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Environmental effects of urban geometry changes on air temperature and outdoor thermal comfort in arid climate of Mashhad (Case study: Pachenar and Shahed)

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Received: September 10, 2017

Accepted: February 4, 2018

Expanded Abstract

Introduction

Decreasing environmental problems by reducing ambient air temperature can enhance human health as one of the most important concerns of today's professionals, which can be expressed by outdoor thermal comfort as one of the most important environmental indicators of urban open spaces. We often think of people living their life inside buildings and we may not see that in fact for one reason or another we spend much of our time outside—between the buildings. The spaces and places of these, and many other everyday activities, have a special social, cultural and even economic significance. In recent years natural disasters, such as the heat wave lead to mortality rate increased due to high air temperature, and research focus on providing thermal comfort as one of the most important issues for enhancing health and satisfaction of people from being in urban areas. Designers and planners ensure that people should live in comfortable places by means of environmental factors. Therefore, man-made and natural spaces in cities can provide comfortable environments. Moreover, urban geometry such as urban canyons and green spaces at pedestrian level is effective factors and there is limited attention in Iran. Evaluating thermal comfort of the locals may help architects and planners to deal with urban problems by identifying thermal comfort needs in indoor and outdoor environments, so that the intensity of temperatures is reduced in open spaces by using design elements. In Iran, thermal comfort issues in academic studies are more focused on indoor spaces, and in recent years, approaches to outdoor thermal comfort have increased. This study focuses on effects of urban geometry on outdoor thermal comfort in two urban areas PACHENAR and SHAHED tissue in Mashhad. The first part of the article examines researches carried out in the subject area of the paper, and then, in the next section, theoretical foundations of the articles, thesis and books have been extracted. Air temperature, wind speed, mean radiant temperature (MRT), and the physiologically equivalent temperature (PET) are simulated with ENVI-met and Rayman to highlight the strengths and weaknesses of the existing urban geometry in summer season.

Materials & Methods

The methodology is practical research based in two parts. First, the framework theory is extracted from researches such as papers, books and dissertation. The climatology data collected from weather station of Torogh which is located near Mashhad. After that Gis maps are used for neighborhood. In order to reach the PET values, the proposed method is applied to an urban canyon, which is simulated in terms of mean radiant temperature and PET, combining ENVI-met (<http://www.ENVI-met.com>) and Rayman. First, a simulation of the case study model is conducted in ENVI-met. Second, some of the key results and values from ENVI-met are imported into Rayman and other simulation runs.

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ENVI-met simulations

The three-dimensional micro climate model ENVI-met is designed to simulate the surface-plant-air interactions in urban environment. ENVI-met software is a useful tool for planners to analyze and predict the thermal comfort impacts of various factors. ENVI-met is a 3D model, which seeks to replicate the major atmospheric processes that affect the micro climate. This model simulates wind flows, radiation fluxes, temperature, humidity and other parameters, based on the fundamental laws of fluid dynamics and thermodynamics which is able to simulate the interactions between different urban surfaces, vegetation and the atmosphere. ENVI-met allows analyzing the effects of small scale changes in urban design on micro climate under different mesoscale conditions. A major shortcoming with ENVI-met is that buildings which are modeled as blocks whose width and length are multiples of grid cells and have no thermal mass. Input data required to initiate ENVI-met simulations are: Wind speed and direction at 10 m above ground level; Roughness length (Z_0); Initial temperature of atmosphere; Initial temperature and humidity of the soil; Specific humidity at 2500 m; Relative humidity at 2 m. The model calculation includes: Short-wave and long-wave radiation fluxes with respect to shading, reflection and re-radiation from building systems and the vegetation; Transpiration, evaporation and sensible heat flux from the vegetation into the air, including full simulation of all plant physical parameters. In this study, simulation was carried out in the summer (August) and based on the data of the meteorological station of Mashhad. This simulation was selected on August 28, 2017, during the sunrise and sunset times between 6 AM and 20 AM, which represents the hottest day in summer.

Rayman simulations and Assessing PET

The Rayman is produced by Matzarakis. This model has been developed in the Meteorological Institute of the University of Freiburg in Germany in 1998. This model is developed to simulate the short and long wave radiation flux densities from the three dimensional surroundings in simple and complex environments. RayMan is in fact a freely available radiation and human bioclimate model. The aim of the RayMan model is to calculate radiation flux densities, sunshine duration, and shadow spaces. The thermo-physiologically relevant assessment indices using only a limited number of meteorological and other input data. For such models to be applied in simple situations, the following atmospheric parameters are required: direct solar radiation, diffuse solar radiation, reflected short-wave radiation, atmospheric radiation (long-wave), long wave radiation from the solid surfaces. The following parameters describing the surroundings of the human body also have to be known to sky view factor, view factor of the different solid surfaces, albedo of the different solid surfaces, emissivity of the different solid surfaces.

Assessment of microclimate and thermal comfort outdoors

Due to the wide use of the PET index in different climate studies and the ease of expression of outdoor thermal comfort of individuals, in this paper, the PET index is calculated. Since these numbers are not localized in Iran, and in particular to Mashhad. The range of 23 is based on the Matzarakis and Mayer studies as a thermal comfort range. On the other hand, trees play an important role in this study. The simulation carried out in Envi-met has also been based on field observations of the density of these trees, which is called the LAI index (LAI). Dense trees with 10 m height (LAI= 4.73) and very dense trees with 15 m height (LAI= 9.35) were designed for simulating the vegetation. In addition, grass with 0.1 m height (LAI= 0.03) was also used.

Model calibration

In order to make the results of these models based on simulations more credible, the model had to be calibrated. The input values have to be changed slightly, so that the output values turn out to be a more accurate representation of reality. In order to do that the model was calibrated with on-site long-term measurements of air temperature (T_a), relative humidity (RH), wind speed (Ws) and direction (Wd) at two tissues as well as properties of ground surface materials. The general input data as a result of the calibration are shown in Table 1.

Discussion of Results & Conclusions

Simulation MRTs and wind on outdoor thermal comfort

PACHENAR has a compact urban geometry with an average height of 6 m. On the other hand, SHAHED with urban geometry of East-West and North-South street with widths of 4 to 20 m, and according to the regulation with occupancy level of 60%. Annual radiant temperature in summer is shown in the two case studies in summer and from 6:30 to 20:00 (Fig. 3). This chart shows that PACHENAR with a H/W ratio has a lower rate of MRTs at summer hours (11-14), while in SHAHED with a lower H/W ratio this rate has increased in these hours.

SHAHED showed an average distribution of MRTs between 40°C and 8.9°C and PACHENAR between -44°C and +8.8°C. In fact, Δ MRTs in the SHAHED were 31.1°C and in the PACHENAR is 35.3°C which indicates that the levels of radiation in this case.

Wind flow is one of the climatic parameters affecting outdoor thermal imbalance. Despite the difference between the height of buildings and the distance between buildings and pedestrian directions in the PACHENAR, the average wind speed does not change significantly in this area. This is especially true for high-H/W high passages with a very high enclosure, with no higher impact at 0.57 m/s, but in the new texture, due to the lower H/W rate, the effects of the wind have been somewhat affected by the impact, and as shown in Figure 4, less enclosure. Wind flow rate up to 2 m, there is also the effect of wind on the second new tissue and in the streets of closeness is less significant.

Calculated thermal comfort

The PET value was calculated for 14:00 hours. PET values compare between 2 tissues (Fig. 4). The simulation shows that PACHENAR is between 8:00 and 13:30 hours (the PET value is from 27 to 48°C) and has thermal stress. This value reach peak at 12:00 (48°C) and nearing sunset, heat stress reduced. SHAHED has less heat stress than PACHENAR, with value ranging from 9.30 to 13 (PET values from 25°C to 29°C). In general, considering the difference in mean of Δ PET values between 8.30 and 14:00 in PACHENAR tissue is 9.9 and in SHAHED value is equal to 0.05, which indicates high heat stress in this time. Comparison of thermal comfort was done separately and also according to the ratio of H/W.

The impact of urban geometry of PACHENAR with North-South orientation

Data analysis of North-South street receptors shows that average H/W rate is 1.5 (Fig. 5). The results of the simulation indicate that the heat stress level (maximum PET values at 10.30 at 42.6°C) in the North-South orientation in PACHENAR compared to the other receptor with a higher H/W= 2. Thus, increasing the ratio of height to width and shading, enhance outdoor thermal comfort.

The impact of urban geometry of SHAHED with North-South orientation

Data analysis of North-South street receptors shows that H/W ratio is same, the western part of street due to the orientation of the sun light (western side) with PET index 37.5°C has a lower thermal comfort compared to the other direction (eastern side) with a maximum PET index of 42.3°C, in which the thermal stress is near to the PACHENAR, and therefore the thermal comfort in the western side of the sunshine is less than other side.

The impact of urban geometry of PACHENAR with East-West orientation

Data analysis of East-West street receptor shows that H/W= 1.5 rate has a heat stress rate with a maximum PET index at 12.30 at 48.5°C, which is comparable with other receptors with rate of H/W= 3 (Fig. 6). Moreover, increasing H/W rate and shading, boost outdoor thermal comfort.

The impact of urban geometry of SHAHED with East-West orientation

Data analysis of East-West street receptors shows that H/W ratio is same (height ratio to 1.87), but the northern side exposure to the sun with a maximum PET index of 42.7°C has a lower thermal comfort than the southern side with a maximum PET index of 41.3°C (although this difference is negligible; Fig. 6). Despite high H/W rate in PACHENAR, vegetation and buildings materials road surfaces cover is important in enhancing outdoor thermal comfort. Wind flowing effect thermal loss, in addition shading can enhance thermal comfort. There is a need for suitable vegetation to provide outdoor thermal comfort.

Discussion of Results & Conclusions

This study investigated the relationship between urban geometry, urban microclimate, and outdoor comfort in two different built-up areas, with different urban geometry, in the city of Mashhad, during the warm season. The study illustrated that PET index has inverse change with the rate of H/W and urban geometry play an important role on outdoor thermal comfort. Simulations carried out in PACHENAR shows that the higher H/W rate lead to boost PET index and pedestrians thermal comfort. The study shows that in SHAHED, increasing H/W rate, lead to enhance outdoor thermal comfort and the PET values. The reduction of PET may reach 15°C. These results are matched to Emmanuel et al. (2007), Yang et al. (2015), Saud Alznafer (2014) and Rodríguez Algeciras et al. (2016). The study depicts that PET index is not affected by the street orientation to a significant extend and it depends on shading. Moreover, street canyons and their orientation in PACHENAR are not suitable for flowing wind and its effect is negligible in this case. However, in SHAHED shallow street canyons reason to flowing

wind. An analysis of the distribution of MRT in areas showed that high rise buildings in SHAHED had the highest frequency of high MRTs than low rise buildings in PACHENAR. Green areas and trees are another parameter that has an effect on outdoor thermal comfort. Due to the narrow and deep valleys in PACHENAR, there was no green spaces and trees, while in the SHAHED, vast range of trees with different umbrellas was simulated. The study illustrates green spaces have reduced air temperature. According to the software reviews and outputs, the physiological equivalent thermo-physiological index of PET in SHAHED is higher in the thermal comfort range. Findings show that urban geometry such as the H/W ratio, vegetation reduced thermal stress. These results are matched to Ali-Toudert, Mayer (2006) and Abreu-Harbich, Labaki et al. (2014) studies.

Keywords: Envi-met, outdoor thermal comfort, PET index, Rayman, urban geometry. .

Evaluation of factors affecting mean radiant temperature in a public apace (Case study: Shanbedi passage way in Bushehr)

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Received: May 9, 2017

Accepted: February 4, 2018

Expanded Abstract

Introduction

Rapid urban growth and expansion caused reduction in the level of thermal comfort in urban open spaces. Reducing the use of air-condition systems in buildings is one of the positive interventions for protecting the environment in the cities in order to create suitable thermal conditions in the interior space. There is a direct relationship between thermal parameters of interior spaces and the outside ambient temperature. Creation of peoper outdoor condition for buildings and public spaces in city is the first and foremost action in order to control and optimize the thermal behavior of buildings. In a hot climate, creation of enclosure in urban open space leads to create more shadow and decrease radiant temperature which results in improvement of comfort condition and reduction of building energy use for cooling and saving energy consumption. Today, outdoor design should be put in our urban planning for improvement of environmental conditions.

Using appropriate enclosure in urban open spaces especially in hot and humid cities, one can improve the microclimate condition. Todays, morphological changes, plants and landscape reduction, air pollution and inappropriate construction lead to disturb the environment and increase temperature. Historic fabric is a good source for harmonizing urban planning with the climate. The meteorological parameters such as temperature, humidity, wind speed and radiant temperature have significant role in thermal comfort.

Thermal comfort is a necessary factor that should be considered in every stages of urban design process. One of the main issues in the assessment of the human comfort in outdoor spaces (especially in sunny outdoor conditions) is the amount of mean radiant temperature which is the sum total of short-wave and long-wave of absorbed radiation flows by the human body. The mean radiant temperature assessment is more sensitive because radiation is one of the meteorological factors which has a huge effect on human thermal comfort. The Mean Radiant Temperature is used as a benchmark more than the air temperature or the temperature for analysis of the impact of weather on the comfort of people. In the past, mean radiant temperature of historic fabric was balanced with creation of shades and it can be seen in several design and construction strategies like high walls, narrow passage ways, planting trees and awnings on façade and its glaring area. The mean radiant temperature is influenced by climatic parameters such as temperature, humidity, radiant temperature, wind, orientation and space enclosure.

The aim of this study is to evaluate the effect of urban fabric and physical design on the mean radiant temperature to control level of thermal comfort for inhabitants. Focus on the mean radiant temperature is essential for pedestrian and urban open spaces design. Bushehr is a coastal city in the south-west of Iran (Latitude: 28°55 N, Longitude 50°55 E) which has a hot and humid climate. Providing of thermal comfort is essential for people's presence in outdoor spaces in the city especially in the warm seasons. In cities, promoting use of streets and open spaces by pedestrians has physical, environmental, economic and social benefits. Thus, ensuring people's comfort in open spaces is essential for improving the quality of urban life. In a complex urban environment, the radiation is considerably different in open spaces because of buildings and vegetation shading and due to various surface materials.

Shadow creation and conducting wind flow into open spaces are very important for Bushehr to improve comfort. Shanbadi district is in the eastern part of historic fabric of Bushehr. In historic fabric of Bushehr using enclosure,

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orientation of passages and buildings and use of appropriate materials, thermal stress was reduced through ventilation and shading. Also, high density of physical environment has influenced the thermal comfort. Street enclosure has been created by varying the width of street and height of the buildings. The historic fabric of Bushehr is located in the northeast part of Bushehr and has a triangular shape which is surrounded by sea on three sides (East, West and North) and one connection side (south) to the mainland and it is composed of four districts. Historic fabric of Bushehr is known as Charmahal consists of four districts: Dehdashti, Shanbadi, Kuti and Behbahani. Considered Shanbadi passage way has north-west south-east direction. There are valuable historic buildings in this district. Old bazaar of Bushehr is in this district and some part of that has been reconstructed and regenerated. In present research 7 sections with different enclosure rate have been studied. Shanbadi is one of the 4 historic districts in Bushehr and have lots of climatic design strategies which create harmony of urban fabric and local climate. Some passages leading to this area are input and output of the wind in different hours.

Materials & Methods

In this study, meteorological data are obtained through field study in three seasons (summer, fall and winter) and in four period of time. In this research, summer study is analyzed. The site is in Shanbedi district, one of the four old district in Bushehr. Seven sections with different enclosure were chosen in study area and climate data is surveyed during the day separately in each of these sections. RAY man 1.2 software was used for calculating the mean radiant temperature. RAY man 1.2 software is a tool for calculating the mean radiant temperature and heat index such as PET, PMV and SET in urban studies. Mean radiant temperature calculation in RAY man software requires some information such as geographic location (latitude, altitude and time difference with Greenwich), the time of study data (date and time of study), characteristics of meteorological data (air temperature, humidity, cloud cover, wind speed and vapor pressure), surrounding surface reflection, scattered radiation ratio, the Bowen ratio and the global radiation. Air temperature and relative humidity for calculation of the mean radiant temperature were determined by WBGT device every 30 seconds and the amount of air flow by ANOMETR 3880 every 5 minutes. Both devices were set at a height of 1.7 m above the ground.

Results and Conclusions

The result indicates that in the area surveyed 10 to 12 o'clock enclosure has the most effect on the mean radiant temperature. In many hours of the days, wind has the most influence on the mean radiant temperature. There is a direct relationship between wind speed and enclosure. At 8 to 10 and 10 to 12 o'clock there is a relatively strong relationship between wind speed and enclosure, but in the period of 12 to 14 o'clock and 14 to 16 o'clock, the impact of the wind speed on enclosure is reduced until it loose its effect. In this section one of the influential factor increasing wind speed is multiple passages lead to this section that guide the wind to this area. In different hours of a day, we can see change in mean radiant temperature due to change of wind speed changes. Another influential factor, especially in the middle of the days, is the solar radiation when it is vertical and other factors have more influence than enclosure on the mean radiant temperature. For this time of the days awning and canopy in street is advised to decrease the amount of mean radiant temperature. Generally, in the most hours of the days wind has the greatest impact on improvement in the mean radiant temperature in this area.

To improve thermal comfort and decrease mean radiant temperature, especially in the middle of the day, shade should be created in the pedestrian path areas, sidewalks and public spaces. It can be made through artificial shading elements, locating trees which provide shadow or projections in building. Smart shading devices can be used to respond to need of radiation and shading in different time of the day and different seasons. These shading devices are capable of opening and closing automatically. Other green design parameters such as photovoltaic cells and water facilities to store water can also added to this devices. It can be a good design alternative for maintaining of thermal comfort in urban open public spaces in Bushehr.

In addition, creation of space with enclosure degree (ratio of height to width) of 1.73 makes it possible to create a favorable space. Enclosure can be created through use of the large tree canopy with radius more than 2 m in streets which the width is more than its height. Awing projection should be at least half of the height of the openings to create thermal comfort and reduce mean radiant temperature.

In a complex urban environment, the radiation flow is considerably different in open spaces due to casting shadows by buildings and vegetation and various surface materials. So, change in mean radiant temperature can make considerable spatial sensation changes even in a short distance.

The amount of shading can be optimized by using different shading strategies even in low enclosure rate of section. This can be obtain naturally using tall trees with big green mass and artificially by building projection and in site shades. Light color low reflection materials can absorb less heat and decrease amount of heat gain spatially in open spaces.

Keywords: Mean Radiant Temperature, RAYman software, Shanbedi passage way, space enclosure.

Resolving conflict on the trade-off curve generated by a multi-purpose sustainability model for the natural environment and farming under water bankruptcy

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Received: July 9, 2017

Accepted: February 4, 2018

Extended Abstract

Introduction

The contradiction between increased demand for water and decreased water availability has led to excessive exploitation of water resources and, in some cases, encroachment on the share of water needed to preserve the natural environment. Today, managing water resources and finding optimum strategies for water allocation has attracted the attention of policy makers. Water scarcity, especially in arid and semi-arid areas, makes the situation dire and challenging for water allocation. Such physical restrictions cause competition for water among irrigation and drainage networks and the ecosystem. In order to achieve optimum sustainable strategies for allocation of water between multiple stakeholders, a set of conflicting (negatively or weakly correlated) and incommensurable objective functions should be addressed.

To reach optimum crop area and water allocation schemes, one can optimize the amount of water allocated to the plant by considering the crop response to water deficit. Thus, the cultivation of susceptible and resistant plants could be planned with full and deficit irrigation, respectively, under obtained optimum acreages. On the other hand, the incorporation of crop-water production function into the linear objective function for maximizing agricultural net benefit would transform it to a non-linear objective function. Therefore, the problem would become more complicated.

Regarding practical problems, the optimization of the ratios of variables and parameters would provide a deeper understanding for managers and decision makers than optimizing each of them in the form of a separate objective function. Thus, such formulation can be considered as a tool to assess the sustainability of agricultural ecosystems. Combining the objectives by taking advantage of ratios would facilitate the process of analysis of alternative solutions. One of the issues in dealing with multi-objective optimization problems is the choice of a solution from a usually large set of non-inferior alternative points that make up the optimal tradeoff (Pareto) curve. One can take advantage of social selection methods to resolve conflicts between the objectives of different stakeholders by identifying the best settlement solutions from among an optimal set of non-inferior alternative solutions.

The aim of the current study is to develop a non-linear multi-objective optimization model for water allocation which takes into account crop-water production function, reservoir continuity, and surface water balance. The developed multi-purpose framework is based on four sustainability indicators, two fractional functions and two simple functions.

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Materials & Methods

Study area

The Dorudzan reservoir-river system is situated in the northern part of Fars Province, Iran. The system is fed by the Kor River. The Kor River supplies the water needs for Dorudzan and Korbali irrigation and drainage networks; at the end of its path, it discharges into the Bakhtegan Lake. The Dorudzan irrigation network comprises a main channel and three main irrigation channels that include a primary right channel (Ordibehešt), secondary right channel (Hamoon), and primary left channel.

The construction of upstream dams has remarkably decreased water input into the Bakhtegan Lake and mostly limited it to floods in the region. The drying of this lake has led to the spread of saline areas and occurrence of salt storms.

Water bankruptcy

The two main components of a bankruptcy situation are the amount of resources available and the claimed amounts of the stakeholders. In most water allocation cases, the first component can be easily equated with the amount of water available for distribution between users at a specific time and place.

The proportional cutback rule is one of the long-established principles for bankruptcy situations. It is widely employed to manage water resources under water scarcity in different parts of the world, including allocation of qanat water in Iran. According to the proportional cutback rule, allocated water to each water claimant is according to a proportion of its claimed volume of water. This proportion is defined as the ratio of total available water to total water demands of water claimants.

Deficit irrigation

Deficit irrigation is an optimization policy in which plants are subjected to different levels of water shortages. In each condition, the desirable level of water shortage and the resultant crop yield are determined through an optimization process on the basis of crop-water production function. This function describes the relationship between the gained crop yield and the total amount of water consumed by the plant through evapotranspiration.

Social choice approaches

Social decision-making methods are procedures that take into account all individual preferences in order to reach a social preference. In the current study, social choice rules such as the plurality, Borda count, median voting, majoritarian compromise, pairwise comparison, and Condorcet choice have been employed to choose a compromise point among a set of non-inferior alternative solutions.

Proposed sustainability model for farming and the ecosystem

In this research, we developed an optimization model for multi-purpose agricultural and environmental sustainability. The main goal of the proposed model was to address the optimal allocation of water between farming and the ecosystem in the Dorudzan reservoir-river system. The developed model consists of four objective functions, two fractional functions and two simple functions.

The first objective is the maximum ratio of net income– in terms of deficit irrigation– to blue water utilization. In order to optimize the virtual water content in agricultural products, one can divide the crop water requirement into two parts, green and blue water, and attempt to improve the water use efficiency of irrigation water.

The second objective is the maximum ratio of total crop yields to total blue water utilization or, in other words, the minimum total blue virtual water content.

The third objective is the maximum fairness in water allocation or minimum total difference between the amount of allocated water to each irrigation district and the water share, which is determined by the bankruptcy, proportional cutback, rule.

The fourth objective is the minimum shortage in meeting the water demand of the Bakhtegan Lake ecosystem.

The main constraints of the proposed model are reservoir continuity, surface water balance at the downstream of the dam, crops' acreages, and water consumption in each irrigation district.

Discussion of Results

We computed the average values of the 12-month standardized runoff index (SRI) for the 7-year periods (33 periods) from 1976-2015. According to the outcomes, the period of 2007 to 2014 water years, with an annual average SRI value of -1.25 was selected as a period of water bankruptcy for implementation of a proposed simulation-optimization model for multipurpose sustainability of the Dorudzan reservoir-river system.

By solving the developed model using the Non-dominated Sorting Genetic Algorithm II (NSGA-II), we generated an optimal trade-off set that contained 637 management alternatives. Each generated alternative offered different values for the objective functions of the model.

There was no socially optimal management option based on the median voting and majoritarian compromise rules. This output revealed that none of the generated efficient management alternatives could obtain the approval of the majority of stakeholders, not only at first ranking level, but at all possible ranking levels (637 levels). Moreover, the compromise set derived by the Condorcet rule was an empty set. The latter output indicated that there was no management option in the generated optimal trade-off set, which agreed upon by all stakeholders through the pairwise comparison procedure.

The output of the plurality rule was a compromise set with four members given the fact that the voting took place between the four aspects of sustainability. Therefore, each of the four identified options by the plurality rule was the most desirable option based on one of the four aspects of sustainability in the system under consideration.

Among applied social choice techniques, only the Borda count and pairwise comparison approaches were able to identify a compromise set with a single member, Management Option No. 87, which could be recognized as the socially-optimal conflict-resolving alternative for the problem under investigation.

According to the conflict-resolving management alternative, the 7-year (the bankruptcy period) average of the cultivation areas allocated to wheat, barley and canola would be 16%, 24%, and 41%, respectively. This management option would supply 46% of the water demand of Bakhtegan Lake. In terms of relative satisfaction, this alternative has the second rank based on three sustainability indicators of the blue water productivity, allocating water for preserving the natural environment, and fair distribution of water among identified socially-optimal management options.

Conclusion

Given the nonlinear and multi-objective nature of the problem under investigation, the output of the developed model was an optimal set of non-inferior solutions that form the trade-off curve between four aspects of sustainability (objective functions) in the Dorudzan reservoir-river system. The current study also attempted to find a compromise solution among generated non-inferior alternative solutions by using social choice rules. Results of the proposed methodology provided valuable information on efficient water governance strategies and how to achieve multi-purpose agricultural and environmental sustainability in the study region.

Keywords: equity, fractional programming, multi-objective optimization, social choice rules, water allocation..

Formulation of ecological design and regulating strategies for urban rivers with reference to run-off water control (Case Study: Ziyarat River, Gorgan city)

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Received: July 4, 2017

Accepted: February 4, 2018

Expanded Abstract

Introduction

Urbanization has made fundamental changes on the earth, air, energy resources and urban population that have had immense ecological consequences for urban habitats, including urban rivers. Rivers are the vital elements in the supportive network of urban environment; and urban rivers can be considered with special ecological value which is gradually increasing in urban landscape. Excessive exploitation of natural resources than the environment capacity generates waste out puts that have gradually disrupted life and biodiversity in urban areas. Natural corridors are seen as the components of the landscape structure in landscape ecology and rivers are considered as one of the most important natural corridors in landscape structure. According to Forman and Godron theories, the rivers corridors are classified to three parts such as the channel river bank, floodplain and hill slope.

Ecologists believe that ecosystem services provided through green infrastructure, can present healthy environment and physical and mental health for residents, a healthy environment can improve social and economic benefits and has an important role in various cities of the world. For instance, a landscape which had been neglected in River Mother (in Qian'an City, Hebei Province, China) was rehabilitated and designed based on landscape ecology approaches and users are considered at all stages of the process. Ecological solutions then were presented for rehabilitation and improvement of water quality including municipal wastewater management system to separate urban waste water and surface water, the strategy of flexible and green river, conversation of river natural ecosystem, using native vegetation and reducing maintenance costs, and eventually creating greenway with sidewalks and cycling line.

Materials & Methods

The area under study in this research is Gorgan city in region the western part of Golestan province. The city is located in the range of latitude and longitude (36.83° North 54.48° East) on the northern slopes of Alborz mountain. This region is structurally composed of three zones including, plain, piedmont and mountainous region. The city is built in the piedmont region. The most striking landscape structural elements in Gorgan are Alborz Mountains and rainforest located in the southern region of the city.

To perform this study, first, the library data are collected, analyzed and addressed to formulate the principles and framework. The source of the articles reviewed and information was the journals indexed in of ELSEVIER and SPRINGER databases. After review of the literature and analysis and evaluation of the area the method that was used in this thesis is formed by combining several methods based on ecological landscape planning and design. This research has been studied in three scales, the large (studying the river from Ziarat to Gharehsou basin), medium (inside the Gorgan city) and micro scale (the area developing in the southeast of the area between

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This paper presents part of the findings of Niusha Habibi Ardebili Master Thesis under title: *Ecological landscape design of urban rivers with emphasis on run-off water control, case study Ziarat River-Gorgan city* under supervision of professor M. R. Masnavi, and advising by Associate Professor B. Malek Mohammadi, Graduate Faculty of Environment University of Tehran, Iran.

Ghaleh Hassan and Seyed Masood Bridge). Accordingly among the proposed by ideas Mac Harg and Ying, theories were selected and their methods are applied for the analysis of the river structure in basin on urban scale. Finally, the strategy was developed in the context of ecological landscape design in urban rivers and design solutions were provided for micro-scale (urban area). The stages of this study are summarized as following:

1. Analyzing Ziarat River at large scale based on Mac Harg model
2. Mapping the topography and geographical location of Ziarat River basin and deriving the layers by GIS software
3. Identifying landscape structural elements in Gorgan city according to Ying model (middle scale and the whole city)
4. Land use mapping and extracting appropriate layers (ecological, hydrological and topographical, urban construction, human activity)
5. Synthesis mapping of overlaying layers in large-scale (river morphology and flooding)
6. Synthesis mapping of overlaying layers in urban scale (possibilities and limitations)
7. Strategies and actions in the ecological design landscape in Gorgan
8. Ideas and solutions (ecological rehabilitation of the river landscape with sustainable urban drainage systems and floodplains management in the urban environment).

First, by overlapping the layers the knowledge about Ziarat River was obtained at large-scale. Ziarat River is located among steep rivers that can be divided into four zones in terms of organization and preservation project. In this map four important zones (catchment (1), Naharkhoran (2), urban area (3) and agriculture (4)) were identified and characterized based on overlaying layers in large-scale and middle-scale (urban), then field investigation for checking the status are presented in a table of regulating strategies, policies and ideas for the ecological landscape design of an Ziarat urban river management, flood control and needs of users in those four zones.

Results, Discussion & Conclusions

The world's increased population followed by urbanization and rapid urban development has led to imbalanced presence of nature in cities which has led to serious environmental problems including the disruption of the ecological structure of rivers and increased surface runoff and flood in the city. This has attracted the attention of planners and designers to find solutions and approaches to improve situation. Among these design approaches the urban landscape ecological infrastructures such as urban rivers is among the approaches considered by ecologists, planners and urban designers studies conducted in this study suggest that based on the purposes of river management and flood control of Ziarat River in Gorgan, it is necessary to analyze them based on two scales of Ziarat River catchment (mountains in which the river originates and heads Gharehsou River) and urban scale (Seyed Masood Bridge to the beginning of the agricultural downstream lands) in which Mac Harg (large scale) and Ying (urban scale) methods are used.

The results show that based on Mac Harg and Ying methods at large and middle scales the following cases should be considered:

- Establishing integrity in ecological infrastructure (green) through the integration of the riverside vegetation and upstream forests, creating integrity in hydrologic infrastructure (water) through the integration of the urban and river drainage channels and finally overlaying two green and hydrologic infrastructures to control surface runoff and flood in urban area and river.
- As a result, the initial strategies and initiatives were developed in four areas based on which strategies for planning and environmental design were presented at the micro scale. According to micro-scale studies developing area in the southeast of the region between Ghaleh Hassan and Seyed Masood Bridge, it was found that the river is too narrow in Ghaleh Hassan and is not capable of retaining the flow of five years, therefore, to reduce the damage caused by floods when it rains and there is severe flood, a diversion track is built where the Ziarat and Alangdaerh rivers meet.
- To control the runoff from rainfall due to the slope of the area, four sites are designed to create the retention ponds and storm water treatment to prevent surface runoff flowing into the city. Also, the bioswale is considered to maintain and increase water permeability and lead it to the detour and the city in areas where the slope decreases and water accumulation is likely to happen. Such strategy and framework can help to control surface runoff, rehabilitate river and restore these corridors to their natural structure.

Keywords: ecological landscape design, flood control, urban rivers.

Erosion and accretion monitoring in mangrove forests using remote sensing and Digital Shoreline Analysis System (DSAS) (Case study: Hara Biosphere reserve)

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Received: January 16, 2017

Accepted: February 4, 2018

Expanded Abstract

Introduction

Loss of a wide range of goods and services provided by ecosystems as well as unsustainability of mangrove-dependent human communities are direct results of the destruction and loss of mangrove ecosystems. This shows the importance of effective planning and management strategies for conservation and restoration of mangrove ecosystems. One way to achieve the above objective is to assess mangrove shoreline changes over time, which can be used as one of the best indicators to assess responsiveness of mangroves to sediment morphological and dynamic changes of coastal areas and to assess the vulnerability of these ecosystems to climatic stresses. This shows the importance of assessing the rate of progression and regression and/or erosion and sedimentation to assist the planning and implementing the conservation actions and restoration of mangrove forests of the country. Therefore, the aim of this study is to monitor mangrove's shorelines changes for a period of 30 years in Hara biosphere reserve in Hormozgan province, Iran.

Materials & Methods

Study area

Hara Biosphere Reserve with 85686 hectares areas is located in the south of Iran in the Straits of Khuran between Qeshm Island and the Persian Gulf. The study area lies at 26° 45' to 26°58'N, 55° 30' to 55°50'E situated in the Mehran River delta. It hosts the largest *Avicennia* mangrove along the Persian Gulf shoreline and, represents a centre of biodiversity in Iran. The Strait of Khuran is also a Ramsar site, providing habitat to two globally threatened species: a wintering habitat for the pelican *Pelecanus crispus*, and a regular feeding place for the green turtle *Chelonia mydas*. For ecological reasons such as wetland environment, mangrove forests and biodiversity, this region has attracted many visitors and can be considered as the most spectacular regions of Iran for a unique coastal Seascape.

Processing of satellite images and ground truth and social survey

The landsat images of the years 1986, 2000 and 2016 were used to analyse the rate of progression and regression of mangrove forests of Khamir site during a period of 30 years. Since cloud cover reduces the image quality and causes error in detecting phenomena of the images, by examining a large number of images in the archive of landsat satellite, images without cloud cover were used. Also, to determine the exact boundaries of the Mangrove forests, those images in which the sea level was at low tide, were used in this study. Geometric correction was the first step for image analysis. Although landsat C images are characterized by good geometric precision, in order to achieve maximum possible accuracy, and recorded a total of 128 ground control points using GPS that has a good distribution of the surface area, were also detected in the image. Landsat C images of 2014 with a root mean square error lower than one pixel (in this study, RMS= 0.143) were georeferenced with the use of

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IDRISI software, as well as by recording totally 128 ground control points with a good distribution over the region. Finally, the corrected images of landsat C were used for geometric correction of landsat TM images in 1986, 1998 and also the image of landsat MSS in 1973. RMS value of no one of the landsat TM and MSS images in any of corrections was higher than 0.18. All images were geo-referenced to UTMWGS-1984 zone 40N projection and datum.

In general, according to the resolution of the images used, the closed-canopy edge of the boundary of the Mangrove forests was considered as off-shore (marine) boundary and single trees and seedlings in the area beyond the edge were excluded from the analysis of site boundaries. In order to separate mangroves from surrounded water and land in coastal areas and to draw the final borders of the sites, NDVI vegetation index was used. After preparing NDVI and to achieve maximum accuracy in determining the boundaries of mangroves, the off-shore (marine) border of Mangroves was manually digitized using precise visual interpretation on a scale of 1: 10,000 and by help of expertise of the team leading the project. The off-shore border of the mangrove sites were identified in images of 1973, 1986, 1998 and 2014. Finally, the accuracy of digitalized boundaries were evaluated and approved by putting them on landsat images. Ground validation was performed in 2012, 2013 and 2016. Accordingly, a total number of 620 ground control points determining the off-shore boundaries of Mangrove sites were entered into the GIS and then were compared to boundaries extracted from the images. Also, the location of villages and human settlements in the vicinity of Mangroves was recorded. All recorded points were entered into ArcGIS 10 software for analysis. Also, social surveys were conducted by performing face to face interviews with families living in villages adjacent to mangroves and experts from the Department of Natural Resources of the province. Given that the purpose of the interview was to achieve the respondent views on how the position and size of Mangroves have been changed over time, so those people were interviewed who have the highest history of residence (residence time more than 30 years) in the area. Accordingly, 25 people aged from 50 to 65 years were interviewed face to face. Views recorded were used to analyse the results.

Calculating the change rate of mangrove boundaries using DSAS

As stated above, determining the progression and regression rate of mangroves is based on measuring changes of mangrove boundary position relative to a baseline over time, and transects depicted perpendicular to baselines show these changes over time. In this study, for the selected sites, a number of 1684 transects with a distance of 30 m from each other, were drawn using DSAS software. In this study, by considering the general direction of each site, and also using the mapped buffer for Mangrove boundaries in images of 1998, applied baseline were drawn manually and transects were drawn perpendicular to the baseline. Overall, calculation of the rate of erosion and sedimentation, or the progression and regression can be done using various statistical methods including end point rate (EPR), average of rates (AOR), minimum description length (MDL), by jackknifing (JK), linear regression rate (LRR), reweighted weighted least squares (WLS) least absolute deviation (LAD) and weighted least absolute deviation (WLAD). Among these methods, LRR statistical method has had the highest usage because of assessing changes in coastlines and border of ecosystems at different times (more than 2 periods). In this method, the average rates of progression and regression of mangroves are estimated using the position of mangroves' border-lines and the baseline and fitting the regression line of least squares relative to the position of the border-lines.

Results & Discussion

The results of the analysis of mangroves' boundaries changes showed that calculated LRR values vary in different regions. Within these changes, positive values of LRR for drawn transects indicate progression of mangroves' borders towards the sea (sedimentation) and negative values represent the regression of mangroves' boundaries (erosion) or the landward migration. Analysis of changes rate of progression and regression showed that of 1684 drawn transects for analyzing the rate change of mangrove boundaries in coastal part of habitat. A number of 875 transects had negative LRR values and 809 transects represented positive LRR values. The highest number of transects with negative IRR values occurred in the western part of the habitat (Khamir site; 53% of the negative transects) so that the mean change rate of mangroves' boundaries at these sites was equal to 0.26 myr^{-1} . In an eastward move and by approaching to the Kal river estuary, Mardo habitat which was located in Mardo Island, showed an average rate of boundaries changes 0.74 myr^{-1} or progression towards the sea. Based on these results, the average value of boundaries changes in the coastal part of habitat was equal to 0.50 myr^{-1} . According to obtained results, from 2571 drawn transects for analysing the rate change of mangroves' boundaries in Island part of habitat, a number of 1734 transects (67% of the negative transects) had negative LRR values and 837 transects represented positive LRR values. The average value of boundaries changes in the Island part of habitat was equal to 0.73 myr^{-1} . This shows progression or sedimentation in mangroves. The results also showed that the minimum and maximum value of LRR was equal to -12.77 myr^{-1} and 12.98 myr^{-1} , respectively (Fig. 1). The obtained results showed that the progression or sedimentation rate in the island part of

Hara biosphere was more than coastal part of this habitat. As well, the average value of mangroves' boundaries changes for Hara biosphere reserve was equal to 0.62 myr^{-1} which indicates the dominance of sedimentation process over erosion in this habitat.

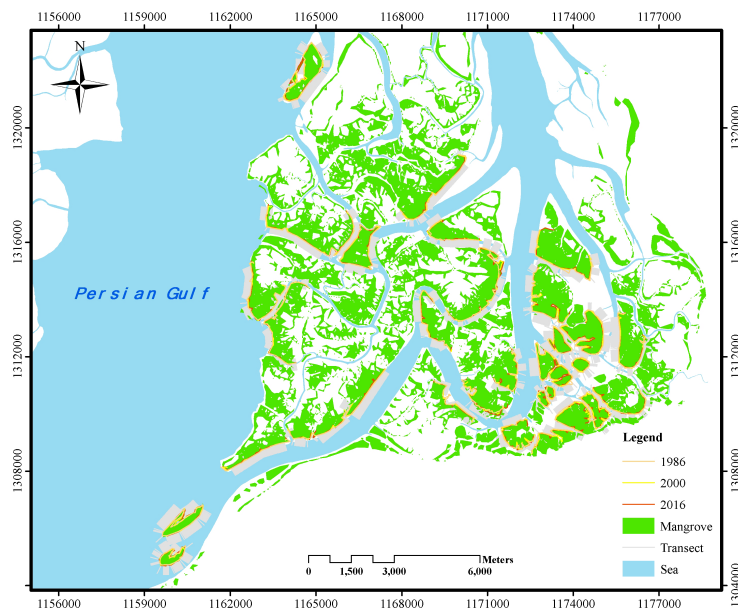


Fig. 1. Mangrove shoreline changes in Island part of Hara biosphere reserve

Conclusion

In this study, the spatial changes of mangroves' boundaries in the Hara biosphere reserve were monitored over a period of 30 years. The results showed that the mangrove forests in the study area are characterized by different rates of progression and regression in their distribution ranges according to the dynamic conditions of the coastal area. According to the results, the average rate of erosion or regression in the studied mangrove forests is -0.62 myr^{-1} . These results are comparable with results of other studies conducted in Mangroves' regions of the world. A study conducted by Ellison and Zouh (2012) on Mangrove forests of Douala Estuary in Cameroon showed that in a 32-year period (1975-2007), mangroves in the region are characterized by an average regression rate of -3 myr^{-1} . Gilman et al. (2007) estimated the average erosion rate for mangroves of American Samoa as -1.11 myr^{-1} for a period of 40 years (1961-2001). In a study carried out by Tran Thi et al. (2014), the average regression rate of Mangrove forests of Mui Ca Mau, Vietnam was estimated -3.24 myr^{-1} during a 51 year period (1953-2011). These results indicate the lower regression or erosion rate of mangrove forests in Hara biosphere reserve compared to mangroves studied around the world. Finally, it can be said that the results of this study can significantly help implementation of conservation and restoration measures by providing detailed information on the progression or regression of mangroves in Iran. In addition, the results of this study showed that the spatial analysis of mangroves' boundaries using satellite images and GIS can be a useful tool for monitoring and identification of the most vulnerable and erodible sites.

Keywords: erosion and accretion, landsat, Mangroves boundaries changes.

Investigating the effects of climate change under different scenarios on groundwater in Kerman Plain

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Received: August 11, 2017

Accepted: February 4, 2018

Expanded Abstract

Introduction

Changes in air temperature and rainfall have a significant effect on water resources and hydrologic variables. Climate change and temperature increase, especially in arid and semi-arid regions, will have more severe effects on water resources. One of the most reliable tools for studying the effects of climate change is the use of climatic variables simulated by exponential microscale models such as LARS-WG, which can predict the climatic parameters on a local scale. On the other hand, due to precipitation decrease in arid and semi-arid regions, excess pumping of groundwater aquifers is commonly. Excessive utilization of water resources has led to over-exploitation of aquifer capacity, which has caused irreparable damage to water resources. Therefore, the management of groundwater should be a principle in the country's planning. On the other hand, our country is geographically located in a region that is naturally and inherently part of the arid and hyper-arid regions (about 66%), but also among the countries with a higher coefficient of climate changes than many other regions of the globe the Earth. Increasing the air temperature along with increasing the use of water for irrigation, drinking and sanitation, and water consumption of livestock and poultry, on the other hand, due to climate change, it is considered as one of the most important parameters in feeding groundwater resources. In the discussion of the effects of climate change on water resources, summary of the research background indicates that it is important to research on the effects of climate change on groundwater resources, especially in arid areas, due to the fragile ecosystem. On the other hand, according to the research of Ministry of Energy, Kerman plain is due to excessive overuse of groundwater resources over the last few years, except for forbidden plains. Therefore, research on the effect of different climate scenarios on groundwater level in the future period of Kerman plain for managers' awareness and planning to reduce its negative effects seems necessary.

Materials & Methods

Kerman Plain located in Kerman province is part of the watershed of Dranjir desert which is part of the central watershed of Iran. This area is located almost in the southwest of the Loot plain. The plain is 2030 km². Kerman plain is located between 56° 20' and 56° 57', 20' and 50' East, 30° 0', 23' until 30° 27' and 5' North. In the first stage, the data needed to study the phenomenon of climate change including daily temperature (minimum, average, maximum) and daily precipitation from 1971 to 2012 were collected from the synoptic station of Kerman. The first version of the LARS-WG in Budapest in 1990 was developed as a tool for exponential microscale by the statistical method in Hungary. The three main parts of this model are: calibration of the model, evaluation of the model and the production of meteorological data. The production of LARS-WG data is done in three phases: calibration, evaluation and creation of meteorological data (Babaian et al., 2009). In this research, GMS software and Modflow code are used. The software that incorporates the Modflow model, with a variety of features added to it, has the ability to build and analyze the model with more modflow software. In order to evaluate the status of groundwater resources from October 2002 to September 2030, four scenarios

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were considered and the level of stagnation was compared to the initial conditions for 2003, 2013 and 2030 compared to 2002.

Scenario 1. Continue the current harvest of aquifers in the future based on constant and climate change utilization in order to evaluate the aquifer management in the current situation and to answer this fundamental question, what will be the rate of change in the aquifer decline over the course of the current period, without changing the climate.

Scenario 2. Continuation of the current trend in the future based on current utilization and climatic conditions of scenario B1, A2 and A1B in this scenario, it is assumed that monolithic exploitation of underground water is carried out. But climatic conditions change according to scenario B1, A2 and A1B.

Scenario 3. Continuation of the current trend with 10% increase in groundwater exploitation and climatic conditions scenario B1, A2 and A1B.

Scenario 4. Continuation of the current trend with a 20% increase in groundwater exploitation and climatic conditions scenario B1, A2 and A1B.

Discussion of Results

Initially, climate change was simulated using the LARS-WG model. After calibrating and verifying the LARS-WG model, the daily temperature and precipitation time series in the period 2030-2011 directly using the simulation of the HADCM3 model in the LARS-WG model under the propagation scenario (A2, B1 and A1B). The synoptic station of Kerman was produced and its changes compared to the base period are shown.

Conclusions

The results of the LARS-WG model during the statistical period (2011-2030) indicate an increase in rainfall in the winter and spring, and an increase in temperature in the summer and autumn seasons. Also, annual precipitation changes in scenario A2, A1B and B1 during the following period were 31.71%, 29.26% and 19.41%, respectively, and the mean values of these values were 8.33, 7.35, and 6.09, respectively. We saw the percentage of annual temperature rise, which stated that the temperature and precipitation values in the upcoming period were 4.74% and 13.92% in scenario A2 and 88.2, respectively and 16.48% in scenario B2.

Also, the results showed that during the statistical period (2031-2002), it indicates that the temperature of the region is increasing throughout the season and increasing precipitation in the winter and spring season. In another part of the study, groundwater modeling was done with the GMS model. Also, to determine the accuracy of the model calculated in the stable state, the mean square error (RMSE) between the values of the surface of the stationary in the wells was obtained with the values calculated by the model in October 2002, which was 1.37, indicating the accuracy above the model. It can be said that the calibrated model has acceptable accuracy and the mathematical model can perfectly simulate the natural conditions governing the aquifer of Kerman Plain. Therefore, this model can be used to simulate the effects of climate change on groundwater fluctuations in the upcoming periods.

Four scenarios were considered with the aim of assessing the status of groundwater resources from October 2002 to September 2030 and providing a management solution. The average of groundwater losses in all four scenarios was for the first scenario (-0.86, -5.85 and -9.9), the second scenario in A2, A1B and B1 states (-9.26, -9.36 and -9.49), the third scenario in A2, A1B and B1 (-12.09, -12.21, -12.28) and the fourth scenario in A2, A1B and B1 modes (-15.43, -15.55, and -15.58). The results of this study indicate that the calibration model error is accurate and the mathematical model can simulate the normal conditions governing the aquifer of Kerman Plain. Therefore, we can use this model to simulate the effect of climate change on groundwater fluctuations in the future periods. The results indicate a decline in groundwater levels under different climate scenarios that should be resourced with proper water resource planning and strategies to adapt to climate change. In order to prevent the decline of groundwater level, water use patterns should be revised in different parts. In agriculture, the irrigation system should be changed, the cultivation pattern will also go towards low-water products. Also, due to the impact of climate change, either directly or indirectly, it is necessary to develop adaptation strategies for climate change in order to save on water consumption.

Keywords: climate change, climate scenarios, Kerman Plain, underground water drain.

A comparative analysis of environmental state in Tehran and London cities using sustainability indicators

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Received: September 18, 2017

Accepted: February 4, 2018

Expanded Abstract

Introduction

It took hundreds of thousands of years for the world population to grow to 1 billion– then in just another 200 years or so, it grew seven fold. In 2011, the global population reached to 7 billion mark, and today, it stands on about 7.6 billion. This dramatic growth has been driven largely by increasing numbers of people surviving to reproductive age, and has been accompanied by major changes in fertility rates, increasing urbanization and accelerating migration. These trends will have far-reaching implications for generations to come. UNFPA helps countries identify and understand such trends, which are critical to development. UNFPA is one of the world's largest funders of population data collection. UNFPA also advises countries which are the best way to ensure sustainable development to deliver a world where every pregnancy is wanted, every birth is safe, and every young person's potential is fulfilled. The SoE framework is the underlying structure used across all themes to assess the environment.

The purpose of national state of the environment reporting is to:

- provide all people with authoritative information on the state of the environment that sustains our economy and wellbeing,
- provide the people public, the government and other decision-makers responsible for managing our environment with an assessment of how effectively the environment is being managed and what the key national environmental issues are.

To ensure that this information is as credible and robust as possible, the report is written by a panel of independent authors, based on the best available evidence, and quality checked through a rigorous consultation, peer-review and fact-checking process. Iran is a developing country that has so far produced its second SOEs. The main purpose of this paper is to compare the London and Iran's SOEs. We decide to using the experiences of other countries, its so better to understand of environmental process provide the planner with the information and make a better decision.

Materials & Methods

In this paper, the indexes of SOE of Iran and London extracted, after that we compared all of indicator of two reports by pay attention to details (Table 1).

Tabel 1. Main indicatore of London and Iran

Lonon SOEs	Iran SOEs
Climate change	Climate change
Flood risk	Water resources
Water quality	Soil
Water resources	Air pollution
Waste	Waste
Air quality, transport and noise	Energy
Biodiversity	Biodiversity

SOEs report usually build on an internationally accepted framework for SoE reporting- the DPSIR (drivers-pressures-state-impact-response) framework but also includes discussions on resilience, emerging risks and environmental outlooks (Fig. 1).

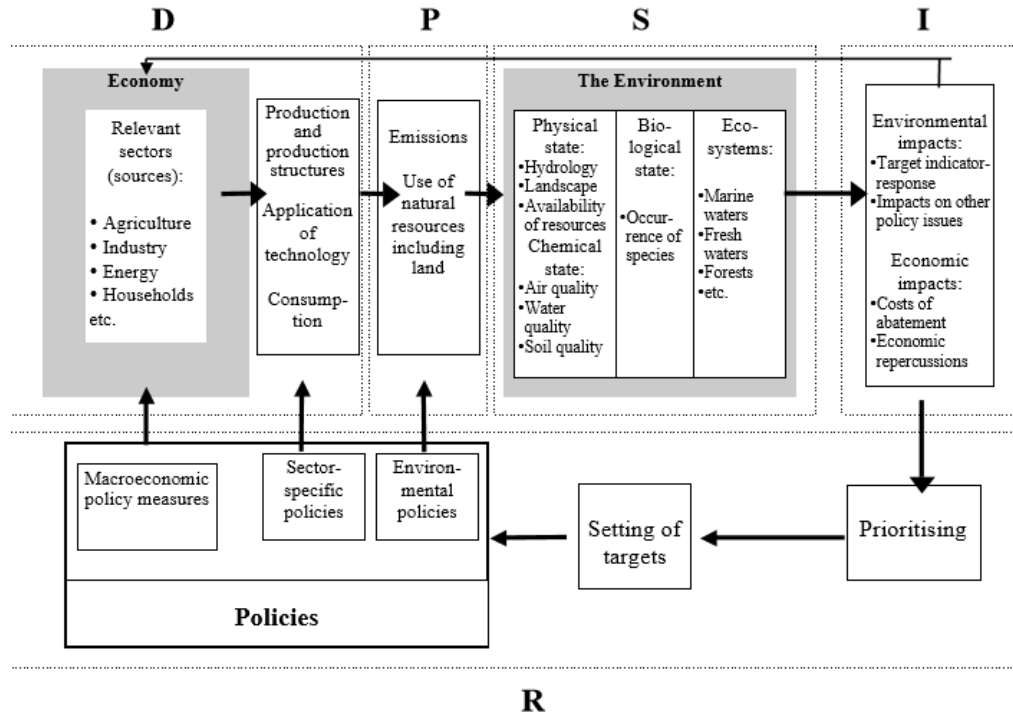


Fig. 1. DPSIR framework

Results, Discussion & Conclusions

Sustainable London 2030 outlined the aspiration of our community and businesses for our local government area to be an environmental leader on a global scale. To guide the implementation of Sustainable London 2030, the city developed a series of environmental master plans and strategies between 2008 and 2015. Soe of landon has environmental action strategy and action plan of London, for 2016-2021. But Iran's report don't pay attention to environmental process and future trend. Iran's report does not predict for future. For example in the landfill indicator in Iran, they only pay attention to the amount of waste produced without any planning for future, but in SOE of London they explored it in two phases:

- **In current status.** 31% local authority collected waste is recycled or composed.
- **Trend comment.** Local authority collected waste sent to landfill has reduced since 2000 (from 72%), with significant reductions in 2011/12 as more is incinerated (rising to 36%).

Using of developed countries' experiences in sustainable development is very useful for Iran, a developing country. A great deal was learned from the experiences of different developing countries. The correct preparation of these reports can be a guide for decision makers and city managers.

Keywords: London, State of Environmental (SoE), sustainable city, Tehran.

The effect of gasoline exhaust pollution on some anatomical, physiological and morphological characteristics of Spinach

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Received: September 28, 2017

Accepted: February 4, 2018

Extended abstract

Introduction

Depending on the fuel type, the main vehicle exhaust emissions are nitrogen oxides (NO_x), carbon oxides, sulfur oxides (SO_x), carbon particles, heavy metals, water vapor and hydrocarbons including aldehydes, single hydrocarbons and polyaromatic hydrocarbons, alcohols, olefins, alkyl nitriles that along with secondary pollutants such as ozone, have negative effects on plant health. Agricultural lands which are adjacent to urban areas, are increasingly vulnerable to vehicle pollution.

The plants suffer a lot from the pollution caused by exhaust of vehicles because they can not move away from the source of contamination.

Plants exposed to exhaust of vehicles, show many disruptions in their general appearance, which are referred to as "visible injuries". In fact, these visible damages to the plants reflect the physiological changes that come with the contaminants. These physiological changes may be considered as "hidden injuries".

There is concern about the compounds of contaminants, because there is an evidence that the plant response to multi-pollutant mixtures may be different from plant response to one pollutant. For example, one-hour exposure to combination of SO₂ gases with concentration of 1310 micrograms per cubic meter and NO₂ with concentration of 940 micrograms per cubic meter resulted in low leaf damage, while none of the gases do not cause damage alone in these concentrations.

There are many reports on the effects of pollutants on the anatomy, physiology and morphology of different plant species. The importance of stomata in plant protection against air pollutants has been investigated and it has been shown that the closure of stomata helps to protect plants from pollution damage. Vehicle contaminants affect photosynthesis and cause oxidative stress in plants.

Air pollution caused a significant increase in membrane peroxidation in *Lavandula officinalis* Chaix. and *Ligustrum vulgare* L. planted in the margin of the streets of polluted and cleaned areas of Tehran.

The activity of Antioxidants enzymes (catalase, peroxidase and ascorbate peroxidase) increased in different levels in contaminated areas compared to clean areas.

There are not enough researches on the effect of gasoline exhaust pollution on leafy vegetables, especially spinach.

According to the considerable amount of cultivated spinach, especially in Iran, in outdoors and on the side of the roads or contaminated urban areas, the effects of the gasoline exhaust pollutants on some anatomical, physiological and morphological characteristics of spinach (*spinacia oleraceae* var *virofly*) were investigated.

Material and Method

The experiment was conducted in factorial test based on a completely randomized design with three replications in greenhouse of Isfahan University of Technology. Twelve small chambers (length: 100 cm, width: 70 cm and height: 70 cm) and an exhaust generator for transferring the contaminants to the chambers were constructed.

VARIOPLUS MRU device was used to analyze the output gases and determine the concentration of contaminants from burning gasoline.

The seeds of *Spinacia oleracea* var. *viroflay* were directly cultured in pots No. 4 which were filled with sand and soil mixtures of 1:2.

When the spinach seedlings reached to 4-leafy stage, transferred to the chambers and exposed separately to the gasoline exhaust pollution for three hours in three different exposure times (10, 20 and 30 days) and after the exposure time, their anatomical, physiological and morphological traits of plants were measured and compared with control plants.

The relative water content was measured by the method of Ritchie *et al.* (1990). Electrolyte leakage was measured by Lutts *et al.* (1995).

The total chlorophyll content and carotenoid content of leaves were extracted by 100% acetone solvent method. The absorbance of light at 661.6 and 168.8 for total chlorophyll and 470 nm for carotenoids were read.

The chlorophyll fluorescence concentration was measured by a chlorophyll meter machine (OS-30P model manufactured by Opti-science, UK) and the Fv/Fm ratio (photochemical effect of photosystem 2) was reported.

Factors related to leaf gas exchange were measured by a portable photosynthesis measurement (LCi model manufactured by ADC Bioscientific Ltd, UK). The amount of proline was measured using the Bates (1973) method.

Catalase activity was measured using modified Aebi (1984) method at 240 nm wavelength. Ascorbate peroxidase activity was estimated by modified Nakano and Asada (1981) by absorbance reduction at 290 nm. The activity of the guaiacol peroxidase enzyme was determined by the Chance and Maehli (1955) method with a slight change.

Anatomical traits were observed by optical microscope and measured through the Edn-2 software.

Statistical analysis of data of all traits was performed using statistical software Statistix 8 and comparison of meanings performed based on minimum significant difference test (LSD) at 5% probability level.

Discussion of results

Anatomical, physiological and morphological characteristics of spinach plants affected by gasoline exhaust pollution in every three exposure time.

Exposure to contaminants for 10 days, significantly increased total chlorophyll content, CO₂ intracellular concentration, stomatal conductance and net photosynthetic rate compared to controls.

No reduction was seen in all anatomical, physiological and morphological characteristics of spinach plants exposed to contaminants for 10 days compared to the controls.

The number of stomata, proline content and antioxidant enzymes activity including catalase, ascorbate peroxidase and guaiacol peroxidase in plants exposed to contaminants for 20 days showed significant increase compared to the control plants.

Dry weight, relative water content of leaves and stomatal conductance of plants exposed to contaminants for 20 days showed significant decrease compared to the control plants.

Plants exposed to the pollutants for 30 days showed significant increases in antioxidant enzymes activity such as catalase, ascorbate peroxidase and guaiacol peroxidase, proline content, electrolyte leakage and the number of stomata per unit compared to controls. But total chlorophyll content, carotenoid, photosynthesis rate, stomatal conductance, chlorophyll fluorescence, relative water content of leaves, fresh weight, dry weight and length of stomata significantly decreased compared to control plants.

Stomata pores in spinach plants that were exposed to the pollutants for 30 days shrunk due to closure of stomata by the pollutants as against other exposure days and control plants.

Significant differences in the xylem and phloem of plants that had the highest and the lowest exposure time to the pollutants were not observed.

Conclusion

Exposure to contaminants for 10 days, significantly increased total chlorophyll content and leaf gas-exchange parameters that are most likely because of the contents in contaminants and also the role of CO₂ in photosynthesis process and the presence of nitrogen and sulfur in NO₂ and SO₂ gases.

Between the three time of exposure in this study, the most trait changes were observed in plants exposed to pollutants for 30 days.

Significant increase in antioxidant enzymes, proline, ion leakage and number of stomata was observed in spinach plants exposed to pollutants for 30 days compared to control plants. The highest increase in this interval was related to the activity of the guaiacol peroxidase enzyme and then the amount of proline.

Among the anatomical traits, the highest change was shown in the number of stoma (62.20%) of plants exposed to pollutants for 30 days compared to controls.

Significant decrease in total chlorophyll, carotenoid, photosynthesis rate, stomatal conductance, chlorophyll fluorescence, relative water content of leaves, fresh weight, dry weight and length of stomata in spinach plants exposed for 30 days were observed compared to control plants.

The highest decrease in plants exposed to pollutants for 30 days compared to controls was observed in stomatal conductance (39.21%) and the lowest reduction was observed in the amount of chlorophyll fluorescence (2.56%).

The results showed that the exposure of spinach plants to pollutants, especially 30-days exposure, caused morphological, physiological and anatomical reactions due to contaminants that could be considered these reactions as the adaptation of these plants to the stress of contamination, in order to adapt or to deal with stress conditions and thus to survive the plant under pollution stress conditions.

Keywords: anatomical, physiological and morphological characteristics, pollutant, spinach.

Southwest Zahedan green belt design with dust reduction approach

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Received: June 9, 2017

Accepted: February 4, 2018

Extended abstract

Introduction

One of the natural phenomena that causes disastrous damages every year especially in arid and desert regions of the world is sandy storms. About two third of Iran is located in arid and semi arid regions. Studies show that 14 provinces in Iran are affected by wind erosion. The province of Sistan and Baluchistan has more than 5 million hectares of desert area, which its 800,000 hectares (about 16% of the mentioned area) are among active dust areas. Dust is one of the unfavorable climatic and environmental phenomena, which is getting far away from its regular cycle in recent years and happens frequently in the Sistan area. Existing dust particles in the air are a group of solid or liquid particles whose size is between 0.002 and 500 micron. One of the most important causes of this phenomenon is the lack of suitable vegetation. Green belt acts as a complete cover surrounding the city and it will help avoiding the entrance of pollution and dust into cities. In recent years, dust pollution happens frequently in Zahedan city. In fact, as Zahedan has a dominantly arid climate, it won't be a new event but the extensive amount of dust entering the city through every wind has made living more difficult. The direction of the most winds blowing toward Zahedan is usually south-west and north-east and they usually carry dust particles with them. The location of the two studied areas which are at the entrance of Zahedan-Khash road (Khalij Fars boulevard), the importance of considering visual beauty at the entrance of the city (the lack of sufficient vegetation at the moment effects its visual beauty), being in neighbor with populous places like universities such as Medical Science University, Quran Sciences University and Payam Noor University and also being in neighbor with some important organizations are the most important reasons which make this area the most qualified for pre-required necessities for applying a precise investigation.

This study was fulfilled to present procedures to decrease dust level in Zahedan city and to bring air quality close to a range of 0-54 mg/m³. In this study, existing *PM*₁₀ particles in the air was measured. After defining air density index, air quality index (AQI) was determined by the use of T-test. Then the required width and length of green belt in order to lessen dust level up to clean air standards were determined.

Materials and Methods

The applied method in this study is a descriptive- analytical method. Its objectives are as following:

- To study the effect of mixed planting on the reduction of existing dust particle in the air in comparison to the existing vegetation
- Determining the required width and length for the green belt in order to lessen dust level up to clean air standards (A: By using the statistical tests, B: By considering city's population)
- Selecting suitable plant species to be planted in green belt and recreational places considering the regions climate.

This research was fulfilled from April 2015 to March 2016 in order to study the density of the existing dust particles in air in two studied areas in Zahedan city. The first studied region consists of one hectare area in the southwestern part of Zahedan. This region has the poorest vegetation with limited number of Pine and Eucalyptus trees. The Distribution of trees and the dominant planting method especially in southwestern part is the same as the existing planting method in the first studied area. The second studied area has the exact area of the first region (approximately about 1 hectare) which is not located far from the first region. The second region is also located in the southwestern part of the city. This mentioned region dominantly has more different species in comparison to the first region which the total tree number is more than the first region.

The density of dust particles in the air was measured by using Grimm sample gathering– analyzing device in regular intervals with predefined periods (annual basis) for both studied areas. Samples gathered in order to evaluate the density of the existing dust particles in the air for both regions was performed once in every five minutes. But the data applied every three days based on the instructions of the U.S environment organization.

Discussion of Results

- To measure the effects of mixed planting (in the second studied area) on reducing the volume of the existing dust particles in the air in comparison to the existing planting in the first studied area based on T-test, the following results are achieved.
- To determine the length and width of the green belt in order to reduce the dust particles, two following methods are used: 1. by using statistical tests, 2. by considering city’s population.

Equation (1) was applied by the use of Excel Software:

$$(A1-A2) \div A1 \times 100 = (137.77-128.44) \div 137.77 \times 100 \tag{1}$$

Based on the first equation, pollutant reduction level in the second studied region was estimated about 6.76%. As Table 1 and Equation (1) show, pollutant reduction level to approach this standard is evaluated as 80.40%. $137.77-27=110.77 \div 137.77=0.4080 \times 100\%=80.40\%$

Table 1. The mean, standard deviation, and variance of related data to existing planting and mixed planting

	Groups	Standard deviation	Variance
Data	Existing planting	137.77±15.78	32629.06
	Mixed planting	128.44±14.27	26505.11

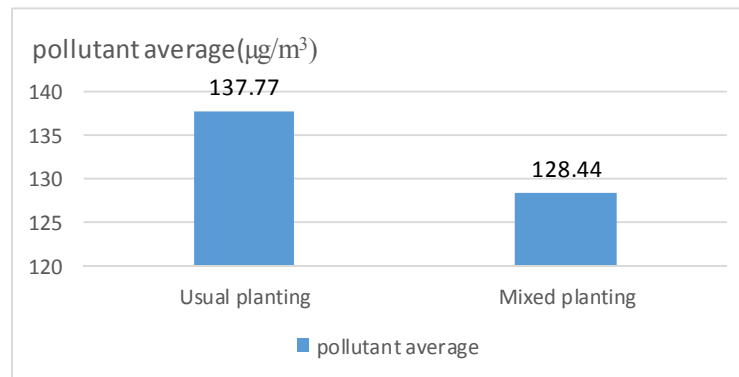


Fig. 1. The study of the reduction levels of dust pollutants in two regular and mixed plantings

Table 2. Air quality index

Quality of air	Quantity of dust (mg/m³)
Clear	0-54
Healthy	55-154
Unhealthy for sensitive people	155-254
Very unhealthy	255-354
Extremely unhealthy	355-424
Dangerous	425-504

Therefore, through adopting evaluated levels of clean air (80.40%) and pollutant reduction percentage which is 6.76, it is clear that suggested green belt area should be increased to 12 times of its existing area which is 1 hectare so that the green belt can have its the most effect on the dust reduction.

$$X = 80.40 \div 6.76 = 12$$

To evaluate the green belt area, the second equation is applied.

$$\text{Green belt area: } 2A \times A = 120000M^2 \quad A^2 = 60000 \quad A = 244.948M \quad 2A = 489.88M$$

Determination of green belt area depends on various factors like the main purpose to establish the green belt, the climate in the studied area, water sources, provided land to establish green belt, resided population, etc. Based on

Table 3, to establish a green belt which its main action is to reduce dust particles in the air, about 3 m³ of green area per person is necessary for everyone living in Zahedan city.

Table 3. Suggested levels of green area

Suggested levels by experts (m ² /per person)	Expectations from green space
3	Aesthetic purposes
8	To provide oxygen
3	To reduce dust
1 or 2	For leisure time
15 or 16	Total

Considering the population based on 2011 census, the total capital is obtained as follow:

$$660575 \times 3 = 1981725$$

Therefore, based on the second equation, green belt width and length was evaluated.

$$\text{Green belt area (m}^2\text{)} = 2A \times A = 1981725 \text{ M}^2 \quad A^2 = 990862.5 \quad A = 995.420 \text{ M} \quad 2A = 1990.84 \text{ M}$$

Because the statistical method is an exact method to measure the green belt area, the estimated area by statistical method is used and applied in the process of designing the green belt in Zahedan city.

Conclusion

Based on the present study, data gathering in an annual period (from April 2015 to March 2016) was performed in the two regions located in southwestern part of Zahedan city, one with existing planting and the other one with mixed planting (second studied area). Using the mixed planting method can cause 6.77% reduction in the amount of existing dust particles in the air. Therefore, through applying T-test and considering population, the suitable area was estimated. In the T-test method, the suitable area to establish green belt was estimated about 120,000 m². In addition, considering population and required capita for green space to decrease dust, the suitable amount of area to establish green space was measured about 1,971,725 m², by using presented tables for expectations from green space. To identify local and resistant plant species to dust, plants with the following characteristics were selected: downy leaves, speared leaves, low water requirement and adaptable in every soil especially weak soils. Some suitable cases are Tehran pine, Tamarisk, Shiraz cedar, Silver cedar, Eucalyptus, Ailanthus, Pomegranate, Buckthorn, and Berry.

Keywords: air quality index, dust particles, green belt, mixed planting, PM₁₀ particles.

Evaluation of lead and cadmium pollutions in morphometric characteristics of Hermit crab (*Coenobita scaevola*)

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Received: August 4, 2017

Accepted: February 4, 2018

Extended abstract

Introduction

Marine ecosystems are impacted by a large amount of pollutants from different sources. The Persian Gulf is a semi-enclosed tropical sea with limited water exchange of the Indian Ocean through the Hormuz Strait. In recent decades, the Gulf countries have grown increasingly in terms of industrial and demographic trends. One of the consequences of this growth has been the significant increase in oil, urban, agricultural and industrial pollution such as heavy metals with both short and long-term impacts.

Heavy metals, as major contaminants, have been drastically increased in marine ecosystems with anthropogenic activity. This causes increasing extinction rate or complete extinction of some sensitive marine organisms, and biochemical and physiological damage to the organisms, subsequently be transferred to human through the food chain. Lead and cadmium are considered as important toxic pollutants for aquatic animals and the adverse effect of them multiply as they move up the food chain.

Evaluating the flexibility of the morphological properties of species populations inhabiting areas with different habitat characteristics and pollution levels would enhance our knowledge about the effects of environmental changes on species characteristics (Kuliev, 1988). Like other organism, crabs adopt a species adjustment mechanism to develop similar morphological characteristics under similar environmental conditions. Crabs' morphological characteristics are highly sensitive to changes in major environmental factors such as habitat type, environmental pollution, water flow, vegetation, competition, predation, and availability of food resources.

Morphometric studies generally use traditional or geometric approaches (Eigdari & Nasri, 2012). Traditional morphometries apply multivariate statistical methods to examine morphological variations within or between groups (Webster et al., 2010). Traditional morphometric studies usually use multivariate statistical tools to assess a set of distance measures. Hermit crabs (*Coenobita scaevola*) are more noteworthy in recent years because of the following: they are included in aquatic and shore birds' food chain; they have an important role in cleaning the environment; and also they are one of the most important animal communities in tidal zones.

The purpose of this study is to investigating the effects of heavy metal pollutions on the morphological specifications of hermit crabs in two different pollution contexts by using traditional morphological method.

Material and Methods

In June 2016, sixty hermit crabs were collected from two different stations in south and southeast of Kish Island (30 sample from each station) and then transferred to the lab. At first, the morphological variables of each sample have been measured by the traditional morphological techniques.

Table 1. Morphological variables

Morphological variables	
TL	Total Length
AbL	Abdomen Length
HL	Hard Length
CL	Carapace Length
ASL	Anterior Shield Length
EI	Eyestalk Length
AL	Antennal Length
1WLL	1 st Walking Leg Length
2WLL	2 st Walking Leg Length
CHL	Cheliped Length
CW	Carapace Width
EW	Eyestalk Width
CPW	Cheliped Propodus Width
TW	Total Width
Sex	Sex

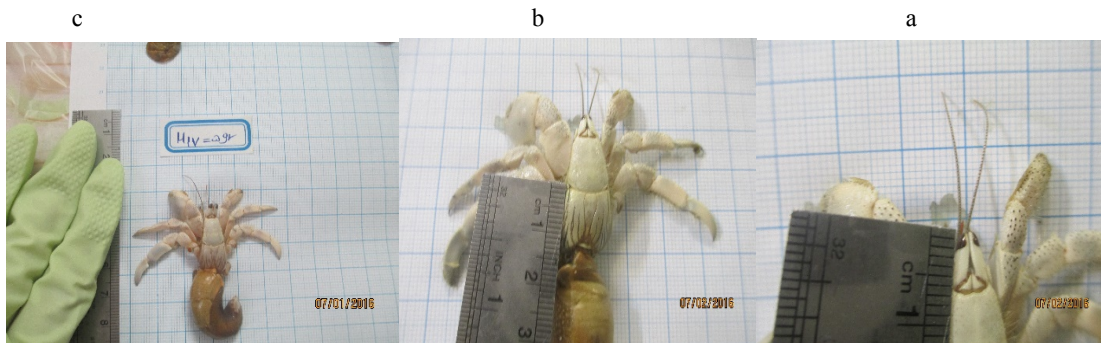


Fig. 1. (a) Eyestalk length, (b) Carapace length, (C) Total length

Due to the fact that in crustaceans, heavy metals accumulate more in hard tissues, the hard tissue was removed by cutter from the soft tissue. Then, after extraction wet digestion technique according to AOAC, 1980, lead and cadmium concentration were measured by atomic absorption spectrometry. The recovery rates ranged from 96% to 101% for both investigated elements.

Finally, in order to compare the lead and cadmium concentrations at each station with global standards, data normality and comparison of lead and cadmium concentrations between two stations, SPSS Software and for the Principle Component Analysis (PCA), the CANOCO software were used.

Results and Discussion

According to the results, the mean lead concentration in hard tissue in the southeast station is 2.38 mg/l and in the south station is 22.49 mg/l. As a result, the lead concentration in both stations is more than the world health organization (WHO) standard and in the south station the lead concentration is significantly more than the southeast station.

The mean of cadmium concentration in the south station is 2.38 mg/l and it is more than the southeast station which is 1.8 mg/l and in both cases it is more than WHO standard (0.2 mg/l). On the other hand, despite the higher mean concentration of cadmium in the south station, but based on Mann Whitney U test, this difference, is not significant. In the southeast station, the carapace length, the eyes stem length, the antenna length, the upper moving legs and the total weight variables are significantly more than the south station. According to the fact that the length of the moving legs in hermit crabs is very important for escaping from the enemies, finding the perfect pair, finding an appropriate oyster and finding food, the effects of lead concentration on this parameter

can decrease the survival rate and making intercross, movement and nutrition disorders in these species in south station.

On the other hand, results show that the south station samples have less flexibility and we predict less abundance for them in the future. Also, according to the PCA results and with regard to the focus of 57% of the important and effective components correlation in first axis, we can link the average low of the morphological variables of the samples in south station is due to high lead and cadmium concentration in hard tissue in this station.

Total Length (TL), Hard Length (HL), Abdomen Length (AL), the Anterior Shield Length (ASL) and the 1st and 2nd Walking Leg Length (1,2 WLL), there is a positive correlation with the cadmium concentration in the hard tissue of the hermit crab. Cadmium has a direct impact on the 1st and 2nd walking leg in hermit crabs and hermit do activities such as finding food, pairs and oysters (to protect the abdomen) and escape from the enemies with walking leg. So, the cadmium has a negative effect on nutrition, growth, survival and reproductive activity.

Thus, due to the presence of hermit crab in the aquatic and shorebirds' food chain as well as its significant role in environmental purification (Seiffabadi et al., 2014), it is also possible to use it as a bio indicator of contaminated water. Also, habitats and populations monitoring of this species are proposed on the southern coasts of Iran.

Keywords: cadmium, Hermit crab, Kish Island, lead, traditional morphometry.

Self-purification of interval mountainous Abbas Abad River of Hamedan

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Received: May 24, 2017

Accepted: February 4, 2018

Extended abstract

Introduction

Surface water, especially rivers, are the most important sources of water for drinking and agricultural purposes. Today rivers, due to the discharge of municipal and industrial wastewater and agricultural drainage waters are exposed to pollution. Under increasing kinds of pollution and the use of rivers as a discharge site, without taking into account the environmental impacts and non-compliance with discharge standards, self-purification capacity of rivers is reduced and water quality is severely affected. Therefore, to have the desired quality water, admission capacity along the rivers should be specified and remain at an acceptable level. In codification of the rules of discharging the effluents to rivers, factors such as the nature of the effluents discharged, self-purification capacity of the river, and the total mass loading of input at various points must be considered. The natural power of rivers in purification and removal of pollutants from the environment has led to use them to purify the pollutants beyond its natural capacity. Self-purification process is the combination effect of dilution, sedimentation, absorption and biodegradation which will lead to improve the water quality. Considering that every river, to a certain extent, has its admission capacity of input pollutants, nowadays the necessity of study quality and environmental resources is raised. The parameters involved in the ecosystem of the river covers a wide range and since the rate of elimination, some commonality, decrease and increase of pollutants and the factors influencing them is different, and there is in some cases, addressing all the features and parameters of water quality is not possible. Therefore, to determine the characteristics of river water quality, taking into account the parameters that mostly influence the process of self-purification of the river, due to the limitations of time and place and method of modeling, which expresses the characteristics of other water quality parameters becomes necessary.

In this regard, water quality parameters such as DO, BOD, COD, NH₄, NO₃ and PO₄ in the Abbas Abad river of Hamedan were evaluated. To evaluate the effects of effluent discharge on the source recipient, it is necessary to do self-purification studies. For this purpose, tools are needed to predict water quality in different conditions. River quality modeling is one of the important and low-cost tools to investigate problems and evaluate solutions, in order to improve the quality of the river. In the modeling approach, phenomena are related to each other so that the relationship between the cause and effect of pollutants entering the river and the water quality can be determined. As a model D₁, QUAL2K is one of the best tools to simulate the water quality with respect to its flexibility, ease of use and its availability.

The purpose of this study, was to simulate water quality parameters of Abbas Abad River with the QUAL2KW models and estimate the amount of pollution entering Abbas Abad River, without making environmental problems of rivers with the river enjoying self-purification capacity. Also, it is noteworthy that no research has been done using this model in Abbas Abad river, so the results can be used in developing control programs pollutant load (TMDL) for Abbas Abad river, and in the related organizations for similar applications.

Materials and Methods

Study area

Hamedan is a mountainous region near Alvand Mountain with 3,312 m high. Abbas Abad River is 18 km long from the slopes of Mount Fakhrabad of a height 3,312 m 12 km southwest of Hamedan flowing to the north. The river in its path (between regions Ganjnameh and Abbas Abad) gets branches and after passing Hamadan Abbas Abad village garden pours in to, in Grachqa Lands into the river (Gishin) Khaku. Abbas Abad River, because is

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a mountainous basin, and the steep, has a swift flow. Due to the snow catchment, this river has a permanent origin.

Research Methodology

In this study QUAL2KW model was used to simulate DO, BOD, COD, nitrate, ammonium and phosphate and calculate parameters of self-purification capacity of the Abbas Abad River. To calibrate the model, the necessary information for the years 2012-2013 was obtained from the Environmental Protection Agency Hamedan. In order to test and validate the model, data collection was carried out in May, June and August 2015. For each parameter, simulation took place in spring (May and June) and summer (August). In order to determine normal flow of the river (as an input to the model), two patterns of the three-year river flow continuity and moving average of the river flow. And according to the 43-year period (1971-2013), the normal flow for months of the study was determined.

Collect and evaluate the existing data

In order to identify the location of Abbas Abad river of Hamadan, the river catchment area, farmlands, access roads to the river, residential centers around the river and their point pollution sources, were determined 1/25000 topography maps. For the simulation of water quality of Abbas Abad River, flow, slope river between each station, the coefficient of manning, floor width, slope, distance between each of stations, mean air temperature, dew point temperature, water temperature, wind speed, number of cloudy days, the percentage of the river that are under the shadow of the mountains and vegetation, and whether there is algae in the river bed, one required for the model. Manning coefficient was selected between 0.028 to 0.035 with respect to the status of the river and the river bed and the wall on the basis of field observations area and also comparison with reference photos. Other parameters at different times were determined based on local surveys, statistics and topographical survey conducted in Hamadan airport meteorological stations. According to the field observations and determination of the locations of wastewater disposal into the Abbas Abad River, water harvesting (dividing the water 1 and 2), lateral branches (Tarykdrh) added, were selected in five stations sampled on the Abbas Abad River from the Ganjnameh to the Natural History Museum (behind Faculty of agriculture), 7.43 km long. These stations were sampled and analyzed in the months and required quality tests were conducted. To model, the river was divided into 16 pieces. Since the water quality of the river is influenced by flow and temperature, to determine the critical month in terms of water quality, based on 3-year moving average and discharge river was 43-year-old took place, who was selected in August as dry months. In addition to August, in order to identify water quality parameters in other months of the year and trend of changes over the years, the months of May and June were chosen as wet months more and simulation was done in these months.

Self-purification capacity and TMDL process

In this study, given Abbas Abad River plays apart to supply water to Hamedan city and another part is used as water right of farmers to irrigate gardens and agricultural land, to use drinking water and agriculture standards in the examination of self-purification capacity river, two interval were considered. First interval, the range of Ganjnameh up to water division 1, to harvest drinking water and second interval of the division of water up to the water withdrawals for agriculture in behind the Agriculture College (water division 2) were selected. In this regard, Iran's water quality standards were used. In this standard, the quality of water source for the drinking is divided into three groups. It is worth mentioning in this study were used of second group for the drinking water standard. In this standard, the lack of values of some investigated parameters, is compensated from other existing standards in the country. Otherwise, the drinking water standard World Health Organization (WHO), and the standard in order to apply the water used in agriculture FAO standard was used. To determine self-purification capacity of river and total maximum of daily load, the TMDL process was used and according to the type of use (agriculture and drinking), in compliance with the respective standards safety margin was considered. For phosphate, the entering load pollutants were reduced up to standard.

Results

Overall evaluation of the results. As already stated, according to the duration curve of the river flow and also calculating a three-year moving average discharge data in a 43-year period (1971-2013), normal flow for months under study, were determined. Then the calculated flow as input to the model was introduced, based on these results, levels of dissolved oxygen in the range of 1 km beginning to change is not considerable, but with the continue the path up to km 4.100, relative to the initial state, the average level A drop in 1.5% relatively minor exists, and then up to the end of the path was increased to 5%. According to the charts of ammonia and nitrate, with the increasing river discharge and dissolved oxygen, process of nitrification taken place and oxygen caused

the conversion of ammonium to nitrate. This increase of nitrate, in the interval (3.500 km), an average of 15%, but is not the index. Also, the flow increased that is combined with the relative increase oxygen, enhanced the quality of river water, and dropped amounts of BOD and COD an average of 45%. This also causes the status of phosphate to improve in the river.

Self-purification capacity of river. In order to determine the amount of self-purification, the load was determined. In order to increase the load to the defined standard for its intended use does not violate continues. In cases where the load exceeds a set value based on the standard was based on the standard amount is reduced. Based on the results of the simulation can be summarized as follows:

For drinking purposes, if the values of BOD, COD, NH_4 and NO_3 increase up to level 1, 0.3, 9.3 and 10, fold respectively, they are still acceptable in terms of drinking water standards. It should be noted that this is accordance with position and place of harvest of the river for drinking purposes (the first interval). If in future, the harvesting place of drinking water is changed, the assessment will not be valid. It should be noted that the amount of Phosphate River is always higher than the standards for drinking purposes and thus should be reduced to the initial value of 0.64. Also, for agricultural purposes, if the values of BOD, COD, NH_4 , NO_3 and PO_4 respectively up to 35, 28, 25, 46 and 40-fold increase, still will be accepted in terms of agricultural standards. As already stated, this would suit position and harvesting of water from rivers for agriculture (second period) is valid. If the relative increase parameters, examined compared to relevant standards, we find that the BOD further increases other elements, although significant difference cannot be observed between respective elements, also, there was determined the lowest level of self-purification in the first interval of COD and the second interval of NO_3 .

Conclusion and Recommendations

The aim of this study was to determine assimilative capacity of the Abbas Abad River of Hamedan, in compliance with the standards and quality criteria such as parameters of DO, BOD, COD, NH_4 , NO_3 and PO_4 . In this regard, QUAL2KW one-dimensional model and the measured data in May, June and August 2011, 2012 and 2015 were used. The TMDL process for to determine the self-purification capacity of the river and total maximum daily load was applied. The results showed that due to the mountainous and steep area, re-aeration is properly done so that although the values of BOD, COD, NH_4 and NO_3 increase up to 1, 0.3, 9.3 and 10-fold respectively, they are acceptable in terms of standards for drinking. The river PO_4 is always higher than the standards for drinking purposes and it is necessary to decrease the initial value of 0.64. For agricultural purposes, if the values of BOD, COD, NH_4 , NO_3 and PO_4 , respectively, and up to 35, 28, 25, 46 and 40-fold, they will be accepted in terms of agricultural standards. Based on these results, self-purification capacity of the river in the first interval (drinking) is more than that in the second interval (agriculture). Also, pattern of behavior of DO, BOD, COD, NH_4 , NO_3 and PO_4 parameters in river follows a normed probabilistic distributions, normal, Pearson, log normal, Pearson and normal respectively, and this information can help in the prediction of variability in this quality index.

Keywords: Abbas Abad River, QUAL2Kw model, self-purification, water quality.

Identification distribution pattern and origin of petroleum hydrocarbons in core sediment of southwest coast of the Caspian Sea (Kiashahr)

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Received: August 1, 2016

Accepted: February 4, 2018

Extended abstract

Introduction

Petroleum hydrocarbons are as the most ubiquitous organic contaminants worldwide in the marine area. The hydrocarbons in sediment cores have been used to identify source and to reconstruct the historical records of these hydrocarbon inputs for environmental impact studies. Of these, the *n*-alkanes are commonly used to characterize organic matter of various environments.

Similarly, a large number of terpane, hopane and sterane biomarker parameters is important tools for discriminating between biogenic and anthropogenic origins hydrocarbons deposited in sediments, confirming a petroleum contribution.

Caspian Sea is the largest freshwater lake in the world. International oil and gas industry special attention always was paid to this lake especially since early 1900s. Oil fields in Azerbaijan covered the southern part of the Caspian Sea where the first data on oil extraction go back to the 7th century and at the beginning of the 17th century. Also, 30–40% of oil resources in Kazakhstan and Turkmenistan are located in offshore. There was not exploration from Iran wells (Anzali wells) but since natural seeps should also be taken into consideration, these wells can be one of the possible sources of the hydrocarbon in sight. However, there has been no report on biomarkers (anthropogenic hopanes and steranes) in sediment cores to identify origin reconstruct a history of oil pollution.

In this respect, this study focuses on the determination of composition, concentration and origin of hydrocarbons based on the examination of the following geochemical markers: *n*-alkanes, isoprenoid alkanes, petroleum biomarkers in one core sediments from the southwest Coast of the Caspian Sea.

Materials & Methods

Sample collection

Core sediments were collected using a gravity corer at Kiashahr (CK) at the depth of 20 m on 25 October 2012. In the field, the cores were sectioned at into 1, 2 and 5 cm intervals immediately after sampling in the upper 10 cm, from 10 to 30 cm and higher than 30 cm to down of the core, respectively (a total of 35 samples)

Samples were stored in clean aluminum foil and transported to the laboratory in a cool box and then stored at 21°C until further analysis.

Extraction and fractionation

Sediment samples were freeze-dried and about 5 g of each freeze-dried sample were extracted by soxhlet apparatus using 100 ml of dichloromethane, over 8 h. The extracts were transferred onto the top of 5% H₂O deactivated silica gel column. All hydrocarbons were eluted with 20 mL of DCM/hexane (1:3, v/v) and transferred onto the fully activated silica gel column (0.47 cm i.d., 18 cm) and eluted with 4 ml hexane to obtain the aliphatic hydrocarbon fraction (AH) fraction.

Analytical methods

GC/MS analyses were carried out on an Agilent Technologies (Palo Alto, CA, USA) instrument with a gas chromatograph (GC), model 7890A coupled to a quadruple mass spectrometer (MS), 5975 C. Compound identification was based on individual mass spectra and GC retention times in comparison to literature, library

data, and authentic standards. Detection of hopanes and steranes was carried out using mass fragment ions at $m/z=191$ and 217 respectively.

Results & Discussion

Aliphatic hydrocarbon

The total aliphatic hydrocarbon (TAH) concentrations varied from 5.11 to $643.30 \mu\text{g g}^{-1}$ in CK. According to results, TAHs had maximum concentrations at 3, 4, 8, and 55 cm that were concomitant to an increase of U/R and diagenic hopane, pointing out on a greater enrichment of petrogenic organic matter in these layers.

The distribution pattern of *n*-alkane in sediments of Ck presented bimodal pattern in vertical profile: First model that happened in most depths containing an *n*-alkane distribution with not obvious odd to even predominance with high Unresolved Complex Mixtures (UCM) indicating petrogenic input in these layers. The second model that happened in some of the bottom depths of CK contains an *n*-alkane distribution with odd to even predominance and C_{max} was at C_{27} . These distributions indicated biogenic source for aliphatic hydrocarbons in these samples.

The relative UCM abundance compared to the resolved alkanes (R) is served as diagnostic criteria of pollutant inputs that it is varying from 0.5 to 6.8 in CK. UCM/R values >2 confirm the widespread presence of petroleum-related residues. This is apparent in all layers of CK, except for layers (75, 85, 90, 95 and 105 cm) confirming that these sediments contain mainly contributions from petrogenic sources.

The *n*-alkanes from petrogenic inputs show CPI ratios of approximately 1, while CPI values of 4 to 10 have been recorded for the terrestrial plants. Our results showed CPI values (0.83- 1.2) in most sediments of Ck. CPI values higher than 2 were observed only in layers (75, 85, 90, 95 and 105 cm) of CK indicating characteristic of biogenic *n*-alkane input.

The presence of pristane (Pr) and phytane (Ph) is noticed in all sections. Pri/Phy ratios for uncontaminated sediments are typically between 3 and 5, whereas values close to or lower than 1 suggest a petrogenic origin. The Pr/Ph ratio varied from 0.01 to 0.9 in Ck. This low Pr/Ph values suggest predominant petrogenic sources rather than biogenic in this core.

Petroleum biomarkers

Petroleum biomarkers pentacyclic triterpanes (C_{27} to C_{35} carbon atoms) were found at most of the samples. In deferent depths, hopanes ranged within 23 to 1841 ng g^{-1} . Proportions of terpanes to the major hopanes [$\sum\text{Ter}/(\sum\text{Ter} + \text{Tm} + C_{29\alpha\beta} + C_{30\alpha\beta})$] were found to be low for all the samples (0.16 to 0.33), indicating higher concentrations of these catagenetic hopanes. The high relative abundance of $C_{29\alpha\beta}$ and $C_{30\alpha\beta}$ hopanes is indicative of pollution from fossil fuel products.

Several geochemical values elaborated from hopane biomarkers have been used to characterize petroleum residues. One of these ratios that is confirmation of petroleum contaminants is determined by values of the ratio $18\alpha(\text{H})-22,29,30\text{-trisor-hopane (Ts)}/\text{sum of Ts}+\text{Tm}$ $17\alpha(\text{H})-22,29,30\text{-trisor-hopane}$ ranged from 0.33 to 0.8 in CK. Such a range confirms the presence of mature petroleum in sediment.

The ratio of 22S/(22S+22R) epimers of the homohopanes for $C_{31\alpha\beta}$ -hopanes was from 0.56 to 0.66 in, very close to the equilibrium value of full maturity at 0.6. This criterion has been used for characterizing the origin and degree of maturation of crude oils.

Bacterial (biogenic) hopanes (particularly neohop-13(18)-ene, $17\beta(\text{H}),21\beta(\text{H})$ - hopane and $17\beta(\text{H}),21\beta(\text{H})$ -hop-22(29)-ene) generally are absent in most of these samples. The highest values of bacterial hopanes with concentrations ranging from 0.08 to 0.50 ng g^{-1} were observed at 22, 24 and 60 which could reflect the presence of bacteria to organic matter in these layers.

Steranes present in fossil fuels are also useful biomarker indicators for petroleum pollution in urban coastal areas. The sterane patterns showed a prevalence of $5\alpha,14\beta,17\beta$ and $5\alpha,14\alpha,17\alpha$ configurations occurring as 20S and 20R epimers. The total sterane concentrations in the study area ranged from 2.65 to 768.84 ng g^{-1} in CK.

Another evidence of the contamination by crude oils in core sediment is steranes present. In general, C_{27} and C_{29} steranes are indicative of algae and higher plant source of organic matter, respectively. So, a dominance of C_{27} over C_{28} and C_{29} steranes indicates the predominance of organic matter input from marine algae, while a predominance of C_{29} steranes suggests a preferential higher plant input.

In these sediments, the ratios of C_{27}/C_{29} -steranes are in the range of 0.5–0.74, further indicating an abundance of organic matter with higher plant origin in the source rocks for these petroleum contaminants.

Keywords: Caspian Sea, core sediment, hopane, *n*-alkanes, oil pollution, sterane.

Pb (II) immobility in contaminated soils using phosphate, heat and lime (CaCO₃)

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Received: December 24, 2015

Accepted: February 4, 2018

Extended abstract

Introduction

The nature of heavy metals and their solubility in soil is important in the transition of these hazardous materials into plants, water resources and such compounds pose a serious threat to human health. Water, soil and air pollution are important component of industrial activities and directly exposed to the environment. Lead is one of the most important environmental pollutants and can from different ways contaminate soil and water resources. Since phosphate ions form stable complexes with cations such as Pb and Cd, so cause decrease the solubility and mobility of heavy metal in soil. Liming is the most widely used treatment, and leads to the precipitation of metal as metal-carbonates and significantly decreases the exchangeable fraction of metals in contaminated soil. Temperature is also an important factor in stabilization of heavy metal. Heat causes loss of water and hydrated around cations move them to empty spaces clay part of soil. The aim of this study was to investigate the effect of heat and lime, phosphate application on the immobilization of Pb in contaminated soil.

Materials & Methods

Soil sample was collected from waste mining of Angorane in Zanjan region and their physicochemical properties of soil were determined using standard methods. For stabilization mean, two levels of lime 0, 5% and 0, 2.5% phosphate fertilizer and mixed of lime (0, 5%), phosphate fertilizer (0, 2.5%) were added and mixed with 300 gr soil. Treatments as six different temperatures 25, 200, 400, 600, 700 and 800C were heated with electrical oven (Shimiran f.47) and loaded in distilled water for a different times (7, 30, 60 days), so samples were shaken every day 15 minutes. Samples were centrifuged at 2500 rpm for 5 min and passed through a filter paper. Pb concentration was measured in the supernatant using atomic absorption model (Shimadzu 6600). All analysis of variance and mean comparison were performed using SPSS and MSTATC software.

Discussion of Result

Physicochemical properties of soil sample showed in Table 1. The soil was acidic and saline due to the existence of salts Cd and Pb. Ionic strength of soil increases as a high amount of salts and affected adsorption and desorption processing. Also, due to the absence of carbonate in the soil (0%), these salts are available as sulfate of Cd and Pb probably. The soil sample contains 23% clay and has a silty loam texture class. The XRD result showed that the illite was the dominant mineral of soil. Total Pb concentration was 18,000 mgkg⁻¹ and indicates the severity of soil contamination. Based on the America's environmental protection agency (EPA) standards the allowable limit for the existence of Pb in soil is 100 (mg kg⁻¹). Therefore, concentration of the metal in the soil was too standard and introduced as a contaminated soil.

Table 1. Some physicochemical properties of soil sample

Total Pb (mg kg ⁻¹)	CEC (meq100 ⁻¹ g)	pH	Ec (dSm ⁻¹)	CCE %	Clay	Soil Texture
18000	8.6	5.5	20.4	0	23	Salty loam

Statistical analysis

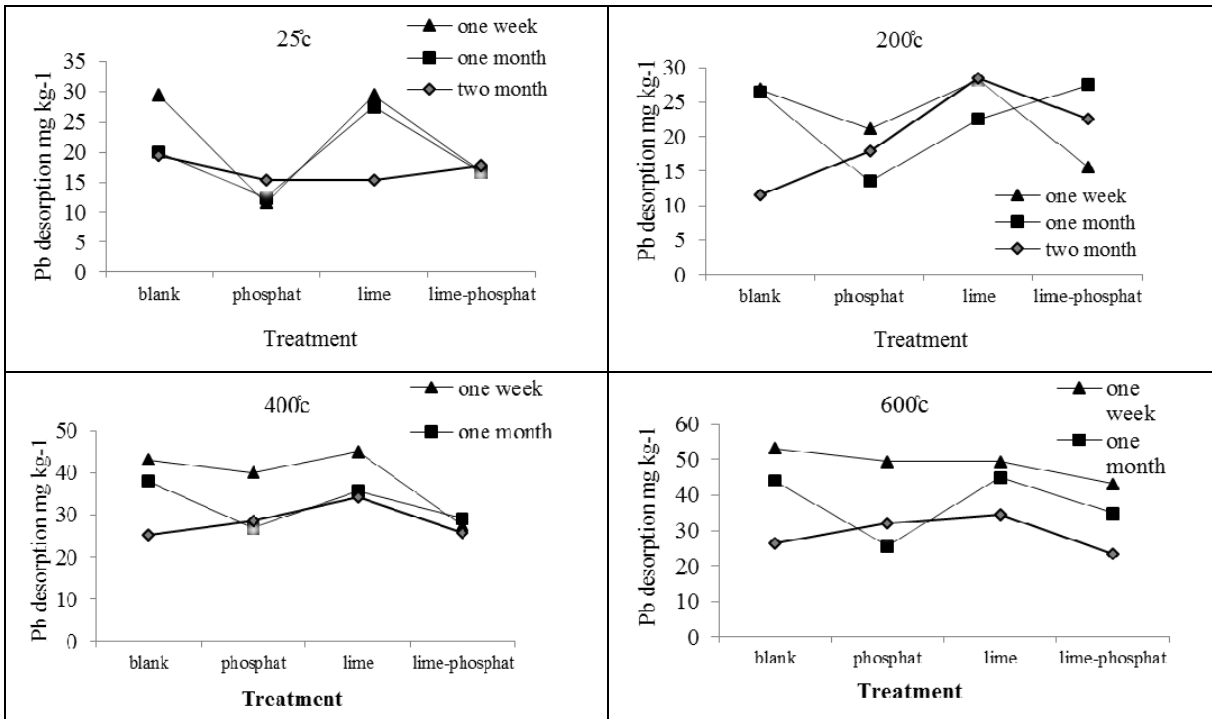
Analysis of variance showed independent effects of heat and treatments during the total periods were significant. The interactions of factors at 7 and 30 days were significant (Table 2).

Table 2. Analysis of variance for effected by heat and treatment (phosphate, lime, and time) on desorption of Pb

Source	df	Mean Sqaure		
		7day	30day	60 day
Heat	5	1299.5***	429.6***	302.2***
Treatment	3	116.8***	168.7**	79.7**
Heat*treatment	15	92.8***	60.2**	31.58 ^{ns}
Error	24	9.77	19.83	13.68
CV (%)		3.1	4.3	2.3

^{ns} no significant, *** significant on the 0.1, * significant on the 0.05

The results showed that lead release was a function of temperature variation and increased Pb release in all treatments except for 200 °C. High temperatures break the crystalline silicate minerals of the soil and Pb release was significant at a temperature up to 600°C, but no significant difference was found between 600 and 800°C. Also, the temperature increase reduces the soil's specific surface and increases the release of Pb (Fig. 1). It seems that the heat treatment causes structural changes in the structure of clay minerals and different minerals. The increase of phosphate causes the change direction effect of heat at stabilized Pb.



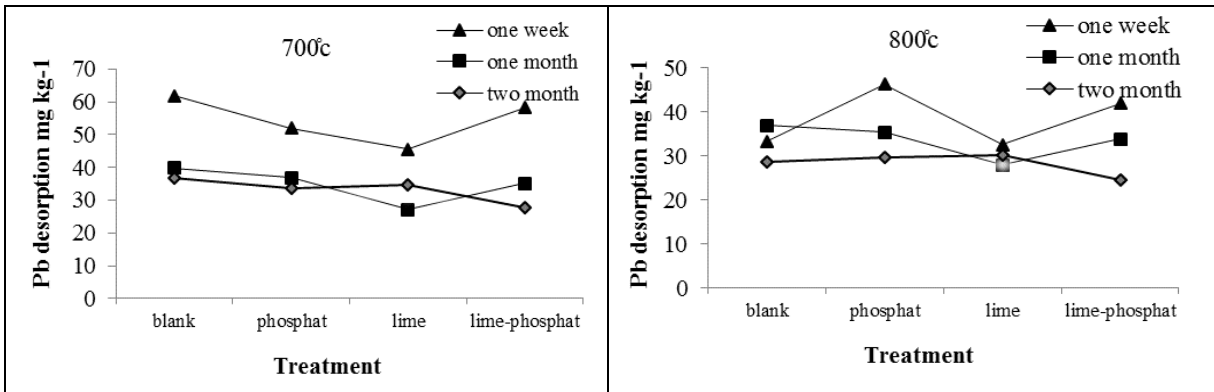


Fig. 1. The main effect of heat and treatment in desorption of pb

The lime application was significantly on lead stabilization compared to the blank on first stage and the highest desorption was observed at 700°C. The soil pH and EC are main parameters controlling the solubility and mobility of heavy metals in soils. Therefore, soil sample was acidic ($\text{pH} < 7$) and high EC. The acidity of the soil studied cause increases the solubility of phosphate anions and Pb solution was precipitated by phosphates anion so reduces the concentration of soluble Pb. The combined effects of phosphate and lime synergistic mode (Synergism) and cause increased the soil pH.

Conclusion

The results showed that lime and ion phosphate behavior were differed in non-removing Pb of contaminated soils, so that phosphate ion reduces the solubility and transfer of lead in contaminated soils. But limestone application was not suitable for the stabilization of Pb in highly polluted soils. Heat changed the structure of clay minerals and increased the release of elements. Also, the heat increase led to a change in the direction of the effect of phosphate on the stabilization of lead. So, the use of phosphate sources was found to be suitable for the stabilization of lead in acidic soils and saltines contaminated with elements.

Keywords: clay minerals, heavy metals, lime, phosphate.