step, in the capacity building matrix, priority is given to the titles and courses that improve knowledge and awareness of these stakeholders. In the second step, after achieving the results of the capacity building process, the implementation of the ICZM at various levels of engagement by each of the stakeholders will be carried out.

Keywords: capacity building, coastal governance, Hormozgan Province, integrated coastal zone management, natural resources management, public participation.