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Assessment of the impacts of Spatial Development Plans on Sustainability Conditions Using Ecological Footprint Method, Case Study: Urban Development Plan, Qazvin City

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Expanded Abstract

Introduction

Population growth and emergence of unsustainable behavioral patterns have caused many environmental problems. Thus, it seems necessary to consider concept of sustainable development which means development within environmental constraints. Given realization of regional sustainability, two indices are considerable means to demonstrate sustainability conditions of communities and to make decisions and policies for development of the regions. The "ecological footprint" is an approximation of environmental demand that measures people needs to a variety of lands in order to meet their demands, and "biological capacity" is an approximation of environmental supply to estimate the capabilities of the environment and regional ecosystem to meet people demands (producing vital materials and absorbing waste). Strategic Environmental Assessment during preparation of spatial development plans is one of probable means to realize sustainability conditions of habitats; but history of the regional development plans produced in Iran indicates ignorance for sustainability in most of plans.

Many studies have been carried out to recognize regional sustainability conditions and monitor its changes over time using ecological footprint in various countries including investigation of ecological footprint in metropolitan area of Barcelona during 1994-2000 by Muñiz and Galindo (Muñiz& Galindo, 2005). In Iran, Sasanpoor assessed sustainability of Tehran in his PhD thesis titled "evaluation of Tehran metropolis by ecological footprint". Furthermore, Jomepoor et al explored regional sustainability in Rasht via ecological footprint. A review on documents indicates that dominant approach of the researches in Iran and the world is based on the assessment of regional sustainability in existing situation via a descriptive attitude or exploration of its changes in a time period in the past. While investigation into consequences for implementation of particular development interventions in the region (as a popular used method of foreseeing regional circumstances) is an effective and beneficial step towards modifying and reviewing development plans and leading them to achieve a sustainable society.

Aimed at inclusion of sustainability considerations in development plans, this paper is dedicated to evaluate the possible changes resulted from implementation of urban region development plan of Qazvin in regional sustainability, as considered in the plan. The plan, prepared by Naqsh Jahan Pars consulting engineers in order to organize, control and lead the development of population and activity concentrations in a 1,400 square kilometer area of central Qazvin and whole parts of Alborz, was adopted by Iranian Council for Planning and Architecture in 17 March 2014. Population of Qazvin city was estimated 658,841 people in 2006 and at 917,190 in 2031. If urban region development plan of Qazvin city is accomplished, area of fields, pastures and woodlands will be declined from 1251 square kilometers in the basic year to 1069 square kilometers in the last year. This change in land use would reduce biological capacity of the region during the period. It gets particularly more critical due to higher value of this kind of lands to meet the needs of population living in the region.

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In addition to the efforts to evaluate impacts of development projects and estimate future conditions of regional sustainability resulted from implementation of the development plan, present paper adopts an innovative method for calculation of ecological footprint. Given that ecological footprint of different communities are related to consumption patterns of various social classes, ecological footprint of Qazvin City is calculated by applying yield factor and equivalence factor obtained from electronic portal of Global Footprint Network after social categorization of the community using stratified sampling and generalization.

Materials and methods

In this study, a comparison between ecological situation of the region in 2006 and 2031 is discussed according to the proposed conditions in urban region development plan of Qazvin. Subsequently, ecological footprint and biological capacity of the urban region is calculated separately in these years; and finally after reducing ecological footprint from biological capacity of the region, ecological sustainability of the region is determined in terms of ecological reverse or deficit. This briefly illustrates the process of achieving this target.

Component method is selected to conduct the research in regard with ecological footprint; it means that the questionnaire prepared by electronic portal of Global Footprint Network is used to calculate individual ecological footprint. The questionnaire prepared only for a few countries is based on the questions about four categories of food, dwelling, transportation, and goods and the options are designed in accordance with specific lifestyle of each country. Moreover, to calculate biological capacity, it is initially necessary to determine existing land types in the area in accordance with six categories of land types. The method used to calculate value of biological capacity in Qazvin city is based on GIS software in order to estimate the amount of existing land types in Qazvin city. After calculation of land types, biological capacity can be determined via following formula using yield factor and equivalence factor.

$$BC = A \times YF \times EQF$$

Where, BC is biological capacity, A is existing area of a specific land type, YF is yield factor, and EQF is equivalence factor.

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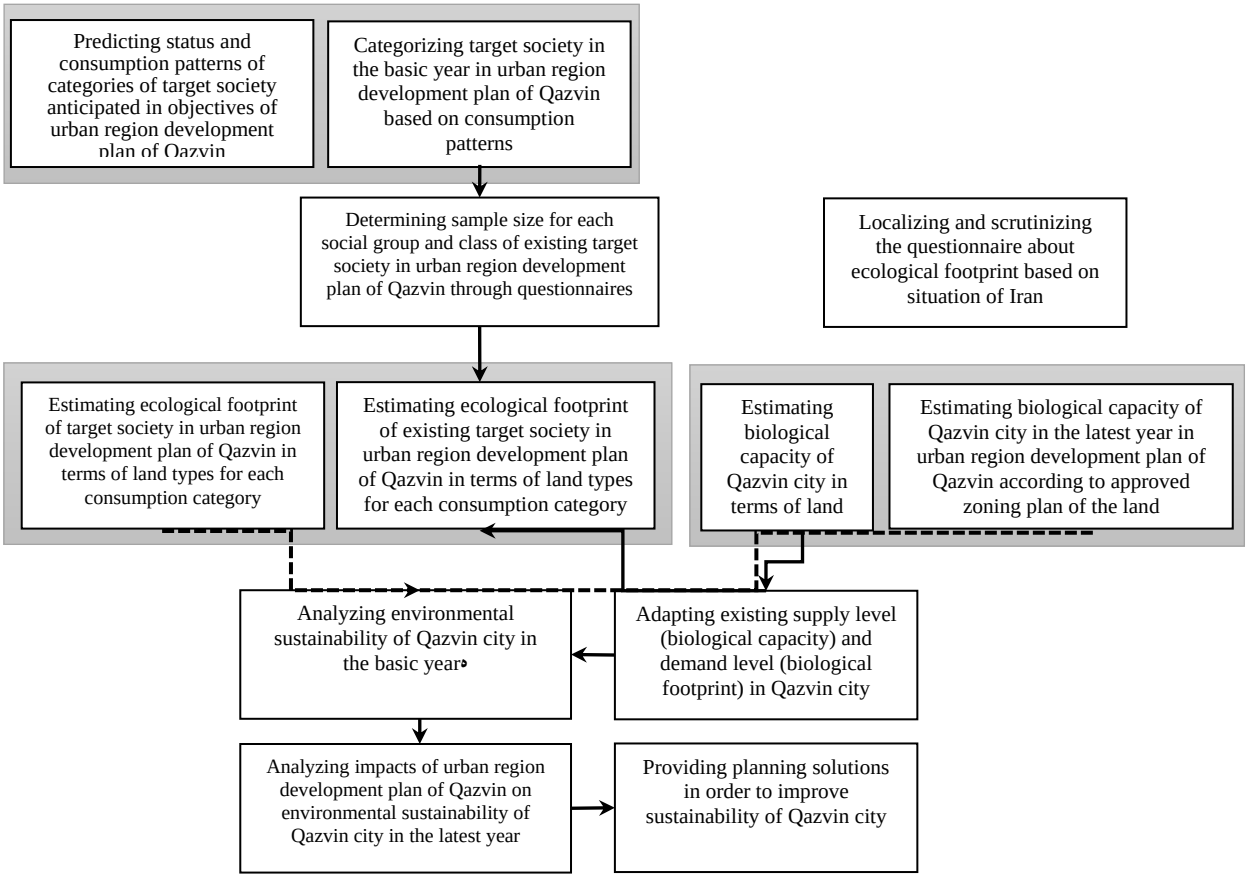

Figure 3: Research process

Achieving research objectives require consideration of defaults as follows:

- Classifying urban society of Qazvin in order to identify differences in people consumption patterns and sampling
- Assuming Iran equivalence factor equal to global equivalence factor
- Using questionnaire options according to Iran situation

Results and discussion

Ecological footprint of Qazvin residents is calculated separately for each group in the following table.

Calculation of ecological footprint	Group 1	Group 2	Group 3	Group 4	Group 5
average footprint for each group (gha)	1.92	2.39	2.87	3.11	3.35
average footprint for all groups (gha)	2.82				

Total ecological footprint of Qazvin city is calculated in the basic and last year using each group's ecological footprint and percentage of the population. As a result, average footprint per person in the last year (2031) is 2.76 hectares per person according to following formula; this value does not seem far-fetched because of increasing environmental awareness in communities.

$$(1.92\times30.7)+(2.39\times1.9)+(2.87\times19.9)+(3.11\times16.1)+(3.35\times31.4)/100=2.76$$

In order to calculate biological capacity, the area of existing and proposed land use is determined via GIS software according to each one of the six land types. Per capita land uses are obtained by existing and proposed area and population. Then, it is multiplied in equivalence factor considered globally for each type of land. Finally, these values are added to obtain total biological capacity of the city. Given the calculations, biological capacity would decrease from 0.37 hectares per person in 2006 to 0.28 hectares per person in 2031 in case of implementation of urban region development plan of Qazvin city. Therefore, ecological deficit in Qazvin city is equal to -2.45 hectares per person in 2006 and -2.47 hectares per person in 2031 due to implementation of proposals of the plan. This is in spite of reduction in per capita footprint because of surplus population. In other words, urban region development plan of Qazvin is faced with an ecological deficit in the basic year and if this consumption trend and changes in land use continue in accordance with the given proposals, there would be the same ecological deficit in the last year just with a slight increase. The ecological deficit is especially relevant to farmlands; because farmlands account for the highest ecological footprint percentage per person (41.96%). However, the recent unplanned developments in urban region of Qazvin show excessive destruction of valuable and historical farmlands and orchards located in Qazvin plain. The areas of farmlands would decline from 714 square kilometers in the basic year to 38 square kilometers in the latest year if urban region development plan of Qazvin city is accomplished. Biological capacity of this type of land use would decrease by 0.167 hectare per persons during these years.

General comparison of ecological footprint in the world, Asia and Iran reveals that exploitation of nature by the Iranian society is far more than that value of whole Asian societies and there is similar trend compared with ecological footprint of the entire world. This study demonstrates that ecological footprint is 2.82 hectares per person in urban region development plan of Qazvin. This value is even more than ecological footprint of each Iranian person which is calculated 2.68 hectares per person on average.

Conclusion

Given the results of this paper, in order to compensate ecological deficit of the region and achieve a sustainable situation, both supply-side and demand-side planning strategies can be considered on regional developers' agenda:

- Demand-side strategies to minimize ecological footprint: These strategies, aimed to reduce consumption of the population, are divided into two groups. First group are the strategies to attract selected population and advanced demands which are responsible for environmental issues within the region, through promoting quality of life and environment in the region. Another group is the strategies to alter and modify patterns of development and population demands.
- Supply-side strategies to increase biological capacity: These strategies, most pursued in more developed countries and communities, seek to increase biological capacities through innovative solutions. Two types of policies can be referred in this regard; policies which tend to enhance beneficial environmental capacities, and the other policies which seek to improve capacity of environmental resources.

Finally, it should be noted that regional spatial development decision-makers play a leading role in this regard.

Keywords: spatial development plan, ecological footprint, environmental sustainability, Qazvin City

A Benchmarking of Policy Instruments and Experiences to Improve Farmland Preservation in Urban Fringes of Iran

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Expanded Abstract

Introduction

Farmland conversion can be seen as a case of market failure in which the free market fails to protect the environment. The reason is that the market value is incapable of reflecting the social benefits of farmland as well as internalizing environmental externalities made by urban sprawl. Farmland preservation in urban fringe is justified by economic, ecological and aesthetic functions, because if farmlands are converted into urban constructed areas, the society will not be able to enjoy those benefits. Thus, given the fact that planning mainly deals with public interest, planners may have the authority to suggest public policies for farmland preservation and urban growth management. They may do the job through public policy instruments including public acquisition and management, regulative instruments and incentive based instruments. In the last half of the century, as a consequence of imbalance in national space arrangement and rapid urbanization, Iran farmlands are being converted into constructed areas in a rapidly high rate. Although some policies are made during this period to fix the problem, farmland conversion is yet on and on. Therefore, to improve policy making in this area, it would be necessary to critique on Iran farmland preservation and urban growth management policies. This paper is seeking to take into account this goal.

Materials and methods

To achieve the mentioned target, the paper initially presents some of the most important public policy instruments for management of urban growth and farmland preservation. The regulative instruments are including planning mandates, urban growth boundary, urban service boundary, greenbelt and agricultural zoning. Also, the main incentive based instruments are development impact fee, infill and redevelopment incentives, tax incentives/disincentives and acquisition of development rights/credits. Then, five nation's experiences about farmland preservation (the United States, Canada, the Britain, the Netherlands and Iran) are reviewed. Using a comparative methodology, the nations are comprised together in some standpoints such as possible preservation reasons and different normative values to conduct the policies and the ways which the instruments were being used. Through the brilliant notions, we discussed main strengths and weaknesses of Iran policy making system in those areas as well as general optimal insights to improve the system. Table 1 briefly explains five nation experiences focusing on the type and scale in which public policy instruments are used. According to what mentioned above, some may consider this paper as a kind of benchmarking to improve environmental management in this area. However, the present study uses a theoretical framework to organize and integrate the concepts and theories form various scientific areas such as economics and public policy related to farmland preservation. Moreover, it develops a policy framework which implies policy making priorities, proposes of some political solutions and connection of knowledge to action regarding this problem.

Results and discussion

As it can be seen in figure 2, farmland preservation in Iran can be investigated from two separated but closely interrelated aspects. In the policy making system, some critiques and solutions are pointed as follows:

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1) Preservation costs are being shared among stakeholders in an unfair manner. In the last decades, as land inflation was increased and at the same time the incomes derived from agricultural activities was also decreased. Hence, it may be concluded that the opportunity cost of keeping farmlands in agricultural use is increased and consequently land use conversion is a more preferred option by farmland owners. In this situation, regulatory restrictions forbid land owners to develop their farmlands, while because of policy making environment it is inflexible and no compensation is offered to them. To fix this problem, it is suggested to expand policy burden and compensate landowners for regulatory restrictions by giving incentives. Conservation facility in the US preservation experiences as well as the right to compensate for land development restrictions in the Netherlands are the good examples for expansion of policy burden. It makes a legal base to use incentive based instruments in those countries.

2) Although there are many policies and plans about farmland preservation and urban growth management, there is no policy framework to coordinate them in a way that integrates all related activities in each city. As a result, farmland preservation activities are being assumed separated from urban growth management. A different governmental organization is being responsible for each of them. To solve the problem, it is suggested to formulate a policy framework for both farmland preservation and urban growth management in every city. The mentioned framework should include three steps: the first defines and announces policy priorities through a political statement. The statement shows why the farmlands are valuable for the city and what preservation goals are more preferred. By clearing such issues, local decision makers can define preservation strategies and instruments very easily as well as their decisions would be publicly more clear and convincible. The second step is to make policy strategies in a way that farmland speculative value would be eliminated while their productive value is being increased. The selected strategies for farmland preservation and urban growth management should be supplemented together. The final step is to choose supplementary policy instruments based on the selected priorities and strategies.

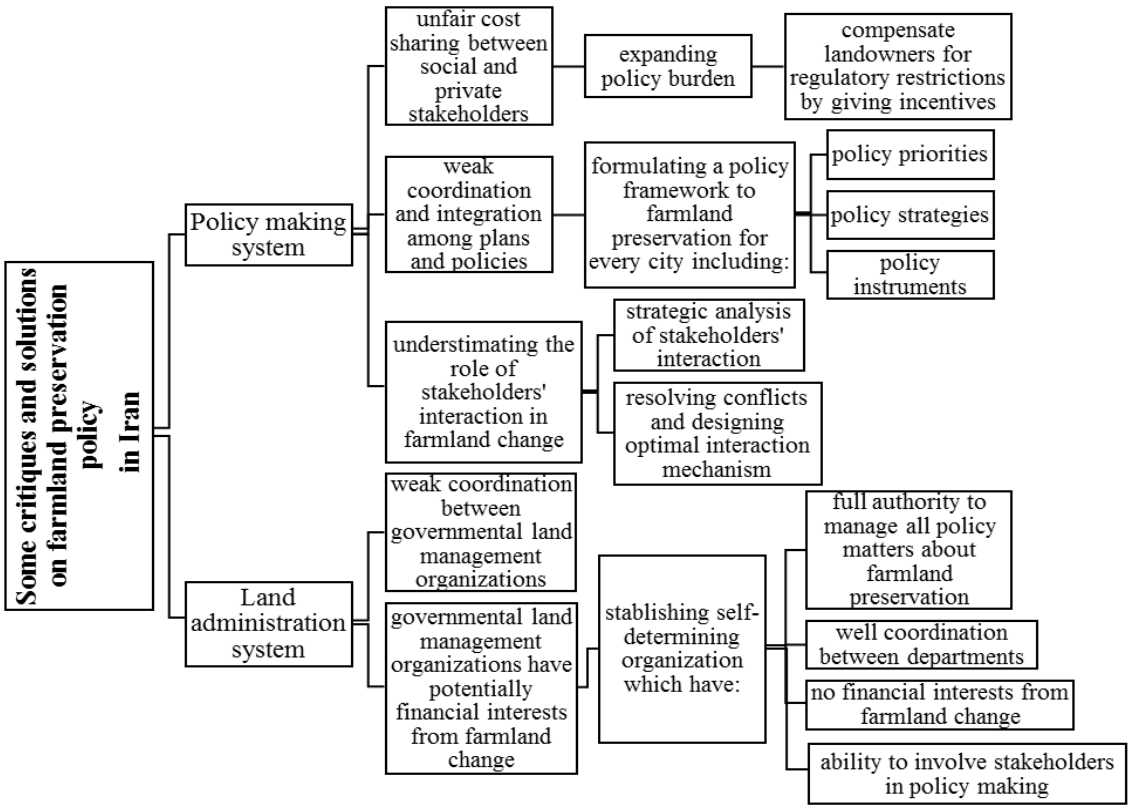

Figure 1. Some critiques and solutions on farmland preservation policy in Iran

Table 1. Five nation experiences about farmland preservation focusing on the type and level in which the public policy instruments are used

Type of Policy Instruments / Case Study	Public acquisition and management of the land	Regulative					Incentive Based					
		Land use plans & zoning regulations		Urban containment			Excise tax	Tax			Grant	
		Planning mandates	Agricultural zoning	Urban growth boundary	Urban service boundary	Green belts	Development impact fees	Capital gain on land sale	Split-rate property tax	Preferential tax assessment	Infill and redevelopment incentives	Acquisition of development rights/credits
The United States	N S R U	S R	S R U	S R U	R U	R U	U	S	U	N S	S U	N S R U
Canada	-	R U	S R U	R U	-	R U	-	-	-	S	S U	N S
The Britain	-	S R U	-	-	-	R U	-	-	-	-	-	-
The Netherlands	N S R U	N S R U	R U	-	-	-	-	-	-	-	-	-
Iran	-	N S R U	R U	-	-	-	R U	-	-	-	-	-

Note:
N: stands for the instrument is applied at National level
S: stands forthe instrument is applied at State level
R: stands for the instrument is applied at Regional level
U: stands forthe instrument is applied at Urban level
-: stands for the instrument is not applied at any mentioned levels

3) Because of conventional top-down process of planning in Iran, it was underestimated to consider the issue of how the stakeholders' interactions could be led to farmland conversion. It would be highly important especially if it is known that there are many stakeholders involved in farmland conversion dilemma. They have different and usually controversial interest about possible uses of the land. They try to maximize their own outcomes and the situation almost is led to conflict. In such competitive and non-cooperative decision making environments, stakeholders act and decide based on individual rationality rather than group rationality (preferring best outcomes for their own rather than best outcomes for all of them or society). Farmland change would be the result of such decision making environments. Therefore, it is suggested that conflict resolution should be considered as an important part of any farmland preservation framework as it was proposed. For effective conflict resolution and to reach equilibrium between social-individual interests, policy makers need to realize the roles of the conflict by strategic analysis of stakeholders' interactions and to design optimal rules of interactions. farmland preservation and urban growth management as two separated policy issues. Therefore, they distribute each of them among different governmental organizations.

Conclusion

Governmental organizations are not well coordinated and their activities are not complemented. Also some of them may have some possible financial interests from farmland change such as land use change permission fees. To modify that problem, it is suggested to integrate all policy matters about the farmland preservation and land use administration through establishment of a self-determining organization with full authority in these areas. The local departments of this organization should prepare farmland preservation policy framework for their own city. Putting preservation as the only interest of this organization, it should not have any possible financial interests from farmland change for its own. They also should not be a part of larger organization who may have such interests.

Keywords: Benchmarking, farmland preservation, urban growth, urban planning

Carbon Sequestration Portion in Global Warming Moderation, Case Study: Shiraz City

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Extended Abstract

Introduction

Growing process of industrialization in different societies, excessive expansion of industries and factories and increase in transport industries all push human toward an unstable development. As a result, massive volume of pollutions is also added to the atmosphere. Air pollution in industrial societies and cities is more intensive. Global warming is one of the major problems of 21 century. CO2 emission dangers in different environmental societies around the world has been emphasized and combat ways to the issue has been considered continuously during the last two decades. From the beginning of industrial revolution, fossil fuel burn and deforestation leads to increase in atmospheric CO2. Global warming may lead to changes like change in raining patterns, sea level expansion and wide range of influences on plants, wild life and human. Gases that can trap heat in atmosphere are named greenhouse gases. Existing proofs show that human activities can increase atmospheric ability to conserve heat (greenhouse effect) and result in climate change (global warming). Increase in CO2, NH4 and NOx resulted from human activities can lead to intense greenhouse effects. These greenhouse gases can trap Oxygen and increase temperature of the earth. These gases are including CO2, CH4, NOx and CFC that CO2 content in the air is more than three others. Different effects of greenhouse gases have been detected until now. The first effect is the effect is a probable increase in heat as a result of absorption of infrared. Urbanization is as one of the important land use practices in 21 century. This is according to anthropogenic reasons rapidly growing in other ecosystems. About 50 percent of world population is living in cities and this process is rapidly growing. Based on anticipations, urban population will reach 70 percent in 2050 because of rapid population growth. Urban growth in different social, economic, political and ecologic areas leads to decrease in the ability of cultivated areas to produce enough foods for world population. Growth in big cities leads to use of sources like energy, minerals, fuel, water, food and production of great sources of sewage and scrap. This intensive ecological form and extreme use of natural resources as an important anthropogenic motivation leads to global continental change. Continent change is one of the important problems of permanent development that can have negative effects on marine and land ecosystems. Main sources of CO2 and other greenhouse gases in urban ecosystems are resulted from industry and transport systems. Bad weather quality in millions of cities is also resulted from effluence of wide range of gases from industrial sources. In comparison to rural areas, there is also more density of CO2, CH4 and ozone in urban cities. Air pollution effects on primary network of production indirectly influence GCC. Worry from mass volume of emitted carbon in atmosphere and its effects on continent can continuously increase human and ecosystem functions .

After these concerns, in 1992 approximately all of the world countries including Iran signed a convention as United Nation Continental Changes Convention. The convention aimed to find a course of actions to balance out volume of atmospheric greenhouse gases and predict budget for this purpose and to search and survey around this problem in member countries of this convention in long term. Pursuant to that convention, another act was approved in 1997 in Kyoto by most of industrial developed countries to find solutions to balance out container of atmospheric greenhouse gases. Most suitable solutions to decrease atmospheric carbon is carbon sequestration by forests, pasture, woodland and soil. Carbon sequestration is long time storage of carbon in surface,

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underground or oceans in the way that decrease CO2 volume (main greenhouse gas) of the atmosphere. Carbon sequestration in plant biomass and soils around this biomass are one of the cheapest and simplest ways to decrease CO2. Dominant vegetation cover is one of the important and effective factors in stabilization and carbon sequestration in ecosystems. Differences in vegetation diversity physiology determine absorbed carbon rate, rate of carbon transmission to the soil and loss of carbon in ecosystem. Consequently, animate and inanimate factors can determine absorption rate, stabilization rate, scale and speed of energy flow in the ecosystem by influence on vegetation diversity. Carbon storage in the soil is one of the different methods to sequestrate atmospheric carbon and prevent pollution. Storing carbon in soil is one of the different ways to trap atmospheric carbon and reduce pollution.

Materials and method

This study is aimed to evaluate the soil carbon storage in herb, shrub and tree covers in human made usages (city) including boulevard, urban park, industrial areas, house gardens, and in agriculture, garden and pasture uses. For this propose, in the study area located in the west part of Shiraz City, 476 samples have been collected from depth of 0-10 and 10-50 from these uses . Dense population, high quality vegetation cover and green spaces in management treatments were reasons to choose this place. In the proximity to Ghasrodasht historical gardens and also to Fars cement factory, as an industrial zone, we can illustrate human factors effects. Soil sampling of different covers is conducted based on systematic random model from the center and corners of 2*2 plots at appointed places in 0-10 and 10-50 centimeters layers by auger. Soil texture was also determined by Bycoushydrometery model and soil acidity by potansiometry via PH meter and also by using mixture of soil and water. Electrical conductivity was determined by saturated clay extract and electrical conductivity measurements. Organic carbon was also determined by Walky Black method. Data normality by Kolmogrov-Smirnov and homogeneity is estimated by Leven test in SPSS software. After the data normality and homogeneity were tested, we used Pierson correlations to show correlation between soil organic carbon stock and other soil factors. Duncan test in SAS software has used to compare average organic carbon .To determine effective factors on soil organic carbon stocks, stepwise linear regression has been used. Statistical analyses have been carried out based on completely random pattern in the form of factorial design.

Results and discussion

According to proportion of molecular mass CO_2/C (44 to 12), the result will be 3.67. This shows that soil carbon could be converted into atmospheric carbon and vice versa. Thus, the portion of any studied land use which decreases atmospheric CO_2 can be computable to the gardens which are part of Ghasrodasht gardens of Shiraz city, with 3.8 ton stored carbon in hectare. These gardens have considerable increase in carbon sequestration in comparison to other land use and thus indicated considerable increase in atmospheric carbon sequestration. The portion of studied vegetation covers has also been surveyed and its results indicated that tree cover has more considerable proportion in decreasing atmospheric CO_2. The maximum average of soil carbon storage is estimated to be at 10- 50 cm layer (6.18 kg/m^2) and minimum carbon storage at 0- 10 cm (1.6 kg/m^2) layer. Study of mutual effects of land use and vegetation cover indicated that the maximum soil organic carbon stock is related to cultivated gardens (4.62 kg/m^2) which has not considerable difference with SOC stock of agricultural land use (4.42 kg/m^2), park tree covers (4.44kg/m^2) and also boulevard tree covers (4.42 kg/m^2). Stepwise linear regression of SOC stock as a dependent variable with vegetation cover, depth and land use treats indicated that vegetation cover is one of effective parts on SOC stock. Depth and land use are at the next levels of importance. Stepwise regression of SOC stock with other soil factors also showed that bulk density, clay percent and soil salinity are effective factors on SOC stock by importance sequence.

Conclusion

Doing action to carbon sequestration based on KYOTO protocol or any other protocols after that, not only make fundamental changes in land management, but it also has considerable straight effects on soil properties, agriculture quality and environment by increasing organic materials. The results revealed an increase in land productivity and efficiency to produce food and food safety. With this economical action, soil storage will be reserved from destroying while ecosystem will be stabilized. This also makes a fundamental change in fighting with climate changes.

As regards toGiven the increase in negative effects of growing Co_2 on weather especially in cities and economic areas, carbon sequestration in free resources of nature like soil and vegetation covers can decrease these negative effects. Study on carbon sequestration in metropolitans and even in small cities and economic areas in countries like Iran is effective in combating climate change and its negative effects. Membership of Iran in climate change conventions can have lots of profits. Thus , based on the results of this study, SOC stock of different urban land uses has been studied and the results revealed that cultivated gardens inside the city (Ghasrodasht gardens) under tree covers has more SOC stock in comparison with other land uses, but other land uses like house gardens

because of considerable extent in whole city are noticeable. Citizens can help storage carbon to decrease damages of greenhouse gases and other effects of climate changes by growing tree species beside other covers in house gardens. Officials can also prevent destroying cultivated gardens like Ghasrodasht gardens to manage gardens toward planting and expansion tree covers to improve carbon sequestration.

For suggestion, the following concepts as practical ways can help decrease the effects of climate change:
1-Converting of urban parks into arboriculture areas to store more organic carbon in soil and increase the solved soil organic carbon
2-Increasing SOC stock and solved organic carbon
3-Motivating citizens to expand more green areas in house gardens and planting more organic carbon and solved organic carbon.
4-Changing waste lands and useless pastures to planted areas with the proportion of lands
5- Calculating the balance of soil organic carbon in urban ecosystems, using Century and Roth models and accurate measurement.

Keywords: urban ecosystems, Carbon Sequestration, global warming, Shiraz

Application of neural network of Multi Layers Perceptron (MLP) in Site Selection of Municipal Solid Waste Landfill with Emphasis on Hydrogeomorphic Characteristics, Case Study: Fereydoonshahr City

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Expanded Abstract

Introduction

Cities are at the nexus of a further threat to the environment, namely the production of an increasing quantity and complexity of wastes. The estimated quantity of Municipal Solid Waste (MSW) generated worldwide is 1.7 – 1.9 billion tons. In many cases, municipal wastes are not well managed in low-income countries, more than 50 per cent of the collected waste is often disposed of through uncontrolled landfilling and about 15 per cent is processed through unsafe and informal recycling. Municipal Solid Waste (MSW) is the natural result of human activities. If an appropriate management system is not used for this problem, it may lead to environmental pollution and jeopardize the mankind's health.

The ANN models are essentially based on the perceived work of the human brain. ANNs can be trained to model any relationship between a series of independent and dependent variables (inputs and outputs to the network, respectively). For this reason, ANNs have been usefully applied to a wide variety of problems that are difficult to understand, define, and quantify.

It should be pointed out that similar to any other statistical and mathematical model, ANN models have also some disadvantages. A large number of input variables are one of the most common problems for their development because they are not engineered to eliminate superfluous inputs.

Literature survey demonstrates that Artificial Neural Network (ANN) models are proper tools for prediction of solid waste generation.

Noori et al., (2008) investigated the Prediction of Municipal Solid Waste Generation with Combination of Support Vector Machine and Principal Component Analysis in Mashhad. In the authors' opinion, the model presented in this article is a potential tool to predict WG and has advantages over the traditional SVM model.

Results revealed that artificial neural network model has more advantages in comparison with traditional methods in prediction of the municipal solid waste generation.

Noori et al (2010) investigated the Evaluation of PCA and Gamma test techniques on ANN operation for weekly solid waste prediction. The findings indicated that the PCA-ANN and GT-ANN models have more effective results than the ANN model. These two models of PCA-ANN and GT-ANN decrease the number of input variables from 13, respectively, to 7 and 5. The accurate prediction of waste disposal zonation plays an important role in the solid waste management system. For this reason, ANN is used and different models are created and tested.

The purpose of this study is application of neural network of Multi Layers Perceptron (MLP) in site selection of Municipal Solid Waste landfilling in Fereydoonshahr City by using 12 primary factors including lithology, level of groundwater, soil texture, distance to habitat, land use, slope, aspect, elevation, rainfall, distance to fault, distance to road, and drainage density.

Materials and methods

Fereydunshahr city is located from 49° 36′ to 50° 19′ longitude and from 32° 37′ to 33° 05′ latitude in geographic coordinate system. The study area is 77646 hectare in area. Fereydunshahr with an average altitude of 2500 m

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above sea level is a mountainous region and located in the province of Isfahan. According to hydrological, geological, and Geomorphologic characteristics of the study area and the goals outlined, it can be said that the parameters used for Municipal Solid Waste landfilling are different. In this research the most important factors used for this purpose are 12 primary factors influencing Municipal Solid Waste landfilling in the study area. These factors are including lithology, level of groundwater, soil texture, distance to habitat, land use, slope, aspect, elevation, rainfall, distance to fault, distance to road, and drainage density. These factors were identified by interpretation of satellite imagery, aerial photography, and field studies.

The map data in this work were geological map at a scale of 1: 100,000, aerial photographs on a scale of 1: 40,000, topographical maps with a scale of 1: 50,000, ETM +satellite images and precipitation (rain-gauge stations). They were mainly prepared by ArcGIS10.2 software.

The digital elevation model (DEM) with 30 meter multiplied by 30 meter pixel size was prepared by topographic map, at scale 1:50000. The distance to drainage and road was extracted by drainage and road networks from topographic map of the study area. The land use map was also provided by including unsupervised classification of ETM+ image, field survey, and accuracy control. The geologic map was also prepared to digitize and polygonize the rock units of the geologic map, at scale 1:100000, using ArcGIS10.2.

Artificial neural networks were originally developed to mimic basic biological neural systems. A network can perform a huge number of tasks quite efficiently (Reilly and Cooper, 1990). This information processing characteristic makes ANNs a powerful computational device able to learn from examples and then to generalize the examples as never before seen.

aAn ANN is a massively parallel-distributed information-processing system that has certain performance characteristics that resembles biological neural networks of the human brain, where knowledge is acquired through a learning process and finding optimum weights for the different connections between the individual nerve cells. The advantage of the ANN is that with no priori knowledge of the actual physical process and, hence, the 'exact' relationship between the sets of input and output data, the network can be 'trained' to 'learn' such a relationship. The ability to 'train' and 'learn' the output from a given input makes ANN capable of describing large scale arbitrarily complex non-linear problems. A neural network is characterized by its architecture that represents the pattern of connection between nodes, its method to determine the connection weights, and the activation function.

A typical ANN consists of a number of nodes that are organized according to a particular arrangement. One way of characterizing ANNs is by the number of layers, as single-layer, bi-layer, and multi-layer. Another way of characterizing ANNs is based on the direction of information flow and processing, as feed-forward (where the information flows through the nodes from the input to the output side) and recurrent (where the information flows through the nodes in both directions). Among these combinations, the multi-layer feed forward networks, also known as multi-layer perceptrons (MLPs), is trained with a back-propagation learning algorithm. The networks have been found to provide the best performance in input–output function approximation, such as forecasting.

In this study, we used the feed forward, multilayer perceptron (MLP) to approximate every measurable function (Gardner and Dorling, 1998). The main issue in training MLP for prediction is the generalization performance. MLP, like other flexible nonlinear estimation methods such as kernel regression and smoothing splines can suffer from either underfitting or overfitting (Coulibaly, et al., 2000). In this situation, error between training and testing results can be increased. For solving this problem, Stop Training Approach (STA) has been used.

Data are divided into 3 parts in this method. The first part is related to network training, second part for stopping calculations when error of integrity start to increase and the third part is used for integrity of the network. In order to evaluate the performance of the ANN model, 3 statistical indices are used: Mean Squared Normalized Error (MSE), Root Mean Square Error (RMSE) and correlation coefficient (R2) values that are derived from statistical calculation of observation in model output predictions. This is defined as:

$$MSE = \frac{\sum_{i=0}^{N}(d_i - y_i)}{N}$$

$$MSE = \frac{\sum_{i=0}^{N}(d_i - y_i)}{N}$$

$$R^2 = \frac{\sum_{i=1}^{n}(obs - \overline{obs})(pre - \overline{pre})}{\sqrt{\sum_{i=1}^{n}(obs - obs)^2 \sum_{i=1}^{n}(pre - pre)^2}}$$

Results and discussion

Accurate landfilling site selection is essential for municipal solid waste management system. In this research, with application of feed forward artificial neural network, an appropriate model was proposed to predict landfilling site selection in Fereydunshahr City.

For this purpose, neural network is trained and tested using MATLAB 7.2.. F Hence, 12 primary factors influencing Municipal Solid Waste landfilling were selected in the study area. These factors are including lithology, level of groundwater, soil texture, distance to habitat, land use, slope, aspect, elevation, rainfall, distance to fault, distance to road, and drainage density as impute layers.

Also, forTo recognize the effects of each input data, sensitive analysis was performed. Finally, different structures of artificial network were investigated and then the best model was chosen to make zonnation for landfilling site selection of municipal solid waste. This was based on Mean Squared Normalized Error (MSE), root mean square error (RMSE), and correlation coefficient (R2) indices.

After performing the mentioned models, Mean Squared Normalized Error (MSE), root mean square error (RMSE) and correlation coefficient (R2) in neural network have been achieved equal to 0.0081 , 0.11 and 0.999%, respectively. The results indicate that trainlm model has more advantages in comparison with trainbp and trainbpx methods in landfilling site selection of municipal solid waste. After the best network structure was determined, zonation map of the best site for landfilling of municipal solid waste using 12 imput-layer was prepared in 5 classes.

The results showed that 37.2% (28884/31Ha) of the total area is very suitable for waste landfilling, 7.2% (5590/51 Ha) as suitable, 12.6% (9783/39 Ha) as fairly suitable, 38% (29505/48 Ha) unsuitable, and 5% (3882/3 Ha) is very unsuitable.

Conclusion

Accurate prediction of landfilling site selection of municipal solid waste is crucial for programming of municipal solid waste management system. In this research, with application of feed forward artificial neural network, an appropriate model was proposed to make zonnation for landfilling site selection of municipal solid waste in Fereydunshahr City.

Keywords: Multi Layers Perceptron, Site Selection, Waste disposal, Fereydunshahr City.

Assessment of Autotrophic Denitrification Process with Different Sources of Sulfur for Removal of Nitrate from Water

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Expanded Abstract

Introduction

Nitrate entrance to water bodies can cause eutrophication and decrease their quality. Furthermore, it can be effect on human health and thus concentration of nitrate must be defined at standard level. There are several methods for reduction or removal of nitrate in water. Some of the methods are ion exchange, reverse osmosis, electrodialysis and denitrification. Microbial denitrification of nitrate in anoxic condition can be a cost effective and high efficiency miner in that nitrate was reduced to N_2 Gas. There are two microbial denitrifications which are autotrophic and heterotrophic. The heterotrophic bacteria requires organic source while in autotrophic process the bacteria requires inorganic source like sulfur components, CO_2, bicarbonate, carbonate as well as H_2.These bacteria have a slow growth rate and, therefore, they produce low sludge. A few studies about autotrophic denitrification has conducted in Iran. The aim of this study was to investigate the autotrophic denitrification process and compare the achieved results in different energy sources for bacteria.

Materials and methods

In this research 9 reactors were designed and operated in 3 series. The water was prepared synthetically with different concentrations of nitrate and sulfur sources. The energy sources were sulfide, thiosulfate and elemental sulfur. To investigate autotrophic denitrification, N_2 gas was initially injected to water for 30 minutes to reduce DO to zero. Then, the operational status was defined according to table 1 and operation of reactors was started. The studied variables were mole ratio of nitrate to sulfur source, alkalinity consumption per every mg/L of reduced nitrate as nitrogen, produced sulfate per every mg/L of reduced nitrate as nitrogen, hardness concentration changes and removal percent of nitrate.

Table.1.the operational status of reactors

		Energy source/concentration mg/L	NO_3mg/L	Mole ratio NO_3/sulfur	alkalinity ($CaCO_3$)	pH	Time (days)
S1.raectors	1	$322/S^{2-}$	1000	8/5	1000	7.68	35
	2	$1130/S_2O_3^{2-}$	1000	8/5	1000	7.95	35
	3	566/S	1000	1/1.1	1000	7.90	21
S2.reactors	1	$5232/S^{2-}$	1000	2/5	1000	7.97	35
	2	$4069/S_2O_3^{2}$	1000	5/8	1000	7.95	35
	3	429/ S	1000	6/5	1000	8.06	35
S3.reactors	1	$515/S^{2-}$	1000	1/1	1000	7.92	35
	2	$1803/S_2O_3^{2}$	1000	1/1	1000	7.99	35
	3	515/S	1000	1/1	1000	8.08	35

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The optimum ratios of nitrate to sulfur source is achieved from the reviewed studies and considered in first series of reactors. In second series, we tried to reverse the previous optimum ratios to see the effect of mole ratio on process, and in third series of reactors the ratios of nitrate to sulfur source were equal to 1. All examinations were according to standard methods for water and wastewater examinations. The operational temperature was 22±1 ºC. Nitrate detection was conducted with Spectrophotometer at 220 nm wave length; sulfate was determined by gravimetric and other parameters like alkalinity, hardness and sulfide were also determined according to titration methods. Autotrophic denitrifier bacteria were prepared from anoxic sludge of domestic wastewater treatment in south Tehran. After the macro and micro elements needed for bacteria were added, the operation of reactors was started. All examinations repeated for 3 times to validate data and the statistics analysis of data was carried out by SPSS program.

Results and discussion

The results of this study have been shown in table no 2.

In denitrification process with sulfur as electron donor, H^+ ions are produced and alkalinity consumed, although it would be different in various sulfur components. In this study, the alkalinity consumption in all reactors was combined to each other. The results show that when the electron donor is sulfide and the mole ratio of NO^-_3 to sulfide is 8:5, alkalinity consumption rate is 1.39 mg/L as $caco_3$ per mg/L removed nitrate as nitrogen. When the mole ratio of NO^-_3 to sulfide was 1:1 alkalinity consumption rate was 1.45 mg/L as $caco_3$ per mg/L removed nitrate as nitrogen. These values are lower than the other energy sources. On the other hand, when the electron donor is sulfide, the alkalinity consumption is lower than other components of sulfur. As shown in table no.2, the added hardness when the elemental sulfur is electron donor is more than other two mentioned energy sources.

Table.2. the results of hardness, alkalinity, sulfate and nitrate variations in autotrophic denitrification

		The added Hardness mg/L $CaCO_3$	Alkalinity consumption mg/L $CaCo_3$ per mg/L NO^-_3 as Nitrogen	The added Sulfate mg/L per mg/L NO^-_3 as Nitrogen	The nitrate removal percent
S1.raectors	1	55	1.39	5.1	93.5
	2	95	2.24	4.55	78
	3	415	5	8	100
S2.reactors	1	–	–	-	0
	2	270	3.3	4.4	100
	3	245	5.21	8.12	80
S3.reactors	1	45	1.45	5.09	82.5
	2	145	2.12	4.57	94
	3	320	5.38	8.46	65

when sulfid was electron donor this addition was lower.

There is a stoichiometry reaction about autotrophic denitrification that is shown below:

$$NO_3^- + 1.1S^0 + 0.76H_2O + 0.4CO_2 + 0.08NH_4^+ \rightarrow 0.5N_2 + 1.1SO_4^{2-} + 1.28H^+ + 0.08C_5H_7O_2$$

According to this reaction, when elemental sulfur is electron donor, the alkalinity consumption is 4.57 mg/L $CaCO_3$ and the added sulfate is 7.54mg/L per mg/L in removed nitrate as nitrogen. The results of this study show that alkalinity consumption in reactors series 1 was 5 in series 2 was 5.21 and in series 3 was 5.38 mg/L as $caco_3$ per removed nitrate as nitrogen. Sulfate addition in reactors series 1 was 8 in rectors series 2 was 8.12 and in reactors series 3 was 8.46 mg/L as $CaCO_3$ per removed nitrate as nitrogen. Statistics analyses of data show that there is not a significant difference between the stoichiometry values and the achieved data from this study ($P>0.05$). There are some other stoichiometry reactions about alkalinity consumption with HS^- and $S_2O_3^{2-}$ as electron donor. These reactions are represented as below:

$$0.844\ S_2O_3^{2-} + NO_3^- + 0.347\ CO_2 + 0.086\ HCO_3^- + 0.086\ NH_4^+ + 0.434\ H_2O \rightarrow 1.689\ SO_4^{2-} + 0.5\ N_2 + 0.086\ C_5H_7O_2N + 0.697\ H^+$$

$$0.421\ H_2S + 0.421\ HS^- + NO_3^- + 0.346\ CO_2 + 0.086\ HCO_3^- + 0.086\ NH_4^+ \rightarrow 0.842\ SO_4^{2-} + 0.5\ N_2 + 0.086\ C_5H_7O_2N + 0.434\ H_2O + 0.262\ H^+$$

According to these reactions, when the electron donor is hydrogen sulfide the alkalinity consumption is 0.93 mg/L as $CaCO_3$ per removed nitrate as nitrogen and when thiosulfate is energy source this value is 2.49 mg/L as

$CaCO_3$ per removed nitrate as nitrogen. Statistics analyses of the data reveal that there is a significant difference between the stoichiometry amount and the achieved data from this study about sulfide ($P<0.05$), but there is not a significant difference between the stoichiometry amount and the achieved results about thiosulfate ($P>0.05$).

Conclusion

The results of nitrate removal indicates that in raectors series 1 with elemental sulfure as electron donor at mole ratio of 1:1.1 in nitrate to sulfur, the nitrate removal was complete. When the mole ratio changed to 6:5, the removal rate of nitrate became 80 percent and in mole ratio of 1:1 it decreased to 65 percent. In rectors series 2 with tiosulfate as electron donor at mole ratio of 5:8, the nitrate removal was also complete. In mole ratio of 8:5 the nitrate removal was 78 percent and in mole ratio of 1:1 it was 94 percent. Since the thiosulfat is soluble and more available for microorganisms than other studied components of sulfur , high concentrations of thiosulfate can be effective on nitrate removal. In other rectors with diffrent mole ratios, the results were different. In reactors series 2 with sulfid as electron donor because of high concentration of sulfid the process was stoped while at series 1 reactors with mole ratio of 8:5 the efficiency of nitrate removal reached up to 93.5 percent and in ractors with mole ratio of 1:1 the nitrate removal became 82.5 percent. The results show that the mole ratio of nitrat to sulfur sources play an important role in autotrophic denitrification. If the operation status and the optimum ratio of nitrate to energy source were choosen correctly, the autotrophic denitrification seems to be an effective process for removal of nitrate from water. In this study, sulfid was the best source since the alkalinity consumption and hardness addition and nitrate removal percent all were acceptable.

Keywords: water, nitrate, autotrophic denitrification, alkalinity, hardness.

Modeling the Effects of Land Use on Water Quality Parameters Using OLS and GWR Multivariate Regression Methods in Fars Province Watersheds

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Expended Abstract

Introduction

The characteristics of water quality are an important component for planning water resource management and of watershed evaluation. In recent years, several studies around the world have found that land use has a strong impact on water quality and that there are significant correlations between water quality parameters and land use types. Generally land use types have adverse impacts on water quality and positive relationships exist between percentages of these land use types and concentrations of water pollutants. In other words, negative relationships are usually found between the percentages of un-developed lands (e.g. forest and rangelands) and concentrations of water pollutants (good water quality). In contrast, higher percentages of these developed land use types are related to higher concentrations of water pollutants (worse water quality). The relationships between different land use types and different water quality parameters vary greatly. A land use type might be positively associated with one water pollutant but negatively related to another. The relationships between water quality and land use obtained in the previous studies are usually analyzed by conventional statistical methods such as Ordinary Least Squares regression (OLS). In recent years, a simple but powerful statistical method named Geographically Weighted Regression (GWR) has been developed to explore the continuously varying relationships over space. Similar to OLS, GWR builds a model to analyze how one dependent variable changes in response to the change in one or more independent variables. This can calculate a set of local regression results including local parameter estimates. This study applied the GWR technique to explore the spatially varying relationships between land use and water quality in 42 watersheds located in Fars Province, Iran. The main objective of this study is to explore how the relationships between land use and water quality indicators change over selected watersheds.

Materials and methods

The present study was carried out in Fars Province, Iran, and water quality data from 1971 to 2011 were obtained from the water company authority in Fars. The water quality parameters consist of Ca, Cl, EC, CO_3, HCO_3, K, Mg, Na, P^H, TH, SAR, SO_4 and TDS. Seven land use types, including bare soils, rangelands, fallow, agricultural, Orchards, residential and forest lands, were selected in this study. The land use map was created and validated by Landsat TM images (12 frames in July 2010) based on the widely-used remote sensing techniques known as the maximum likelihood method. The spatially varying relationships between land use and water quality indicators were analyzed using GWR. Water quality indicators were used as dependent variables, while land use indicators were independent variables. Because there are high correlations among the land use indicators, each GWR model used only one land use indicator to analyze its association with one water quality indicator. There were seven land use indicators and thirteen water quality indicators. Therefore, the relationships for 91 (13 times 7) pairs of water quality and land use indicators were analyzed by building 91 GWR models. GWR analyses were conducted using GWR4 software package. Afterwards, the local parameter estimates, the values of t-test on the local parameter estimates, and the local R^2 values produced by the GWR models were mapped to give a clear visualization of the spatial variations in the relationships between land use and water quality and to illustrate the abilities of the land use indicators to explain water quality. All mappings and GIS analyses were performed using the ArcGIS 9.3. OLS is the simplest and most used method among the linear multivariate regression methods.

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Based on the OLS method, coefficients are estimated in a way thatthe differences between the observed and estimated values of the dependent variables are minimized. In fact, the regression model has the least deviation or error, and most similarity with the observed values of the dependent variable. The development and application of OLS regression to estimate each of the water quality indicators (dependent variable) and the percentage of land use types (independent variables), is a common method for building water quality models using statistical software packages like SPSS. This method assumes that the coefficients of the regression under study are constant over space. The OLS models are as the following:

$$Y = \beta_0 + \sum_{i=1}^{p} \beta_i X + \varepsilon \quad (1)$$

Where, Y represents the dependent variable, β_o is the intercept, and $\beta_i X$ is the coefficient and the independent variable, ε represents the error term, and p is the number of independent variables. The GWR model differs in that it incorporates the coordinates of each location "i" with a metric coordinates "u" and it is defined as:

$$y_i(u) = \beta_{0i}(u) + \beta_{1i}(u)x_{1i} + \beta_{2i}(u)x_{2i} + ...\beta_{mi}(u)x_{mi} + \varepsilon_i \quad (2)$$

The model GWR is calibrated using an exponential distance decay function:

$$W_{ij} = \exp\left(\frac{-d_{ij}^2}{b^2}\right) \quad (3)$$

Where in the weight of site "j" as it effects site "i", W is calculated using the distance (d) between sites "i" and "j" by selecting "b" as the bandwidth. The weight decreases rapidly when the kernel is smaller than the distance. For this study, an adaptive band was used because the density of sample sites varied across the study area. We used the Global Moran's I statistics for the residuals of both OLS and GWR models to test spatial dependence (Autocorrelation). Global models assume that relationships between water quality and explanatory variables are the same across space. This is particularly problematic given the variation in land cover and multiple sources of pollutants. To evaluate two model performances, we utilized the coefficient of determination (R^2) and the corrected Akaike's Information Criterion (AICc). The purpose to compare GWR with OLS models was to identify whether GWR models have better model performance than the corresponding OLS models. The comparison was performed by comparing the model R^2 and the AICc values from both GWR and OLS models. Higher R^2 means that independent variable can explain more variance in dependent variable. A lower AICc indicates a closer approximation of the model to reality, lower AICc also means better model performance. Usually, a decrease in AICc lower than three might be caused by sampling error, but not a result of a real difference in models.

Results and discussion

The global R^2 of GWR in comparison with R^2 of OLS for each pair of dependent variable (water quality indicator) and independent variable (land use indicator) indicate that a dramatic improvement in R^2 of GWR over OLS is observed for every pair of water quality and land use indicators. The R^2 values in GWR in all watersheds were larger than 0.83 and the AICc for all water quality parameters were much smaller than the OLS models. The AICc differences between models for all water quality parameters were larger than 3 and the criteria values for GWR were always less than OLS. The higher values of the global R^2 from GWR than the R^2 from OLS indicate the improvement in model performance of GWR over OLS. However, the statistical significances of the improvements need to be verified with AICc values. The statistical test results for improvement in model comparisons of the AICc value indicates a closer approximation of the model to reality. Thus, in this study, a GWR model is considered to be significantly improved from its corresponding OLS model if the AICc value of the GWR is at least three lower than that of the OLS and the F-test is significant at p-value < 0.05 level.

The results of Moran's I statistics for GWR model shows that the assumption of spatial autocorrelation is rejected at a significance level of 5 percent for Ca, EC, K, Mg, SO_4 and TDS, and for the other indicators, the autocorrelations are not significant. The spatial autocorrelations of the GWR model are less than the OLS model. Therefore, the OLS model possesses a higher spatial autocorrelation problem in the analysis of spatial autocorrelation, especially in environmental research, and that the GWR method also successfully reduces spatial autocorrelations to a great extent.

β values or the coefficients of the independent variables (percentage of land use) in the OLS regression models for different water quality indicators represents that Ca and K have significant positive correlations with land use types. The significant positive correlations are also observed between land use types and water quality indicators, including Cl, Na, Mg, SAR, TDS, EC (except for agricultural lands), SO_4 (except for orchards lands) and CO_3 (except for orchards and residential lands). Most of these coefficients (significant positive) in most of the

parameters were related to orchard lands and then residential lands, which illuminates the increasing role of human activities on the amount of water pollution indicators.
The spatial maps of the GWR model parameters, reproduced for the study area in the ArcGIS 9.3 for EC and CL, indicated that rangeland, fallow lands, orchards and residential in the southeast, bare soil and agricultural lands in the north, and forest lands in the southwest of Fars Province, have the significant increasing impact on EC indicator values. Furthermore, bare soils, rangelands, fallow and forest regions in the west, agricultural areas in the southwest, orchards and residential areas in the south of this Province have decreasing impact on EC values. For the case of chloride (Cl), bare soils, rangelands, agricultural areas and forest in the north, orchards and fallow lands, in the southeast and residential zones in the east show a significant increase in the impact on this indicator. In addition, bare soils in the northwest, rangelands, fallow lands and forest in central zones, orchards and residential in the south, agricultural lands in the southwest of this province, have not significant increase on the chloride.

Conclusion

This study examined the relationships between seven land use types (%) and thirteen water quality indicators using both OLS and GWR models in 42 watersheds of Fars Province, Iran. Most GWR models show great improvements of model performance over their corresponding OLS models This is proved by F-test and the comparisons of model R^2 and AICc from both GWR and OLS. Many GWR models also successfully reduce spatial autocorrelations examined by Moran's I statistics. The GWR models improved the reliabilities of the relationships between variables by reducing the spatial autocorrelations in residuals. The visualization of the GWR model in local parameter estimates (Beta maps), and local R^2 maps in ArcGIS, highlight the great spatial variations in the impacts of different land use types on different water quality indicators and help identify their spatial patterns. Nevertheless, our recommendation to other researchers is to consider other characteristics of the watershed when they are making a model for water quality based on the GWR method. These characteristics, that can be climate, soil texture, geology, and plant species and crops diversity, can have a great effect on the river water quality. We do also recommend the researchers to use a higher amount of watersheds to increase the validity of their model and to reduce the amount of uncertainties. Moreover, researches should provide maps illustrating land use maps and land use changes in percentage for different time intervals (e.g. every ten years), and also examine the effects of temporal land use changes in their modeling of water quality parameters.

Keywords: Water Quality, GWR, Spatial Autocorrelation, Fars Province

Assessment of the Effects of Concentration and Temperature of 3-Mercaptopropionic Acid on Remediation of Mercury and Chromium, From Contaminated Soil Using Soil Washing Technique, Case Study: Tehran Oil Refinery Site (TOR)

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Expanded Abstract

Introduction

The expanding production of fuels, drugs, fertilizers, chemicals, and hazardous materials has caused considerable environmental contaminations. The contamination of soil and groundwater with petroleum hydrocarbon-based fuels as a result of accidental spills or improper storage has been reported frequently. Iran is seriously faced with soil contamination problem, due to 8.58% of the global oil fields. This generates 35 million tons of petrochemical products with more than 20000 km of pipelines. The extraction of 1 kg of crude oil usually generates 10–20 g of waste residues. Petroleum refineries are burdened with the problem of handling large sludge quantities. It is estimated that more than 28,000 tons of petroleum oil sludge are being generated each year from each petroleum refinery. This oily sludge is recognized as hazardous waste under the Resource Conservation and Recovery Act (RCRA). Since the early 1970s leaks from evaporation ponds, storage tanks and underground pipelines at Tehran Oil Refinery (TOR) is located in the Shahre-Ray district, south of Tehran, Iran. This was the major sources of soil and groundwater pollution in the area. For many years, the wastes contaminated with chromium and mercury from the TOR site has contaminated the area. Thus, this causes the pollution of soil, air and groundwater in the region. Heavy metals have toxic characteristics, and due to their non-degradability and persistency, they impose adverse effects on human and ecosystems. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) consider mercury and chromium among the 100 most dangerous toxic substances. Furthermore, the toxicity characteristic leaching procedure (TCLP) lists these metals as toxic metals, while their concentration in soil leachates should not exceed 0.2 and 5 ppm, respectively. Chromium is also the 21st most abundant element in the Earth crust with an average concentration of 100 ppm.

Chromium can damage the kidneys the liver and blood cells through oxidation reactions, when reaches the blood stream. Contact with the products containing chromates can lead to allergic contact dermatitis and irritant dermatitis, resulting in ulceration of the skin. In addition to these sorts of effects, the carcinogenicity of chromate dust has been proved since 1980 when the first publication described the increasing cancer risk of workers in a chromate dye company.

Mercury (Hg) is a silvery liquid metal. The primary source of Hg is a sulfide ore called cinnabar (HgS). Although the Hg usually obtained by-product of processing complex ores which contains mixed sulfides, chloride, oxides and minerals, it could occur as the principal ore product.

Mercury can be absorbed through the skin and mucous membranes. Mercury vapors can also be inhaled. Accordingly, containers of mercury are extremely sealed to avoid any spill and evaporation. In order to avoid exposure to mercury vapor, heating of mercury or decomposable compounds is always carried out with adequate ventilation.

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Soil washing is a combination of using liquids (usually water, occasionally combined with solvents) and mechanical processes to scrub soils. "Solvents are selected on the basis of their ability to solubilize specific contaminants, and on their environmental and health effects."
The soil washing process separates fine soil (clay, silt, etc) from coarse soil (sand and gravel). Since hydrocarbon contaminants tend to bind to fine soil particles (mainly clay and silt), separation of the smaller particles from the larger ones may decrease the volume of contaminated soil. The smaller volume of soil, which contains the majority of clay and silt particles, can be further treated by other methods such as incineration or bioremediation or disposed according to federal regulations. The clean, considerable volume of soil is seemed to be non-toxic and can be used as backfill. Generally, semi-volatile organic compounds (SVOCs), petroleum and fuel residuals, heavy metals, PCBs, PAHs, and pesticides are the target contaminant groups for soil washing.
This technology lets the recovery of metals and it can purify a wide range of organic and inorganic contaminants from coarse-grained soils. Because of reduction in the quantity of material which would require further treatment, soil washing is cost-effective compared with other technologies.

Materials and methods

In this paper, 3-mercaptopropionic acid reagent was used for soil washing of the samples. Brief description of this reagent is as follows:
3-Mercaptopropionic acid (MPA), HSCH 2CH 2COOH, is used in a variety of applications. The MPA itself is used as cocatalyst in the manufacture of Bisphenol A, which is a key raw material in Polycarbonate production. MPA enhances the process efficiency.

Reagents preparation

A 250-mL solution of 3-mercaptopropionic acid with the concentration of 1.22 kg/L was prepared in the laboratory for testing of the samples. This solution was used as the main washing reagent to evaluate the contaminants removal efficiency under various temperature and concentration conditions.

Washing procedure

Twenty grams of the contaminated soil were placed in a 600-mL beaker and 400 mL of reagents solution were added to the sample (1-20 is TCLP ratio). The soil was mixed with the designated washing solution using Jar test equipment for 4 hours at the rotational rate of 250 rpm.

Temperature effects

To obtain the effects of temperature on contaminants removal efficiencies, three washing solutions were made at 25, 35 and 45°C (respectively named T_1, T_2, and T_3). To maintain the desired testing temperatures, the samples were kept in different water baths during the washing procedure.

Concentration effects

To evaluate effects of solutions concentration on the soil washing efficiency 4 different concentrations of 3-mercaptopropionic acid solutions (0.05, 0.1, 0.15 and 0.2 normal) were prepared.

Extraction method

U.S. Environmental Protection Agency (U.S. EPA) METHOD 3050B was applied to digest soil samples for ICM-MS tests. This method has been written to provide two separate digestion procedures, one for the preparation of sediments, sludge, and soil samples for analysis by flame atomic absorption spectrometry (FLAA) or inductively coupled plasma atomic emission spectrometry (ICP-AES) and one for the preparation of sediments, sludge, and soil samples for analysis of samples by Graphite Furnace AA (GFAA) or inductively coupled plasma mass spectrometry (ICP-MS). The average values of 155.7 and 27.2 ppm, respectively, were used as the concentrations of chromium and mercury in raw soil samples of Tehran oil refinery contaminated site in this study.

Results and discussion

Effects of solutions concentration on mercury removal efficiency

The removal efficiencies of the contaminants were 67.88, 73.39, 81.57, and 84.53% at 0.05, 0.15, 0.1 and 0.2 N concentrations of 3-mercaptopropionic acid solution, respectively.

Effects of solutions temperature on mercury removal efficiency

By using 3-mercaptopropionic acid in 4 different concentrations (0.05, 0.1, 0.15 and 0.2N) the removal efficiencies of mercury were measured to be 71.31, 79.12, 84.94, and 86.98% at 35°C and to be 75.15, 83.44, 86.79, and 87.90% at 45°C, respectively.

Effects of solutions concentration on chromium removal efficiency

The average amounts of chromium removals corresponding to 0.05 N and 0.2 M 3-mercaptopropionic acid solutions at 25°C were in the order of 51.37%, and 63.45%, respectively.

Effects of solutions temperature on chromium removal efficiency

By using 3-mercaptopropionic acid in 4 different concentrations (0.05, 0.1, 0.15 and 0.2N), the removal efficiencies of chromium were reported to be 52.35, 53.98, 57.89, and 67.63% at 35°C and to be 55.11, 57.89, 62.76, and 75.21% at 45°C, respectively.

Conclusion

The outcomes illustrate that the highest mercury and chromium removal efficiencies from the sludge samples is achieved by 0.2 N 3-mercaptopropionic acid solution at 45°C (87.90% and 75.21% respectively). Furthermore, using 0.2 N 3-mercaptopropionic acid solution was extracted at 25 °C, %84.53 of Mercury and %63.45 of Chromium.

Keywords: Mercury, Chromium, Soil washing, 3-mercaptopropionic acid

A Pilot Study for Evaluation of Membrane Bioreactor for Advanced Treatment of Industrial Effluents and Reverse Osmosis Pretreatment

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Extended abstract

Introduction

Treated industrial wastewater is typically discharged to the environment in most industrial towns in Iran. It is, however, a potential water resource to produce industrial process water. To reach this reuse application, further treatment would be needed. Nowadays, membrane separation processes are becoming quite popular in wastewater treatment and reclamation, since they combine process stability with an excellent effluent quality. One of this membrane processes for water reuse and reclamation is using Reverse Osmosis (RO) that is increasingly being used in all over the world. The RO relies on pressure differential to force a solution (usually water) through a membrane that retains the solute on one side and allows the pure solvent to pass to the other side.

The main problem of using RO is its membrane fouling that is prevalent in water reclamation applications. In fact, membrane fouling is the main cause of permeate flux decline and loss of product quality in reverse osmosis systems. Sources of fouling can be divided into four principal categories: scale, silt (particular), microorganisms (bio fouling, growth of bacteria and other organisms) and organic fouling. Therefore, RO systems need to be coupled with an effective pretreatment system to avoid common issues that can result in system failure.

Scaling and particulate fouling can be managed by using appropriate pretreatment (cartridge filters and addition of antiscalants), limiting recovery, and periodic membrane cleaning while biological and organic fouling can be more difficult to control. To remove dissolved organics, a biological treatment process is required. MBR has been widely studied and applied on full scale in wastewater treatment and it is considered as a new pretreatment for reverse osmosis in water reclamation and reuse among many different pretreatment schemes for RO.

MBR is a process in which conventional biological system is coupled with the membrane process (microfiltration, MF or ultrafiltration, UF). There are two configurations for MBRs which are in-series and submerged MBRs. In the in-series MBR configuration sludge is pumped from an aeration basin to a pressure-driven membrane system outside the bioreactor where the suspended solids are retained and recycled back to the bioreactor and the effluent passes through the membrane while in submerged MBRs the membrane module was submerged directly in the aeration tank and permeate is obtained by applying low vacuum. Submerged membrane bioreactors have lower power requirements than the external MBR configurations.

Due to the shortage of water resources in the Shokouhieh industrial town (located in Qom province, Iran)), reclamation and reuse of industrial wastewater treatment plant effluent using RO modules was put on the agenda. Effluents of this WWTP were not being adequately treated by biological treatment and there are biodegradable organic matters in effluent of wastewater treatment plant. This research has focused on the evaluation of the pilot scale operation and monitor of an MBR system to advance treatment of an industrial wastewater in order to produce water with appreciate quality as RO feed water. In other words, this study has discussed the feasibility of RO pretreatment for water reuse from industrial wastewater treatment effluent (before disinfection) with

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operation of a MBR pilot. The removal of certain pollution parameters such as chemical oxygen demand (COD) and suspended solids (SS) were monitored.

Materials and methods

Wastewater source

Actual wastewater used in this study was taken from an industrial wastewater treatment plant of Shokouhieh, Qom, Iran. This plant receives and treats the wastewater from different factories such as welding, dairy, beverage, and metal finishing. The treatment system in this wastewater treatment plant consists of screens, a equalization tank, an anaerobic reactor, an aeration aerobic tank, sedimentation, sand filter and a disinfection system. Due to poor design this existing treatment system is not effective in removing the all organic load of influent wastewater. So there is significant amount of biodegradable organic matters in effluent. The wastewater samples as MBR feed wastewater were collected from outlet of sand filters in plastic containers and were delivered to the laboratory where pilot is operated there.

MBR pilot unit

Continuous operation of a pilot scale ultrafiltration membrane bioreactor system was carried out in this study. The bioreactor was made of Plexiglass with total volume of 32 liters. A flat sheet membrane ultrafilter was placed in the center of bioreactor.

Membrane operated at a constant flow rate of 4 L/hr using a prestaltic pump. Air blower was used to provide required sufficient air during operation of the MBR. Air was introduced via perforated plastic tube air diffusers which were located at the bottom of the reactor to produce fine and coarse bubbles to supply the dissolved oxygen required for biological process in the reactor and reduce fouling on the membrane, respectively. Also, the pilot was equipped with control instruments to measure temperature, dissolved oxygen (DO), pH and wastewater level.

Operating conditions

Membrane bioreactor was operated continuously, corresponding to an 8-hour hydraulic retention time (HRT) and the duration of operation was 30 days. Prior to use, membrane was washed with tap water until a steady pure water permeate flux was obtained. The MLSS temperature in the bioreactor was kept constant at 22–27^{0}C with a heat exchanger. Permeate flux was set to approximately 83 $lm^{-2}hr^{-1}$ using a prestaltic pump and trans-membrane pressure (TMP) was continuously recorded using an analogue pressure gage. Chemical cleaning of the membrane module was not carried out during the operation. No biomass was initially removed from the reactor to allow the biomass concentration build up in the system to about 2000 mg/L. After that Daily withdrawal of mixed liquor was conducted from the reactor in order to maintain the predetermined SRT (25 day) and to control an excessive increase of organic matter and solid concentrations in the bioreactor.

The membrane was cleaned chemically once the pressure reached about 60kPa. In this stage, after the membrane was taken out, it soaks in a 250 mg/L NaOCl solution and afterwards with 4000 mg/L citric acid solution for at least 4 hours. Then, the membrane was cleaned with tap water. Fine bubble aeration was provided to maintain the dissolved oxygen (DO) concentration in the biological reactor higher than 2 mg/L. Fine bubble aeration was accomplished using suitable diffusers placed at the bottom of the biological reactor. Also, coarse bubble aeration was supplied to the membrane module to minimize membrane fouling.

Analytical method

Laboratory analyses were conducted to determine the characteristics of influent wastewater to pilot, activated sludge and MBR permeate. For this, suspended solids, chemical oxygen demand, total nitrogen and phosphate were analyzed. Most analytical techniques used in this research followed the standard methods described by APHA (1998).

Results and discussion

Permeate water quality of MBR

the start of the experiments, at startup phase, MBR module had been operated for more than 2 weeks to obtain the stable phase. At times, high values of the MLSS concentration were measured and MLSS concentration was increased up to a value of around 2000 mg/L and after that sludge removal was initiated to maintain MLSS concentration constant in the reactor. During 30 days of operation of the reactor, MBR performance based on influent and effluent quality and removal percentage data of SS, COD show that system produced permeate water of good quality.

Inlet SS concentration ranged from 179 to 243 mg/L. During this study, it was detected that the MBR had MLSS in the range of 1600–2300 mg/L. Because of the extend order of magnitudes of the concentration values, the concentration measurements are plotted on a logarithmic scale.
As results represented, excellent solids separation was achieved by the UF membrane. Removal of SS reached greater than 98% resulting in the MBR permeate with SS levels below 3 mg/L. and the results also indicate that the removal efficiencies of COD for influent and effluent of MBR reactor and SDI of MBR permeate was less than 3 in most of cases which show that permeate has good quality to be used via RO.

Conclusion

In this study, we presented the possibility and applicability of MBR to reclaim effluent in an industrial wastewater treatment plant and the MBR pilot was evaluated in terms of effluent quality. In general, it can be concluded that MBR can produce high permeate quality and is capable to be a very efficient method for RO pretreatment. Product permeate from MBR with average SDI less than 3 indicate that by using MBR pretreatment for RO system, it can be anticipated that the rate of membrane fouling is reduced and the life of RO membrane modules is extended. The effluent water from the MBR has also a high quality according to SS and COD removal during operation.

Keywords: Membrane bioreactor, Reverse osmosis, Industrial wastewater, Reuse

Application of Backward Probability Method in Pollutant Source Tracking in Non-Uniform Flow Rivers

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Extended abstract

Introduction

Rivers are very vulnerable to the chemical pollutions released from industries and agriculture. Contaminants are suddenly entered into rivers. Thus, the location of the contaminant that was released to the river should be identified quickly to control and decrease the pollution and determine responsibility. If the location or the release time of the contaminants is unknown, in order to determine the location or the release time, it requires using the backward model in both location and time. Backward probability method is one of the backward models able to determine the location and the release time of the contamination. Identification of contaminant sources is identified with two parameters, the first is the location of contaminant and the second is the release time. Accordingly, the identification problem is illustrated with two kinds of probability concept. Backward location and backward travel time probability are the two different ways to identify the location and the release time of the contaminant sources. Backward location probability determines the location of the contaminant sources based on the assumption that the release time is known. In contrast, backward travel time probability gives the information about the release time based on the assumption that the source location is known.
rivers of steady state.

Governing Equations of Backward Probability Method

Governing equation for mass transport in non-uniform and unsteady rivers is advection-dispersion equation (ADE). Upstream boundary condition in the ADE is the third type and downstream boundary will be the first type.
Adjoint analysis is an efficient approach for sensitive analysis. In common, sensitive analysis approach we need to run the model more and more, but adjoint equation is solved once and the results are used for sensitive analysis. This equation is used as Backward Probability Method. Therefore, the governing equation for Backward Probability Method is adjoint equation. Adjoint equation is similar to the ADE, and it will be:

$$\begin{aligned} &\frac{\partial h}{\partial C}+\frac{\partial(\psi A)}{\partial \tau}+\frac{\partial}{\partial x}(DA\frac{\partial \psi}{\partial x})+\frac{\partial(\psi Q)}{\partial x}=0 \\ &\psi(x,0)=0 \\ &\psi(x,\tau)=0 \end{aligned} \qquad (1)$$

Where, ψ is the adjoint state, τ is the backward time and $\partial h / \partial C$ is the source term. Source term is different in both kinds of Backward Probabilities. Dirac Delta Function approximates source term. It can be utilized as an initial condition. Boundary condition for adjoint equation is indicated in equation 2:

$$\begin{aligned} &D\frac{\partial \psi}{\partial x}=0 \qquad at\ \ x_{\ detection}=0 \\ &D\frac{\partial \psi}{\partial x}+V\psi^{*}=0 \qquad at\ \ x\ upstream \end{aligned} \qquad (2)$$

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Adjoint equation controls both Travel Time and Location Probability, but the source term make a difference between Backward Travel Time Probability and Backward Location Probability. The source term is determined based on the type of the probability. After one time simulation, both Backward Probabilities can be obtained.

Backward Simulation

A numerical code was developed to compute the backward probabilities based on adjoint equation. The control volume method based on explicit scheme is utilized for the numerical code. In this study, we first utilized the backward code with existing analytical solution for a uniform canal. Therefore, we reached an accommodation between analytical solution and Backward Probabilities Solution. After verifying the model, it was used for a hypothetical non-uniform river. To compute hydraulic parameters of the river, we need a hydrodynamic model. So a standard step method was used to compute the hydraulic parameters. Therefore, the backward model inputs are outputs of the hydrodynamic model with a modification on flow field. For using hydrodynamic results in the backward model the flow field is reversed. Three release points were assumed in non-uniform. These are 500 m, 10 km and 20 km from observation point. We used a forward explicit method to compute the arrival time of the contaminants to the observation point at x=0. Then, it will identify the release time and the location of the contaminant by using the backward probability model. The model was run for 40000 s. We show both PDF and CDF figure for the backward location and the travel time probability.

Results and discussion

The model was verified with analytical solution. It was applied for a rectangular canal with constant velocity. The length of the canal was 8 km. the contaminant was released at 5km from detection point. It took 10000 s to arrive to the detection point. We verified both the Backward Travel Time Probability and the Backward Location Probability.

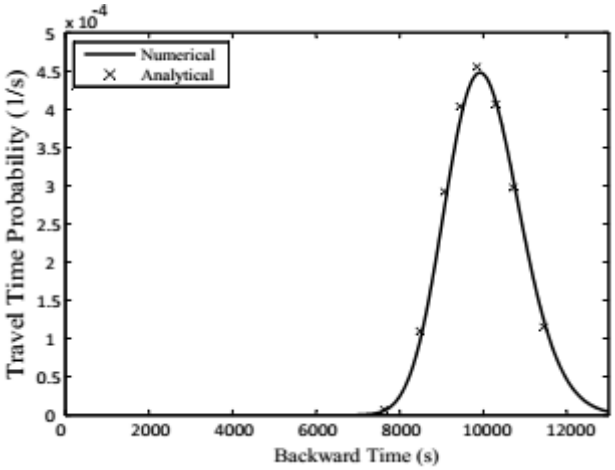

Figure1: Verification of Backward Travel Time Probability

The model predicted the release time of the contaminant very well. The most percentage of the backward location probability is at the 1000 point. Thus, the release time of contaminant is 1000 s.

The model has been tested in a non-uniform river. The contaminant was released contaminant from 3 different points, to test the ability of the model. Here we just show the second point (10 km).Contaminants arrive to detection point in 4.2 hr.

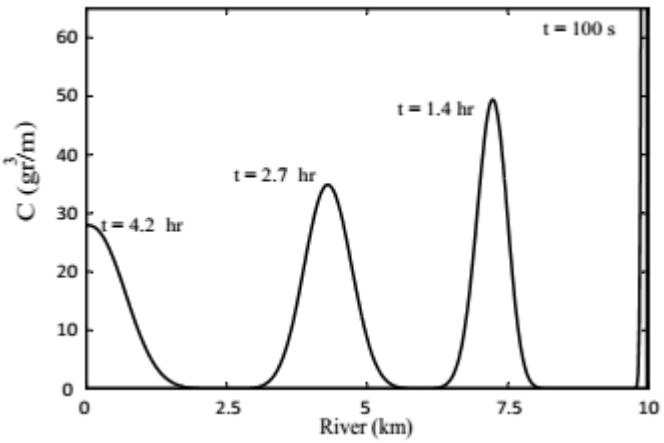

Figure2: Pollutant Released from 10km

Contaminant arrive to detection point in 4.2 hr.

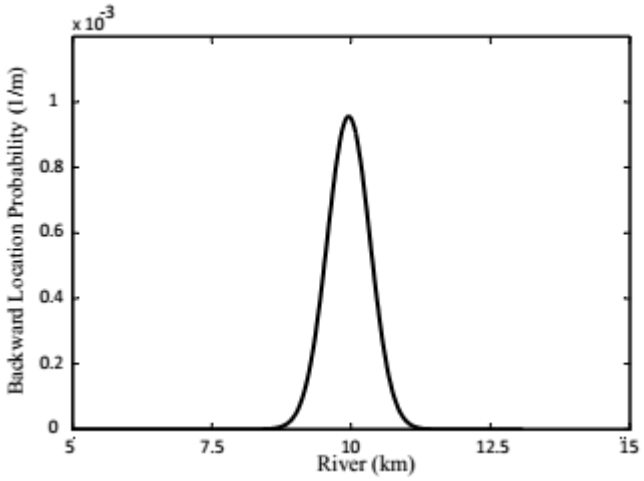

Figure3: Backward Location Probability in 4.2 hr

The model predicts the source of the contaminant very well. Therefore, the most percentage of backward probability is at the 10 km. Therefore, the source of contaminant is 1000 s.

Conclusion

In the past researches, backward probability method has been used less in surface water. But in the present paper, the backward probability method was used in non-uniform and Steady State River. According to the results backward probability method is able to apply for the non-uniform and rivers of steady state. This method is able to identify the location and the release time only by one simulation. The accuracy of the model depends on the condition of rivers. The accuracy is high in uniform rivers, but it decreases in non-uniform rivers. Therefore, this method is fast, since it does not need to run several times. Finally, it is suggested that this model test in non-uniform and unsteady rivers.

Keywords: Identification of Contaminant Sources, Backward Probability Model, Adjoint- Analysis, Non-uniform Rivers

Application of Dilation Mathematical Morphology Algorithm to Detect Transition Zone of Ecosystem

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Expanded Abstract

Introduction

According to the regime shift and extension of the desert boundary in last decades, it is important to identify transition zones, which are the most likely area to cross over the desert state in arid ecosystems. The shifts in relationships between climatic variables especially soil moisture and productivity relationships are not easily traced, mainly because the responses of biological processes to variation in rainfall and soil moisture are characterized by several temporal and spatial scales. Between-season differences in magnitude and frequency of rainfall events, and in seasonal rainfall amounts and distribution are added to the difficulties to define threshold values of ecosystem responses to changes in rainfall characteristics. Thus, detection of changes in ecosystem productivity should be established through a long-term study. This is especially true in the case of annual vegetation, which exhibits no carry-over effects from previous seasons, i.e., the productivity of each growing season reflects only that specific season's weather conditions. The impact of changes in climatic conditions on productivity is, therefore, complex and combines the effects of several driving factors. Identifying and mapping such thresholds is difficult because of the high diversity of vegetation, soil and bare rock patterns and ecogeomorphic instabilities in these regions. Embedded recovery and erodibility potentials in these patterns are combined together by erosion vegetated and dilation of complementary phase or conversely. The adjacency of ecological (vegetation) and morphologic (soil and rocks) parameters in transition zones is illustrative high potential to cross over into an irreversible threshold. Therefore, early detection of transition zones can be effective in controlling and preventing of desert borders extension. For this purpose, application of mathematical morphological algorithm like dilation provides the tools to implement spatial domination of these patterns. The application of morphological analysis is a new technique in environmental sciences spatially in Iran and one of the most basic morphological operations is dilation. Dilation algorithms affect the shape and structure of a feature and add the pixels to the boundaries of features in an image. It is in binary images. Generally, morphological operations apply a structuring element to an input image, create an output image of the same size. In a morphological algorithm such as Dilation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors. By choosing the size and shape of the structure element, it is possible to construct a morphological operation that is sensitive to specific shapes in the input image. In this research, we assessed the application of dilation algorithm to detect transition zones in part of Khorasan Razavi Province.

Materials and methods

In this research, we applied a mathematical morphological algorithm to detect the transition zone between arid and semi-arid regions in part of Khorasan Razavi province, because of an altitude and climatic gradient. The altitude difference in this region is more than 800 m from the west to the southeast which the effects on rainfall fluctuations about 200 mm through this gradient. As a result, vegetation covers as an ecological stabilizing factor is under the influence of such gradient. An image processing was applied to detect desert areas based on spatial differences and geomorphic properties in lithology, soil and vegetation relationships. The required data in this survey was surface reflectance images of MODIS for June 2004. These data sets are known as "MOD 09 Surface

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Reflectance 8-day L3 global" product with spatial resolutions 500 m and are computed from the MODIS Level 1B land bands 1,2,3,4,5,6, and 7 (centered at 648 nm, 858 nm, 470 nm, 555 nm, 1240 nm, 1640 nm, and 2130 nm, respectively). The product is an estimate of the surface spectral reflectance for each band as it would have been measured at ground level if there were no atmospheric scattering or absorption. In the first step, binary images as inputs to implement dilation algorithm was obtained from implementation of spectral angle mapper algorithm for spectral un-mixing on surface reflectance images. In this step, it was necessary to determine surface conditions as a function of the relative cover of vegetation, bare soil, and rocks. Radiometric and geometric enhancements were applied before image classification and processing. However, in order to find the accessibility of normal state of ecological conditions, the monthly image of June was produced by using a weighted average. Such parameterization may be obtained by a spectral angle mapper (SAM), which classifies pixels based on the spectral distance between the pixel integrated reflectance and the representative spectra of these three surface cover types. The morphological algorithm of dilation was performed by laying the structuring element on the image. Since the size and shape of structuring element (kernel) are important in morphological operations, in the second step, selection of a proper structuring element was required for implementation of dilation technique. Therefore, three kinds of 3×3 kernels of two-dimensions were examined and the most appropriate kernel was chosen for this purpose. Where the origin of the structuring element coincided with a pixel with 1 value (60 in this research), there was no change and moved to the next pixel. But where the origin is coincided with a pixel with 0 value, it made black all pixels from the image covered by the structuring element. Finally, the fringes of dilated phases were extracted to subtract the dilated cover fractions from the main image. Transition zones are then identified as boundaries between erodible and recovery area by a combination of two dilated layers.

Results and discussion

In As a result of implementing the spectral algorithm, the surface conditions were determined as a function of the relative cover of bare soil and rocks, and green shrubs. In this context, we have two complementary phases of vegetation and bare soil and rocks. Recovery potential concerns the domination of shrub and other green vegetation and erodibility refers to the domination of bare soil and rock surfaces. Bare soil fraction and shrub cover is changed inversely along the altitude and climatic gradient in the case study. Implementation of dilation by structuring elements of two dimensions involves 1 value. This provided a proper covers surrounded by each pixel completely. The implementing morphological algorithm of dilation on both cover types in a 3*3 kernel resulted in a significant extension of cores of maximal cover proportions. In other words, the operation of dilation set the maximum value of all pixels in the input pixel neighborhood for the value of the output pixel. In this study the maximum value was 60 (or 1). Subtracting the dilated cover fraction revealed the most distinctive narrow boundary zone characterized by the convergence of differences between the inverse extension potentials of shrubs and bare rock cover. The results have proved that there is a significant variation in shrub and soil fraction distribution along these climatic gradients. This study hypothesizes that the patterns composed of a patch of shrubs and bare rock surfaces contain information in the boundaries formed between desert fringe ecosystems. The approach was tested here using surface reflectance image of MODIS, with a proper spectral resolution. A different approach for overcoming spectral resolution limitations may be the use of the phenological characteristics of the different vegetation formations.

Conclusion

In this research, a new methodology was developed to the approach based on the analysis of potential inverse trends of erosion and recovery embedded in heterogeneous patterns of vegetation, soil and rock cover in transition zones. We also hypothesized that this heterogeneity in itself contains important information in the formation of desert thresholds in transition zones. This information includes the mutual trends of inverse recovery and erodibility potentials in spatial patterns. The methodology employs spectral mixing analysis to map surface conditions and uses mathematical morphology algorithms of dilation for detection of transition zones, where two complementary phases are located adjacent to each other. Accordingly, we could separate the area with a high rate of erodibility potentials into the southeast part of the case study. Although the desert boundary was detected, the results indicate an expansion of desert boundary into the North West. The new methodology has proved application of morphological algorithms in the detection of arid ecosystems fringe. It may also be implemented in wide regions of semi-arid to arid transitions and provide information that is instrumental in identifying eco-geomorphic changes under global climate change and changes in human disturbance regimes.

Keywords: Mathematical morphology, Dilation Algorithm, Transition zone, Kernel, Desert borders

Application of Logistic Regression in Landscape Aesthetic Quality Modelling, Case Study: Ziarat Watershed of Golestan Province

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Extended abstract

Introduction

Main trend of ecotourism is nature and its beauties and finding the beautiful landscapes and evaluation of the aesthetic values of the area would be considered as one of the principles of recreational planning. Scenic beauty is a major component of every action in the natural environment in tourism and recreation activities. Visual elements of landscape not only present aesthetical values but also verify the mutual relationships of these values in cultural, economic and biological dimensions. The perceived aesthetic value of landscape is beyond identifying processes of physical and biological signs on the landscape. It is virtually a perceptional process originated from visual aesthetic exchanges between the observer and geographic space. This perception is a process through which sensory information can be detected and classified into meaningful structures. The aesthetic appreciation of a landscape as it is perceived by humans has been a subject of theory development in various disciplines. With the development of land use planning, and its requirement for environmental data on which to base land use decisions, came an increased desire to elaborate valid means to quantify the scenic characteristics of landscapes. Due to the fact that visual sense has the highest amount of influence on the quality of individuals' recreational experience, visual quality assessment seems to be essential. Integration of GIS with field surveys has provided more sophisticated decision support tools for solving complex management problems such as evaluating the scenic value considered as a non-quantifiable source in the recent past. Most studies have been conducted to assess the landscape visual quality in Iran is based on subjective approach and there is no references about objective assessment. Accordingly, the purpose of this research is to evaluate the visual quality of landscapes to single out more valuable landscapes.

Materials and methods

Since the main trend of ecotourism is nature and its beauties so finding beautiful landscapes and evaluating aesthetic values of the area would be considered as one of the principles of recreational planning. Special geographic position, climate diversity, special topographic and geomorphologic states are considered as unique potentials of ecotourism. Given that Ziarat watershed as one of the tourism poles of the Golestan province in Iran and the above mentioned characteristics was selected as the study area to assess and model the aesthetic value of its walking tracks using an objective approach as it named logistic regression method.

Regression model is a statistical model explained the relationship between a phenomenon (the dependent variable) and some of its elements (independent variables) based on a defined set of observed data. Logistic regression model is a special type of regression model with Boolean structure as independent variable. The main assumption of regression logistic is that the possibility that the dependent variable take the one score (a positive response) is followed by a logistic curve and this value would be calculated using the equation (1):

Equation (1):
$$p(Y=1/X)=\frac{exp\sum BX}{1+exp\sum BX}$$

According to the above equation:

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P: Is the probability in which the dependent variable takes one score.
X: Is the independent variable
B: Is the coefficients of the independent variables
This logarithmic change caused the predicted possibility was in the range of 0 to 1.

- Accuracy assessment of regression model:

Accuracy assessment of regression model will be calculated using Pseudo-R^2 and ROC indices. Pseudo-R^2 will be examined in the fitness of the model based on the rate of the possibility as it followed (equation 2):
Equation (2): Pseudo- R^2=1-(log (likelihood)/ log (Lo))
If Pseudo- R^2 was higher than 0.2 , it would be regarded as a good fitness of the model in spatial studies.

In summary, the main steps of this research are as it follows:

1. Identifying effective criteria on scenic values of the study area (independent variables)
2. Marking the most beautiful points of the study area (dependent variable)
3. Mapping independent variables
4. Standardization of independent variables
5. Running the regression model
6. Accuracy assessment of regression model

Results and discussion

After data were collected and the factors affecting the aesthetic value of the study area were mapped, these criteria were standardized between 0-255. Finally, eight criteria including tree types, vegetation density and diversity of vegetation density, ecotone of tree type, viewshed layer for waterfalls, peaks and rivers along the walking tracks, and visibility of points with higher diversity were inserted in the model as independent variables. As mentioned in previous part, dependent variable is a Boolean layer including beautiful and non-beautiful point of the study area. Finally, after the implementation of the model, each variable with respect to their impact on the aesthetic value has separated regression weights as represented in table 1.

Table 1. Regression coefficient assigned to each criterion

Independent variable	Regression coefficient
Tree type	0.00113912
Vegetation density	0.01807187
Diversity of vegetation density	0.01763468
Ecotone of tree type	-0.00324110
Waterfall viewshed	0.08655779
Peak's viewshed	0.00562768
River's viewshed	0.00970483
High diversity point viewshed	0.01256638
Intercept	-7.2442

The results of regression model (coefficients) indicate that the ecoton of tree type has an inverse relationship with aesthetic value. By increasing the ecotone value, the aesthetic value will be decreased while other parameters have a direct relationship with the aesthetic value.
The model was validated using Pseudo-R^2 and ROC indices. The estimated value of Pseudo- R^2 for this model was equal to 0.4129, and this value was higher than 0.2 which represented the good fitness of the model. Validating by ROC confirmed the results of the model, as ROC index was equal to 0.875. Fig (1) shows the prediction map of the model. This map has predicted aesthetic value of the study area using the independent variables.

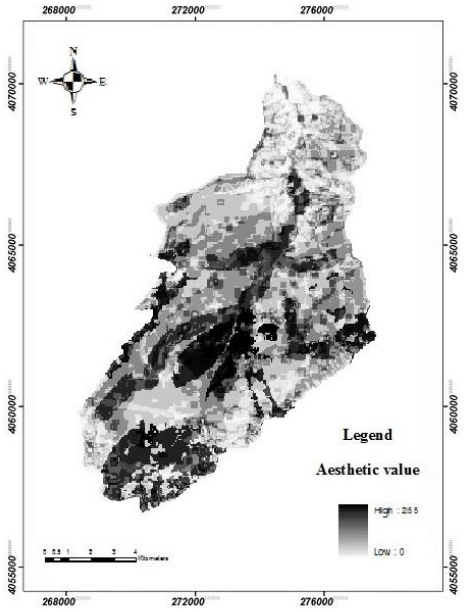

Fig (1): Prediction map of the aesthetic value using logistic regression model

In order to determine the importance of each independent variable, we tried to remove each of the variables from the regression equation and examined the impact of each criterion (fig 2). The indices of river and the visibility of high diverse point were the most effective criteria.

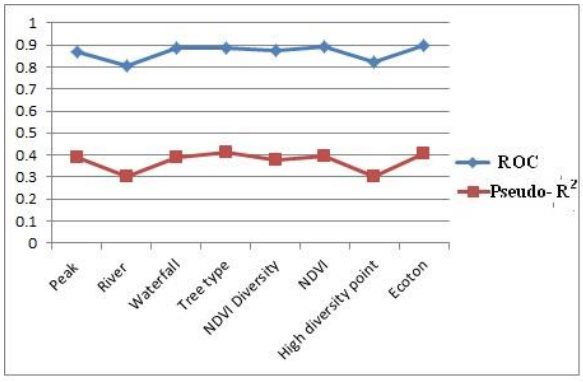

Fig (2): The elimination effect of each independent variable on model validity

Conclusion

The development of measurement for aesthetic/environmental quality has experienced progress over the last years. In addition, it is possible to create statistically reliable maps to predict visual quality of environment. The process is relatively efficient and effective. Planners, designers, and citizens can measure the perceived effects of spatial treatments and can assess the perceived impact of various proposals and plans. The represented approach in this research is one more tool in a toolbox of expert and statistical measures to understand the impacts proposals and plans may have upon the environment. The proposed approach (not with the same criteria as each region can differ in their biophysical characteristics) can be conducted in other similar geographic regions to evaluate and rank the scenic beauty of landscapes.

indicated that the zones which have had more aesthetic value often has been located in central region, eastern and western ridge and south part of the study area. Validating the regression model by Pseudo-R^2 and ROC indices represented the high capability of model to determine the areas which have the high aesthetic quality. The results of this research can facilitate decision making process in site selection for more beautiful recreational areas.

Keywords: Ecotourism, Aesthetic values assessment, Logistic Regression, Ziarat watershed

Cooling Effect of Urban Green Spaces, Case Study: Munich City

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Expanded Abstract

Introduction

Humans have actively managed and transformed the world landscapes for the millennia. After the industrial revolution (between 1820 and 1840) with increase in sanitation, food security and quality of life in the human population increased tremendously. Urbanization, the demographic transition from rural to urban, is associated with the shifts from an agriculture-based economy to mass industry, technology, and service. For the first time ever, majority of the world population lives in city, and this proportion continues to grow. One hundred years ago, 2 out of every 10 people lived in an urban area and by 2050; this proportion will increase to 7 out of 10 people. The result was the physical growth of urban areas, in horizontal or vertical dimensions. Urbanisation is an extreme form of Land Use and Land Cover Change (LULC) that occurs when the natural vegetation of an area is replaced with buildings and roads, which tend to have significantly higher air temperatures than their rural surrounding. This phenomenon is known as Urban Heat Island (UHI). UHIs can directly and indirectly affect the thermal comfort and health of urban residents. UHIs cause generation of more CO2 emission by increasing the energy consumption for cooling the infrastructure, but they also influence water use, biodiversity change and human discomfort where all together aggravate social and environmental quality in cities which collectively contributes to global challenges. Increase in atmospheric CO2 concentration in association with LULC changes are among the main drivers to climate change.

Energy consumption, generating CO2 emissions and contributing to earth warming, in association with land use and land cover changes are amongst main drivers of global climate change on the one hand and of increasing the 'Urban Heat Islands'(UHI) – higher temperatures in cities compared to their surroundings – on the other. Therefore, urban vegetation can have a role in mitigating the UHI effect. Urban vegetation through several mechanisms of shading, increasing albedo and evapotranspiration decreases the penetration of sun during the day. Urban vegetation also decreases summertime energy demand to cool the indoor climate, decreasing CO2 emissions as well.

Remote sensing has proved to be a useful tool for cross-scale ecological research at various spatial, temporal, and spectral scales. Remote sensing images of the apparent surface temperature of cities show the marked cooling of vegetated surfaces in general and parks, in particular. Therefore, 'urban greening' has been proposed as one approach to mitigate the human health consequences of increased temperatures resulted from climate change. However, urban vegetation not only regulates climate but also acts as an important amenity for the neighbouring communities; it support urban life and can ensure social cohesion and wellbeing. The goal of this paper focuses on the cooling effect (pattern) of urban vegetation in the city of Munich, Germany, for more than 10 years. Consequently, it is hypothesized if the urban vegetation cooling effect takes place during continuing years, including the warm year of 2003 in the study area?

Materials and methods

In order to make this study happen, rRemote sensing data, GIS and LULC data has been used for the study area. The study area is located in the South-East of Germany and is the capital city of Bavarian state. This city is approximately 310.43 km^2 with the population of 1.37 million inhabitants in 2011. Munich is a developed city

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and a stable region in terms of land use and land cover in the period 2002 to 2012. Distribution of green parks within the administrative area of the city (33.8 m^2 per person) is the advantage of the study area (fig 1).

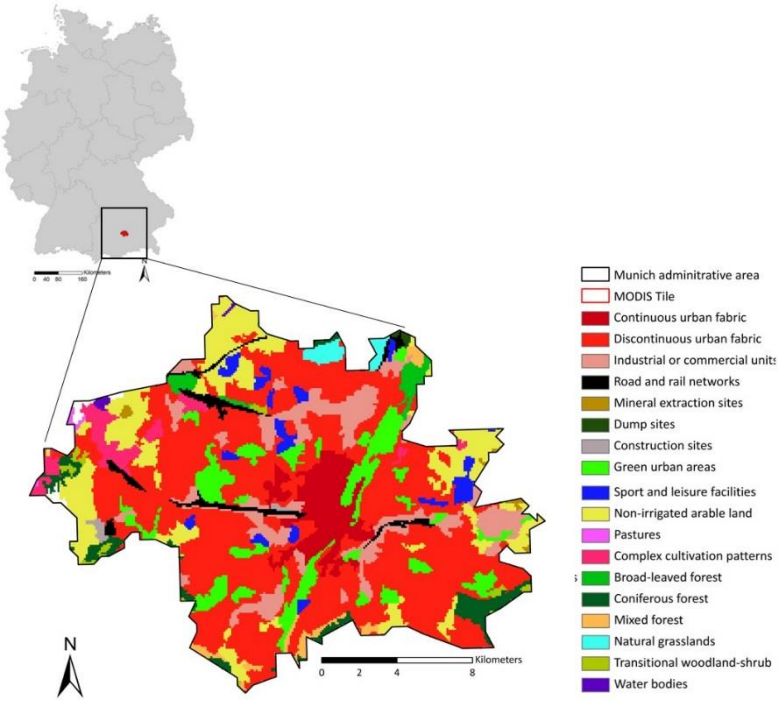

Fig 1. Geographical location and the distribution of the land use and land cover in the study area (based on CLC2006).

The land surface temperature data were obtained from MYD11A2 product of MODIS sensor which is an 8-day interval data. The LST data were collected for the warm season of 2002 to 2012. The LULC data were used from the European Environment Agency (EEA) called Corine Land Cover (CLC) database which has been prepared for more than 25 European countries with 44 classes. Due to similarities in the behavior of surface temperature of different CLCs, some classes were reclassified and combined to form two major rather simplified homogenized classes; one of urban areas and the other one being the urban vegetation. The homogenized map was merged to LST data in order to compute the relationship. Therefore, Kernel Quantile Regression (KQR) was used. KQR performs non-parametric regression and is a method to estimate functional relations between variables for all portions of a probability distribution and aims at estimating either the conditional median or other quantiles of the response variable. QR was used to calculate for the 25, 50 and 75 quantiles for each month, which illustrates the change of LST in urban areas and urban vegetation.

Results and discussion

The results revealed that (I) there is a higher daytime surface temperature in dense urbanised area rather than well-vegetated and surrounding urban areas, due to thermal emissivity properties of urban surfaces and heat capacity, (II) a positive and increasing trend can be seen between LST and the ratio of urban, while a negative and decreasing trend between the LST and the urban vegetation within every pixel. Estimates of Weng et al. (2007) also reported that abundance in vegetation is one of the most influential factors in controlling LST measurements through partitioning solar radiation into fluxes of sensible and latent heat. (III) There is a non-linear trend between LST and the proportion of LULC within each pixel, especially for urban vegetation. Vegetation can be effective as it delivers several mechanisms of cooling simultaneously and in a complementary manner. Urban vegetation reduces heat islands through shading and evapotranspiration. Shading restricts energy storage and heating of the local environment by limiting solar penetration. Plants convert water into water vapour through evaporation; energy is being used to drive the evaporation process rather than being transferred to the sensible heat that heats up the city. As a result, cooler air temperature is observed within well-vegetated areas. Therefore, fully vegetated pixels were expected to have a cooler surface temperature. (IV) There is also a remarkable and stronger cooling effect in terms of LST in the regions where the proportion of vegetation cover was between seventy and almost eighty percent per square kilometer. Better air flow and convection, which are lower in densely vegetated areas, might be the reason for this finding. Leuzinger et al. (2010) demonstrated that

trees responded differently to extremes in temperature. Results also demonstrated (V) that LST within urban vegetation was affected by the temperature of the surrounding urban area. A good example is the year 2003, when LST increased in comparison with the records of previous years as a result of the well-known heat wave in Europe. The results of this study demonstrate that LST of urban vegetation is related to the temperature of its urban surrounding. Therefore, dependency may differ according to the size, shape and location of the vegetated area. Finally, (VI) the coolest places were the areas far from the core of the urbanized region.

Conclusion

This study concluded that regional and local scale studies within the changing climate can improve our understanding of urban ecological challenges and facilitate appropriate adaptation to regional and global climate change. Therefore, this research could provide urban planners and landscapers with strategies to mitigate the UHI effects through the strategic placement of urban vegetation.

Keywords: Urban ecology: Urban green vegetation; Global climate change; Urban Heat Island (UHI); Land Surface Temperature (LST).