

Efficiency Assessment of Wastewater Treatment Plant of Tabriz Using Artificial Intelligence Models

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Received: Jan., 2014

Accepted: July., 2014

Expanded Abstract

Introduction

Because of shortage of water resources in the world, it seems necessary to refine wastewater, particularly in arid and semi-arid areas such as Iran. Correct treatment, management and the control of refining process needs to investigate about effective parameters in this process. Therefore, because of the uncertainty and complexity in finding qualitative parameters and their relationship, artificial intelligence such as a fuzzy model (FL) and Artificial Neural Networks (ANNs) were used in this study for modeling the behavior of Tabriz wastewater treatment plant.

Tabriz city as the capital of the East Azarbaijan Province is the most industrialized and urbanized city in Northwest Iran (Fig. 1). The sewage of Tabriz city, including industrial and domestic wastewaters, collects gravitationally the wastewaters and conveys them into the wastewater treatment plant. It is located in Qaramalek District, four kilometers away in west of downtown on the southern side of the Ajichay river and on the lowest part of the city in an elevation of at 1334 meters above sea level. The wastewater treatment plant is designed in

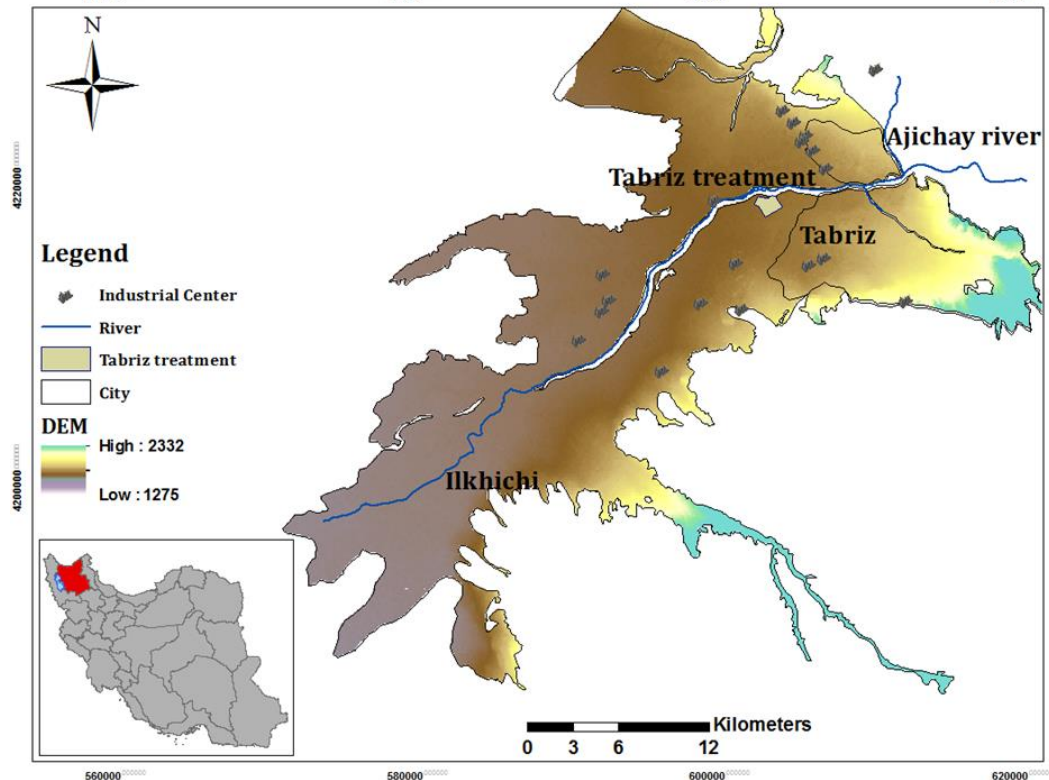


Fig. 1. Location of wastewater treatment plant of Tabriz city in Tabriz plain

three stages. The first phase of Tabriz wastewater treatment plant was established in July of 2001. Currently, due to incomplete sewerage network in Tabriz city, only the first phase of this plant is exploited with about 30% of total capacity. The second and third phases are under study. Tabriz wastewater refinery has an average annual rate 1.5 cubic meters per second and a peak flow rates in the rainy and non-rainy days of 3.8 and 2.5 cubic meters per second, respectively. Refinery process is including both primary and secondary treatment stages. The physical refining is done in the first step and biological treatment and finally disinfection are carried out subsequently.

Materials and Methods

Influent and effluent data of refinery system were used in this study to develop an artificial neural network and two fuzzy logic model and Mamdani and Sugeno FL models for evaluating the performance of wastewater treatment plant of Tabriz city. In this study, the system influent applied as input model to estimate the qualitative factors of effluent. For quality assessment in wastewater and sewage treatment plant, the parameters that are usually measured and recorded are the Temperature (T), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS) and pH compared in the input and output of wastewater treatment. In Hence, the monthly values of BOD, COD, TSS, T, and pH of effluent raw wastewater and effluent treated water of treatment plant were analyzed for the 11 years from 2002 to 2012.

At first, the data set containing 660 data from Tabriz refinery were divided into two parts of testing (130 data) and training (530 data). A FL method consists of three main parts, fuzzification, inference engine (fuzzy rule base), and defuzzification. In the fuzzification step, the four crisp inputs are transformed into fuzzy set for constructing the inference engine. The inference engine is composed of rules. Each rule, in turn, is formed from multiple inputs and a single output. When the antecedents of fuzzy rules include more than one rule, then fuzzy operators are used to connect them. The most common fuzzy operators are AND which supported min (minimum) and prod (product), OR (maximum) and NOT. The consequences of a fuzzy rule assign an entire fuzzy set to the output through the process which is called implication. The input to the implication process is a single number given by the antecedent, and the output is a fuzzy set. Since decisions are based on the testing of all of the rules in an FIS, the rules must be combined via aggregation processes in order to make a decision. The process of transforming the aggregation result into a crisp output is termed defuzzification. The most common defuzzification methods are centroid, bisector, middle of maximum (the average of the maximum value of the output set), largest of maximum, and smallest of maximum.

Results and Discussion

The Sugeno fuzzy logic model is constructed by subtractive clustering method. The optimal cluster radius is assigned based on the minimum Root Mean Square Errors (RMSE) and MAPE of 2.71 and 8.08, respectively. Based on the optimal clustering radius, five clusters and five If-Then rules were determined using Gaussian membership functions. The average correlation coefficient of this model is 0.82.

For constructing Mamdani fuzzy model, FCM clustering method is also applied. By using minimum RMSE and MAPE that are 2.83 and 8.88, respectively, the optimal numbers of input and output clusters are assigned. The Membership functions are Gaussian membership functions and the average correlation coefficient of this model is 0.8.

The perceptron network and three layers of artificial neural networks are including input, hidden and output layers. Data division in train and test steps is same as the FL models. Input layer have 5 nodes including BOD, COD, TSS, T and pH that is used as input data for predicting 3 output parameters (i.e., BOD, COD and TSS). To select the appropriate number of neurons in the hidden layer the various methods such as trial and error and also mathematical rules were proposed. In this study, 3 neurons are determined in the hidden layer by the trial and error method. At the first step, the network must be trained. The purpose of the learning network is achieving Minimum Absolute Percentage Errors and optimal weights of the network. Due to the high R^2 , the lowest RMSE in the optimal structure is 5-3-3. The obtained results for test step (average RMSE= 3.63) confirm high ability of artificial neural network in estimating parameters of wastewater treatment plant.

Finally, to evaluate the output of wastewater treatment plant and the results of artificial intelligence models in removing and reducing studying parameters, percentage of removal efficiency was used according to equation 1.

$$RE_x = \frac{1}{n} \sum_{i=1}^n \frac{x_{in} - x_{out}}{x_{in}} \times 100 \quad (1)$$

This index indicates the isolation of each of the quality parameters of the wastewater after treatment. In this equation, RE_x is the index of removal efficiency percent of x, X_{in} is the amount of input mass of parameters x to treatment plant and artificial intelligence, X_{out} is amount of output mass of the parameters x from the treatment plant which was estimated by artificial intelligence, and n is the number of data for each pollutant. This equation

was performed in two cases, one based on the measured data in the input and output of treatment plant and the other based on the measured data in the input and the estimates of the artificial intelligence. At the end, the efficiency of reducing emissions calculated and compared separately for each pollutant for both cases.

The removal efficiency of each three contaminants is close together and the TSS pollutant has maximum removal efficiency (93.74%) for three artificial intelligence models. The results represent a good performance of applied models. Consequently, the neural network and Mamdani and Sugeno fuzzy models have good accuracy in evaluating the performance of treatment.

Conclusions

Although three artificial intelligence models have acceptable results, but based on the correlation coefficient and RMSE for each of the parameters in the models, the Sugeno fuzzy model is more preferred than other models. The superiority of the Sugeno fuzzy model over an artificial neural network is due to high uncertainty of wastewater treatment plant parameters. Calculation of the percentage of contaminant removal efficiency was also determined in the output treatment. The maximum removal efficiency was related to TSS pollutant that is equal to 93%. TSS values were also very close to other pollutants. Similarly, the removal efficiency of pollutants from the estimated values by fuzzy model and neural network is the same and close to the observed values due to the good performance of used models.

Keywords: Artificial Neural Networks (ANNs), Mamdani and Sugeno fuzzy model, removal efficiency, wastewater treatment plant of Tabriz.

Numerical Simulation of Discharging the Wastewater of Chalous City into the Caspian Sea Using Outfall

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Received: Dec., 2013

Accepted: June., 2014

Expanded Abstract

Introduction

Coastal towns have specific positions for the possible utilization of sea and tourism attractions. Finding useful methods for sewage disposal at lower costs with higher efficiency and also expanding the capacity of the coastal towns is very important. Releasing residential sewage of Chalous city into the Caspian Sea makes marine environment a source of raw wastewater and these contaminants affected the water body.

The contaminants can pollute fishes, sediments and coastal waters and then transmit to human bodies through the consumption of contaminated marine organisms or by swimming. Many of researchers and experts believe that secondary treatment of wastewater needs a lot of costs and energy and sludge disposal and production should also be continuously monitored. But with proper planning of drainage system for the sea, we can discharge large amounts of sewage into sea with no need to treatment maintenance. Oceans, seas and great lakes have high self-purification capacity to absorb sewer of coastal towns.

There are many types of wastewater discharges into the sea. These are including discharges directly onto the beach, discharges with a short outfall with likely contamination of recreational waters and discharge with an effective outfall designed so that the sewage is efficiently diluted and dispersed and does not pollute recreational areas.

Dilution of the wastewater into the sea have three phases including near-field, far-field and long-term flushing. Generally, the near and far field dilution mechanism strictly disagree that they act separately as an independent treatment service. The outfall system typically consists of tunnel or pipeline, diffuser and ports on the diffuser; in this system the basis is the dilution of wastewater without any problem for the marine environment. Prediction of near field mixing requires understanding of the dynamics of jets, plumes and buoyant jets; a jet is a flow driven by the source momentum flux only, a plume is driven by the source buoyancy flux only and a buoyant jet is driven by both momentum and buoyancy fluxes. Discharges from an outfall diffuser have both momentum and buoyancy and are, therefore, buoyant jets, but the buoyancy flux is usually dominant and ocean outfall discharges can often be approximated as plumes. In this study, the use of outfall as sewage disposing system in the city of Chalous, where is located near the southern coast of the Caspian Sea, has been assessed in term of environmental effects.

Materials and Methods

Mathematical models are now widely used to predict the fate and transport of ocean discharges. This is not possible to simulate these types of discharges with one overall omnibus model, because of the very wide range of lengths and time scales for various mixing processes. Therefore, linked sub-models of the various phases are usually used.

In general, the assumptions used in the modeling of dispersion and dilution of waste water are the incompressibility of flow. The pressure is hydrostatic and molecular scattering is ignored. The theory of mixing zone and near-field models are different by far-field models and the length scale, entrainment and CFD models. For far-field, the hydrodynamic models were developed in the past few decades to predict increasingly the fate and transport of marine discharges.

There are three basic equations for the discharge of sewage into the sea through an outfall: mass flux, momentum flux and buoyancy flux. One of the common near-field models is CORMIX for analyzing the discharge of various types into marine waters. CORMIX is a comprehensive application system for the analysis,

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prediction, and design of outfall mixing zones resulted from discharge of aqueous pollutants into diverse water bodies. It contains mathematical models of point source discharge mixing within an intelligent computer-aided-design (CAD) interface. Its focus is environmental impact assessment and regulatory management. CORMIX has been developed under several cooperative funding agreements between US, EPA, US Bureau of Reclamation, Cornell University, Oregon Graduate Institute (OGI), University of Karlsruhe, Portland State University, and MixZon Inc. during the period of 1985-2007. The major emphasis of the CORMIX system is on the geometry and dilution characteristics of the initial mixing zone including compliance with regulatory constraints as well as predicting the behavior of the discharge plume at larger distances. However, this system has also capabilities to predict the wastewater over long distances in the far-field. CORMIX contains three core hydrodynamic simulation models: simulation models for single port discharges (CORMIX1), simulation models for submerged multiport diffusers (CORMIX2) and simulation models for buoyant surface discharges (CORMIX3). In this paper, the CORMIX2 has been used for predicting and modeling of the discharges from an outfall diffuser; the following items must be respected in the design of a multi-port diffuser: port and nozzle diameters (not too large to cause the sea water to enter diffuser and not too small that waste increase pumping costs), nozzles angle to the seabed in a way to flow horizontally into the water body because of optimal dilution and the outlet port shape of nozzles. This must notto cause friction in the direction of wastewater disposal.

Factors of water contamination are nutrients, bacteria and pathogens, toxic chemicals, organic, heavy metals and suspended solids. Pathogens are the most important factor to design the outfall. It can be controlled by initial mixing, diffusion and destruction by sunlight.

California ocean plan is an instruction to a successful discharge of sewage into marine waters without complications for the environment. This plan limits the level of water quality such as bacterial, chemical and physical properties and also considers some limitations for sewage.

The most important indicator bacterium in sea water and natatorium is Enterococcus. According to the California Ocean Plan, USEPA has limited the levels of coliform bacteria Enterococcus for the 30-day geometric mean to 35 units per 100 ml. The maximum of coliform units in the discharged wastewater to the sea is also limited to 1000 units per 100 ml.

Discharges near environmentally sensitive areas such as coral reefs or shell fishing beds should be avoided. If the diffuser cause rapid dilution and dispersion of the effluent and the waste field transport to critical areas is minimized, only the preliminary wastewater treatment such as milliscreening may be needed. To choose a convenient location for an outfall, the various parameters are effective. These are water depth and the slope of the seabed, type and direction of currents, swim areas, regional water quality, concentration of population, and entry of river waters into the sea; thus, three routes along the coast of the Chalous City are proposed and the proper route and discharge depth are chosen during a process of trial and error.

The worst dilution conditions such as no currents and strongest density stratification must be considered for designing an outfall. Therefore, to obtain the worst dilution case, the model is run for different seasons. Thus, outfall designing takes place based on specifications of the summer season when the currents are minimal and the density difference is the highest value.

Results and Discussion

Diffuser geometrical design is plotted using CorSpy that is one of the CORMIX post processing tools. The diffuser has the length of 50 meters with eleven ports that each port has a T-shaped nozzle with 25 cm height and 50 cm from the seabed. Due to strong density stratification of sea in the summer, the discharged sewage doesn't reach to surface water and becomes stuck in the terminal layers. The distance between the source of discharge and where the plum meets bank is about 6500 meters and due to average speed of the currents, that is 0.058 meters per seconds, the time of reaching to the bank is about 31 hours. Thus, that is more than 24 hours and there is enough time to kill bacteria. According to the results of CORMIX the bacteria reach certain standards within regulatory mixing zone and there are no worries about natatorium area that is the thousands of meters away.

Because of poor density stratification of sea in winter, the discharged sewage reaches to surface water and, therefore, the 100 value of dilution must be checked at that water level; By CORMIX modeling the distance between discharging sewage and where it reaches to surface level is about 120 meters and the dilution value is 250.

According to the results of the modeling, the discharged wastewater meets the bank with a distance about 10 to 25 kilometers from the source with different ambient currents that is adjacent to residential and swimming areas. But as its arrival time is more than 24 hours, there is enough time to kill bacteria.

The model was also tested for the reversal ambient current that is usually occurring on cold days and the plume meets the bank with a distance about 10 to 20 kilometers from the discharging source with different ambient currents. The results of the modeling in terms of average monthly current in summer and winter show that the value of plum dilution when it reaches to water surface in winter and the time the plume meets the bank from the discharging source in summer, are two main parameters for designing of Chalous city outfall.

Conclusions

The goal of this project was to design an efficient outfall that have features such as proper drainage location, sufficient diffuser length, proper discharge depth, safety purposes, economic value, and trustworthiness of the biological, chemical and physical effects. The outfall was designed in the worst environmental case modeling with almost no currents and maximum density stratification in summer. To ensure the proper functioning of the outfall, other conditions were also modeled.

Desired location for installing outfall is chosen according to the parameters like beach slope for decreasing outfall pipe length, flows and wastewater fate in the far field so as not to reach swimming and tourist areas and pollution from streams and existing municipal waste.

The results of the model indicate that in the first movement, sewage discharge is diluted more than 100 times in a few minutes and within 10 meters of the discharge location, all pollutants comply with environmental conditions and adherences to the strictest standards. This amount of dilution is more than a lot of secondary treatments ability.

The major environmental advantages of the project are protection of groundwater from contamination by sewage, elimination of the direct discharge of wastewater into the Caspian Sea and thus improvement of the quality of sea water, removal of the harmful effects caused by sewage sludge dumping, and reduction of energy consumption and thus production of less heat and pollution.

The results of this study also demonstrated that the use of marine outfall in the city of Chalous with some considerations such as preliminary treatment prior to discharge is desired option. In addition, the results indicated that the outfall not only eliminates the environmental problems of wastewater disposing, but it is the most economical method for sewage disposal.

Keywords: Chalous, CORMIX, Marine environment, outfall, wastewater disposal.

Coastal Solid Waste Management in Mazandaran Province

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Received: March., 2014

Accepted: June., 2014

Extended Abstract

Introduction

Due to proximity to the sea, beaches always attract tourists. On the other hand, the coastal ecosystems have the most important and sensitive dual nature (land, naval) with a variety of animal species.

The most important (and also longest) coastal area in Iran are Persian Gulf and Gulf of Oman in south with about 2530 km long and Caspian Sea in north with about 922 km long. Coastal pollution in developing countries causes various difficulties for these sensitive ecosystems. For example, in Mahashtera Seashore especially in its Mangrove forests, different kinds of municipal and industrial wastes are scattered and a large area is covered by plastic bags.

Solid waste management in the coastal line is the most significant issue in management of coastal areas is the first and the most important factor in maintaining the health of the natural environment.

In the recent years, in Istanbul, a waste management system with transfer station with sanitary landfill sites and methane recovery led to many developments. It is predicted that potential renewable energy from landfill sites can be up to 160 Mw over 10 years.

One of the most substantial items in coastal line is the useful guidelines. It can be said that without enough regulations solid waste management system cannot be performed properly. In this paper, the current situation of the waste management in Mazandaran province is assessed and the substantial guidelines for waste management are suggested. Consequently, practical suggestions are offered.

Materials and Methods

Mazandaran Province with 23,756 square kilometers occupied 4.1% of the total area of the country. The total population of the province was 3,073,943 people in 2011, about one quarter of the total population of the country, and the number of tourists in each year is about 12 million people.

The guidelines and regulations of the current status of waste management in coastal line should be reviewed. Thorough examination of the quantity and quality of generated waste at the study area are a clear picture of the current situation of waste management. The strengths and weaknesses of existing systems can be evaluated. Therefore, in this study, one kilometer radius of the study area along the coastal province were selected and evaluated. The latest statistics and information were collected from various organizations such as the recycling of waste management, municipality and environment department of the coastal towns of Mazandaran. For more accuracy, fieldworks were carried out, several experts were interviewed and also a survey was conducted. The main structure of proposed guidelines was obtained by reviewing guidelines of waste management system in developed countries. At last, comparative studies were performed considering the current conditions of area to obtain proposed guideline.

Results and Discussion

Daily waste production in the coastal area is 794 tons. The maximum weight is for Babolsar and the minimum for Sorkh Rood. Daily per capita waste production is about 1.97 kg/d. This has a significant deviation from the average per capita (750 kg/d) in Iran. The deviation is due to the tourism industry. Degradable material is 77.43 percent and this is relatively high due to the amount of the fresh and non-processed material. Approximately 22.57% of the total wastes are dry matters that can be used to reduce 20 percent of the total waste using source reduction strategy.

Daily waste collection and disposal is carried out in the coastal line. The results of questionnaires show that in all cities the collection is done by the municipalities except Noshahr in which 20 % of the waste is gathered by private sector and 80 percent of the remaining by the municipalities.

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In all of these cities, waste is recycled and separated by municipalities. In all cities, waste separation by municipalitie workers has been observed during collection. But it doesn't mean that all the workers do the waste separation. In addition, some homeless persons separate the waste in cities or at disposal sites to find cardboard, paper, glasses or plastics. The results from the questionnaire show that 29 percent of urban waste separation is done at transfer stations and the 71% remaining in the landfill. Pets and plastic waste in all cities are isolated. Paper and metal in 93% and glasses in 87% of cities are isolated.

As it can be seen in the Table 1, in most of the coastal cities of Mazandaran waste disposal method is Stockpile and shallow burial, and leachate treatment system is not existed.

Table 1. Waste dispose situation in the coastal cities of Mazandaran (2012)

City Name	Area (hectare)	Land use Around the Disposal site	Distance to the nearest City (km)	Disposal Method	leachate Disposal location
Babolsar	5	Beach, Residential	0	Stockpile, Trenches	Caspian Sea
Fereydonkenar	2	Beach, Residential	0	Stockpile, Burning	Caspian Sea
Mahmodabad	0.5	Beach, Residential	0	Transfer to Amol city	-
Noor	8	Forest	16	Stockpile, shallow burial	Forest and river
Noshahr	6.5	Forest	1/6	Stockpile, shallow burial	Forest and river
Chalus	7	Forest	2	Stockpile, shallow burial	Forest
Abasabad	3	Forest	4/7	Stockpile, release in a valley	leaking to ground
Kelarabad	1	Urban, farming	0	Stockpile, shallow burial	Forest and river
Tonekabon	8	Forest	4/4	Stockpile, Composting	Forest
Ramsar	5	Forest	12	Stockpile, release in a valley	

In developed countries, rules and instruction of solid waste management are updated and published regularly but the main problem is in application of these rules. Solid waste management rules cover a wide range of concerns in waste management. These rules contain necessary criteria for collection, transportation and disposal as well as burying or incinerating of wastes. These rules also consider design and operation of landfills and incinerators. In addition, they have a special focus on minimizing plastic wastes and encourage recycling.

Any rules or guideline must be based on culture, customs, commercial and economic activity of that society, so it can achieve its final goal, i.e., implantation. Disregarding this fact and simply using laws of other countries result in various problems or difficulties for the authorities.

With the basic assumption in creation of rules or instruction, sources of pollution can be reduced.

First, all the process must have a comprehensive and coordinated approach to include all parts. It also should consider interactions between soil, water and air. Any effort to protect an environmental section without studying its impacts on other parts would be a failure. It would be wrong both scientifically and morally. Second, although

more scientific information is needed, the current lack of information shouldn't be a setback in start of waste management.

In general, structure of the proposed regulations is as follows:

- Purpose
- Definitions
- Authority management (based on Waste Management Law in Iran)
- Executive Items

Conclusion

The results have demonstrated that the non-practical management of waste in the coastal strip can cause environmental damages in this area. The increase of piled waste sites, distribution and poor performance of function elements such as source reduction cause environmental degradation in the region.

The waste of ports, industrial zones and industries located in the coastal cities are usually transferred to disposal area of the near cities. The industrial wastes containing dangerous substances are not separated from other wastes and discharged into municipal landfill. With the waste disposal sites adjacent to rivers, forests, sea and high rainy areas, considerable amounts of the wastes and leachate penetrate into the surface waters and result in contamination in extensive water resources.

One of the most substantial items in coastal line is the guidelines. It can be said that without enough regulations solid waste management system cannot be performed properly. In developed countries, waste disposal in open dumping sites was used until the waste management regulations were published in these countries. Due to a variety of needs and specific conditions to assess the current status of coastal areas and the experiences of developed countries, waste management instruction in coastal areas of Mazandaran Province was written to protect the environment from harmful effects of waste accumulation. The features and frameworks of this instruction are illustrated briefly in this article.

Based on the amount of waste produced, urban distribution, lack of extensive road network and topography of the region, four incineration plants are suggested instead of a centralized plant.

Fereidonkenar and Babolsar must be constructed based on Babolsar, with plant capacity of 200 tons per day; Mahmoudabad, Noor and Royan based on Noor, with plant capacity of 100 tons per day; Noshahr, Chalus, Hachirud and Salmanshahr based on Chalus, with plant capacity of 200 tons per day; and Asabad, Tonekabon, Shyrud, Ktalm and Sadatmahale and Ramsar based on Tonekabon, with plant capacity of 200 tons per day.

It is predicted that future challenges are waste reduction, making an integrated system for waste collection and disposal, using 3rd technology, and conversion of waste into energy.

Keywords: coastal, guidelines, Mazandaran, sanitary landfill, solid waste management.

Optimization of Water Allocation Using Cooperative Game Theory (Case Study: Zayandehrud Basin)

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Received: Feb., 2014

Accepted: July, 2014

Expanded Abstract

Introduction

There is no determined value for water (as a public asset) by its trustees and beneficiaries and its allocation method is more dependent on the requirements of water consumers than comparison of benefits of water affairs with its real value. This is a game to decide which interested group, when and to what extent can use the water. This study is aimed to determine sustainable policies for allocation of water to the interested groups such that high quality and sufficient water is available to survive water bodies and economic purposes of interested groups are also satisfied by sustainability agreement with the environment. For this, the environment is recognized as an independent water user in optimization model and as an independent player in the game theory. Thereby, Zayandehrud Basin has been studied as a case study.

Materials and Methods

The study has first dealt with optimization of the water allocation from the reservoir to consumptions including drinking, agriculture, industry and environment by means of genetic algorithm. To get the most desirable possible state of water supply for consumptions, 4 approaches have been considered, as described briefly below.

The first is supply of biological flows for the rivers which are in an equilibrium using Tenant (Montana) method and available data (providing 2.06 mcm for each month in the cold season and 6.18 mcm for each month in the warm season). The second is supply of the minimum water requirement for lagoon survival and protection of the minimum requirements for the valuable water ecosystem in the area. Continuity of natural life in the swamp depends completely on water depth. The lowest possible depth for vital activities is the depth of about 15 cm. This depth can be achieved by importing 75 mcm of water per year into the swamp. Benthos is hardly survived in this depth. The third includes supply of water with desirable quality for the lagoon based on TDS such that the water requirements for TDS dilution have been assumed as biological requirement. In the fourth, supply of the minimum water requirement for the lagoon is considered with regard to the studies on Gavkhoony swamp, desirable performance occurs with supply of 140 mcm of water per year. This amount provides depth of 30cm for the swamp. Then, having estimated the benefits of each beneficiary, the interactions among the beneficiaries in the basin have economically been investigated by cooperative games.

Results and Discussion

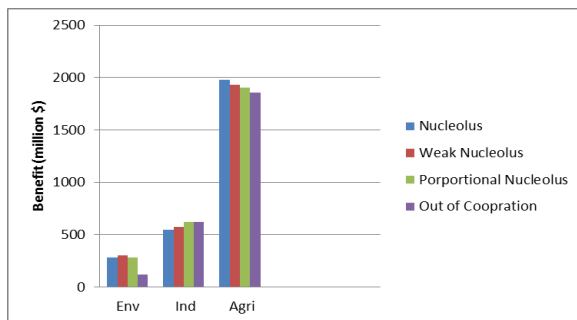
With regard to the data of the study area, in spite of various managerial plans to increase water supply for the basin, it no longer satisfies the requirements of water consumers. Specially, it is the case in the environmental sector. Because of ignorance and devoting water allocation priorities in the recent years, the environmental sector has experienced deficient and is completely dependent on seasonal flows and rainfalls. According to the designed approaches in the environmental sector of this study area, more than 85% of its requirements can be eliminated in allocations. With water supply approach for environment sector, 3-8% of agricultural and 8% of industrial requirements are faced with deficient. From environmental requirement point of view which has been distinctively defined in every approach, the model has shown the best performance in the first approach such that 100% of environmental requirements are satisfied. Given that this approach has accounted for the minimum requirements for the environment, minimum deficiencies have been observed in agricultural and industrial

allocations. Maximum water requirement has been considered in the fourth approach in which the optimization model has allocated 87% of the supply to the environmental requirements. From view point of water allocation to the environment, the fourth approach is the best in that the supply with regard to water content as well as positioning of the lagoon is in a desirable state for survival.

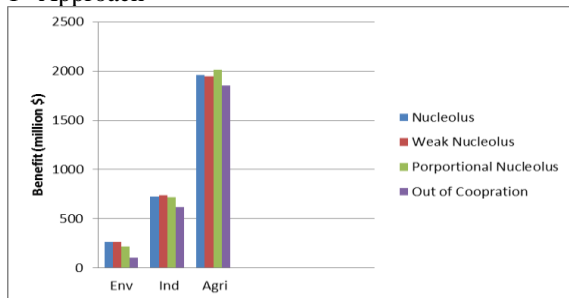
The percentages of requirement for beneficiaries and annual water allocations have presented in Table 1 for different approaches. The benefits of each beneficiary and the results of cooperative game have been illustrated in Figure 1.

Table 1. Gross profit of water users in each approach

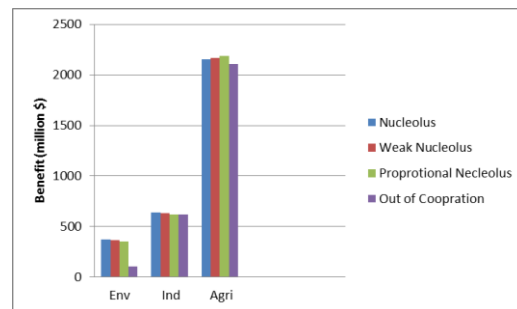
User	1 st approach		2 nd approach		3 rd approach		4 th approach	
	Water use (MCM)	Benefit (\$)	Water use (MCM)	Benefit (\$)	Water use (MCM)	Benefit (\$)	Water use (MCM)	Benefit (\$)
Agriculture	8759	2057.89	9182.32	2157.34	8652.6	2032.89	8756.8	2057.38
Industry	924.17	622.47	924.21	622.49	923.61	622.09	924.3	622.55
Environment	985.05	117.16	890.71	106.03	1044.98	124.4	1747.2	208



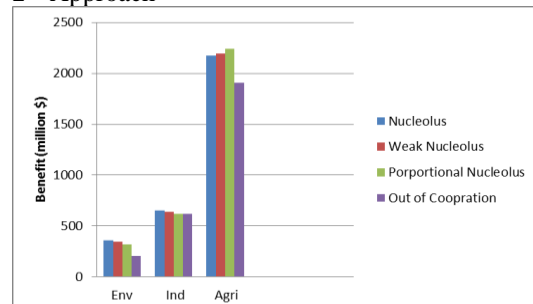
1st Approach



3rd Approach



2nd Approach



4th Approach

Fig.1. Results of cooperative games in different approaches

Conclusion

It can be concluded from the economic analyses of the model approaches that the industry has the same benefit in all approaches despite 8% of change in water allocation. With unfair allocation and low or high environmental utility in different approaches it has no influence on economic performance of the industry. The second approach has the most benefit in agricultural sector and the best performance in environmental sector because of the most desirable state for the river and lagoon survival. Economic analysis shows that agricultural sector has more benefit in second approach than other states. From model allocations, it can be said that monthly allocation and distribution model has impressive effects on the agricultural sector. With constant optimization procedure in the allocations, agricultural sector incurs severe pressures. In the allocated water and benefits in the agricultural sector, the second and fourth approaches have little differences because of monthly water distribution procedure in the first and third approaches.

According to game theory, the benefits from player cooperation in agricultural and environmental sector have been more than no cooperation. The industry earns the same benefit from both states, except for the third approach. Proportional Nucleolus game has the maximum benefit in agricultural sector, except in the first approach. Weak Nucleolus has shown better performance in benefit calculation in the environmental sector, except for fourth approach. Therefore, there is no specified procedure for games but because of more benefit from cooperation in agricultural and environmental sectors the two sectors will get more benefits from cooperation beside water supply requirement. The best benefit allocation has respectively occurred in fourth, second, third and first approaches.

Finally, it is clear that considering the environment as a beneficiary of the basins and planning for water resource management makes always more benefit in the system, although less water allocation to consumers makes less benefit. Because of no profit in the environment sector and no protest against deficiency in the sector, except in critical conditions, this is ignored while water ecosystems are the most valuable resources that their economic value estimation is complicated. With these economic methods it is seen that there are aggregate benefit and profit in the environment protection and survival.

Keywords: allocation, environmental flow, game theory, optimization, Zayandehrud River.

Statistical Analysis of Frost Characteristics in Saghez Weather Station

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Received: Jun., 2014 Accepted: Aug., 2014

Expanded Abstract

Introduction

Frost is one of the most hazardous natural phenomena, accompanied, at times, by abundant damages in the life and properties. Freezing and frost are very important for agricultural products in different stages of the growth. This is because, in case of happening, it results in the reduction of the products. Frost is one stage of water freezing. In such condition, when the air temperature decreases to dew point, ice cover is formed over the surface. Mojarrad Gharehbagh, in addition to presenting a new definition of frost, analyzed and extracted the frost characteristics based on 16 indices systematically. Mirmousavi and Hosseinbabaei studied the temporal-spatial distributions of the frost occurrence probability in Zanjan province. They found that, on average, the first frost events of the region are occurred in autumn season from September 19 to November 15, and generally the frosts events are ended from April 9th to May 20.

Montazeri attempted to study the agricultural frosts in Najaf Abad City. The results of their study showed that the general frequency of frost days were not decreased, meanwhile the occurrence of the severe frosts have been decreased as well as the frequency of the occurrence of zero-temperature frosts have also been highly increased. Jahanbakhsh et al. attempted to analyze the springtime frosts of Tabriz by synoptic approach. Their results indicated that the longest and the most severe frosts occurred between 27 March – 1 April 2003 and 5 April 2004, which this is due to the formation of low pressure centers and deepening of the related troughs over the north of Caspian Sea. Masoudian and Darand investigated the widespread frosts of Iran and found that 5 patterns of sea level pressures (SLPs) result in severe and widespread frosts in Iran. They also concluded that the severity of the frost events in different regions of Iran is in good agreement with those in the path of the anticyclonic systems. Thom and Show proved that the dates of frost occurrences are random and mainly based on a normal distribution. For this reason, using mean and standard deviation are considered as valid indices to study the frost events. Tavakoli and Hosseini analyzed the frost indices and its autumn-time occurrence in Ekbatan-Hamedan station and presented a model to predict the autumn-time frosts. Zolfaghari et al. predicted the last date of spring-time frosts in west and northwest of Iran. Their results showed that it was possible to predict the last dates of the spring-time frosts among the stations in the study area using error post-distribution network. The computed error was low in all the stations. The highest error was measured in Arak station with 1.1142%, while the lowest one was computed in Mahabad station with 0.254%. Easterling attempted to investigate the recent changes in days with frost and no frost in the USA. He found that during the period 1948-1999 the frequency of frost days declined, but the length of the days without frost increased.

Home studied the temporal distribution of seasonal-annual frosts in relation to their trends in the past years. Karl investigated the precipitation and also minimum and maximum temperatures, and found that these parameters can be statistically predicted. Bootsma analyzed the minimum temperature and possible occurrence of frost in mountainous regions of Canada. In a research, Behyar studied the cold event of 27 April, 2003 in Charmahale-e-Bakhtiari province using different meteorological variables to identify the dynamical-synoptic factors responsible for this cold event in the region. Rabani and Karami attempted to study the frequency trend of frost days in Northern Khorasan province. Their results showed that the number of frost days during the examined period indicated a descending trend in such a way that it is in good agreement with the increasing trend of annual temperature in the study area.

Soltani et al. studied the meteorological aspects of an abnormal cooling event over Iran in April 2009. Their results showed that a polar vortex was responsible for the freezing event over the country extending southward extraordinarily in such a way that its ridge influenced most parts of Iran. This was recognized as an abnormal extension of a polar vortex in the recent years. The sea-level pressure fields indicated that a ridge of large-scale anticyclone centered over Black Sea extended southward and prevailed over most parts of Iran. This resulted in the formation of a severe cold air advection from high latitudes (Polar region) over Iran.

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Materials and Methods

In order to investigate the frost characteristics in synoptic station of Saghez, the frequency of frost days is extracted for the period 1976-2007 and then the minimum temperature data are analyzed. The geographic position of the study station is shown in Fig. 1. The homogeneity of the data series verified using Runs Test. After that, the days with a temperature less than 0°C are extracted as a frost day, and the frosts are classified into three categories: weak (ranging from 0°C to -1.1°C); moderate (ranging from -1.1°C to -3.3°C), and severe (less than -3.3°C). Table 1 shows the frequency of occurrence and the beginning/ending date of the frosts with different thresholds during the examined period in Saghez station. In addition, to determine the trend of frost days in Saghez station, a correlation equation was applied between the number of the frost days and length of records (in years), which the linear equation is as follows:

$$y = 0.7953x - 1456.6$$

$$R = 0.435$$

where, x is the length of records; y is the total frost days. It is worthwhile to mention that the above equation is significant at 5%.

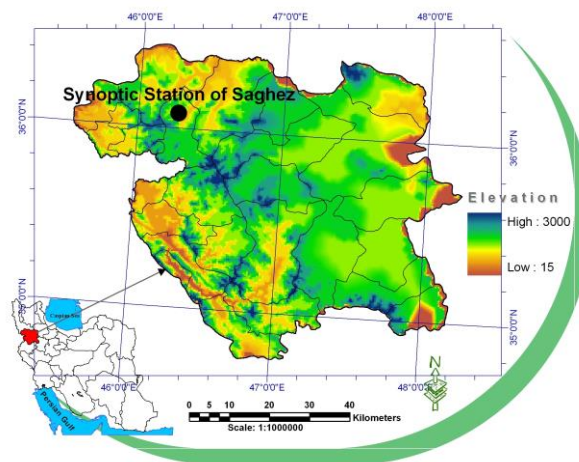


Fig. 1. The geographic position of the study station

Results and Discussions

The knowledge and experience of scientists have presented some solutions over the course of the time, which have been useful in reducing the damages from climatic disasters like frost. The maps of frost occurrence probability and the first data of autumn-time frosts as well as the last date of spring-time frosts are a simple example, but it is significant in studying the frosts for agricultural purposes. By studying the temperature data and frosts days in Saghez station during a 32-year period, we found that the minimum temperature over the past two decades had an increasing (positive) trend in such a way that this trend was most severe in the past five years. This indicates the effect of global warming as a result of a natural process or human activities in the globe. The findings indicate that the severe frosts in Saghez station are mostly occurred in January, February and December months, and the moderate frosts happen in January, February, November, December and March months, and finally the weak frosts usually take place in the months of March, October and April. The trend of frosts days and the minimum temperature in Saghez station indicates a negative correlation as well as an increasing trend in frost days and decreasing trend in the minimum temperature. This unusual trend is due to the decrease of temperature from 1986 to 1989, which is clear for the number of frost days, as well.

Conclusion

The important point in studying the frosts in Saghez station is that according to the obtained equation, there is a significant correlation between the beginning dates of autumn frosts and ending dates of springtime frosts as well as the minimum temperatures of September and April of the same year. The sooner the springtime frosts are ended accompanied by a high minimum temperature of September and April, the later the autumn frosts are started and vice versa. Furthermore, it was determined that the soonest autumn frost occurred on the 2nd day of 2002, and the latest springtime frost took place on the 247th day of this year. Therefore, it can generally be said that through studying and predicting the frost events on time, we will be able to protect the agricultural products against frosts using different methods of using heating systems like stove/heater, wind generator machines or helicopters, producing artificial fog, and etc.

Keywords: frost, linear regression model, occurrence probabilities, Saghez site.

Kinetic and Thermodynamic Studies of Zinc Removal from a Metal-Plating Wastewater Using Firouzkouh Zeolite

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Received: May., 2014

Accepted: Aug., 2014

Expanded Abstract

Introduction

With rapid development of industries such as metal plating facilities, mining, fertilizer product industries, tanneries and paper industries, heavy metals of enriched wastewaters are directly or indirectly discharged into the environment. Zinc as a trace element is effective on human health. It is important for the physiological functions of living tissues and regulation of many biochemical processes. However, too much zinc can cause eminent health problems, such as stomach cramps, skin irritations, vomiting, nausea and anemia. It is present in effluents from various industries such as galvanization and metal-plating facilities, battery manufacture and other metallurgical industries.

The most commonly used methods for the removal of metal ions from industrial effluents are chemical precipitation, solvent extraction, reverse osmosis, ultra filtration, adsorption and ion exchange. Adsorption has been proven to be an excellent and cheap method to remove hazardous materials such as heavy metals and organic dyes from waste effluents.

A good understanding of adsorption equilibrium and thermodynamics is required to design and operate an adsorption process. Natural zeolites are widely distributed in arid and semiarid regions of the world. They are low cost aluminosilicates, with a cage-like structure suitable for ion exchange due to isomorphous substitution of Al^{3+} with Si^{4+} in the structure. They give rise to a deficiency of positive charge in the framework. Due to the above structural characteristics as well as the chemical and mechanical stability, they have received a great attention for the removal of heavy metals from wastewaters. Therefore, this study was conducted to identify the suitability of this mineral for removal of zinc ions from a metal plating wastewater through a series of batch experiments. Accordingly, the influence of contact time, solution temperature, size and dose of zeolite particles were investigated.

Materials and Methods

Wastewater sample

The wastewater samples used in this study were taken from a zinc metal-plating facility in Tehran, northern Iran. The wastewater samples were analyzed for pH, electrical conductivity (EC), the total concentration of dissolved solids, turbidity, and the total concentration of Zn, Fe, Mg, Pb, and Cd ions. The concentration of Zn and other heavy metals was determined using a Savant GBC Atomic Absorption Spectrophotometer (AAS).

Kinetic experiments

All sorption studies were performed using the batch technique because of its simplicity and reliability. The experiments were conducted at pH = 5, sorbent concentration of 2 g l⁻¹, sorbent size of 20-50 μm and at the temperature of 20±1°C.

To investigate the effect of contact time on the adsorption processes a constant mass of zeolite (adsorbent) (0.1 g) and 50 ml of known concentration of wastewater were added to 80 ml polypropylene centrifuge tubes. The mixtures were shaken vigorously on an orbital shaker (175 rpm) and at specified times (5, 10, 15, 20, 30, 60, 120, 240, 480, 720, 1440, and 2880 minutes). Tubes were then removed from the shaker and centrifuged at 2,500 rpm for 25 min and the Zn concentration in the supernatant was measured using AAS.

In order to investigate the effects of suspension pH and temperature, adsorbent dose and particle size of

adsorbents on the percentage removal of Zn, the above experiments were also run by varying initial temperature (20 and 40°C using a thermostatic shaker bath) adsorbent dose (2, 4, 8, 12, 16, and 20 g l⁻¹), and particle size of adsorbents (<2, 2-20, and 20-50 μm), while keeping all other parameters constant. All the experiments were carried out using the largest size and lowest amount of sorbents to identify how removal efficiency is affected if smaller size of particles and higher doses of zeolite particles are applied.

Control treatments with no addition of adsorbent were also run to test the possible adsorption and/or precipitation of Zn onto the container walls. Preliminary experiments showed that metal losses due to the adsorption onto the container walls were negligible.

The amount of Zn²⁺ adsorbed by zeolite, C_s (mg g⁻¹), was obtained as follow:

$$C_s = \frac{[(C_0 - C_e)] \cdot V}{M} \quad (1)$$

where, C₀ and C_e (mg l⁻¹) are the initial and final (equilibrium) concentrations of Zn, respectively; V (ml) is the volume of solution and M is the mass of sorbent (mg). All measurements were carried out with three replications.

Thermodynamic studies

The activation energy of Zn adsorption on zeolite was calculated using Arrhenius equation which is expressed as below:

$$k_2 = k \exp(-E_a/RT) \quad (6)$$

where, k is the temperature-independent factor (g mg⁻¹ min⁻¹), E_a the activation energy of sorption (KJ mol⁻¹), R the universal gas constant (8.314 J mol⁻¹ K) and T is the solution temperature (K).

Thermodynamic parameters of sorption including Gibbs free energy (ΔG₀), change in enthalpy (ΔH₀) and change in entropy (ΔS₀) were also calculated using the following equations (7&8):

$$\Delta G^0 = -RT \ln K_0 \quad (7)$$

$$\ln K_0 = \Delta S^0/R - \Delta H^0/RT \quad (8)$$

K₀ can be defined as:

$$K_0 = C_{\text{solid}}/C_{\text{liquid}} \quad (9)$$

where, C_{solid} is the amount of Zn²⁺ adsorbed by zeolite at equilibrium and C_{liquid} is the equilibrium concentration of Zn²⁺ in solution. The values of ΔH⁰, ΔS⁰ and ΔG⁰ are calculated from the slope and intercept of the plot of Ln K₀ versus 1/T, respectively.

Results and Discussion

Contact time is an important parameter because it can reflect the adsorption kinetics of an adsorbent for a given initial concentration of adsorbate. The results showed an increasing trend on sorption of zinc ions onto zeolite particles. Therefore, the maximum adsorption capacity of zeolite for zinc ions was 17.9 mg g⁻¹ and more than 80 percent of the total amounts of zinc ions were absorbed on zeolite particles within the first 2 hours of experiments. The initial rapid phase may be due to the increase in the number of vacant sites and also the high concentration gradient between adsorbate in solution and that in the adsorbent.

As the temperature increases from 20 to 40°C, the adsorption capacity of sepiolite for Zn²⁺ decreases from 17.9.1 to 14.9 mg g⁻¹. The decrease in removal capacity of Zn²⁺ ion with the rise in temperature is probably due to an increase in desorption of Zn²⁺ ion from the minerals interface to the solution. The results obtained from thermodynamic studies illustrated that sorption of zinc on zeolite particles is a reversible exothermic and physical process.

As compared to the pseudo-first-order kinetic model, a very good correlation coefficient (r²) was obtained for the pseudo-second-order kinetic model.

As expected, the percent removal of Zn²⁺ ions increases as the amount of sepiolite increases. This can be attributed to an increase in the number of sorbent sites after the addition of more mineral particles to the suspension.

The results of the effect of zeolite particle size on the removal efficiency of Zn²⁺ ions from wastewater indicates that as the particle size decreases, the metal diffusion is produced. This increases the accessibility of Zn²⁺ ions by the mineral. This suggests that the most suitable particle size of sepiolite for the removal of Zn²⁺ ions from the studied wastewater is <2μm.

The results also indicated that under similar conditions (T= 40°C), increasing dose of zeolite particles to more than 12 g l⁻¹ with sizes less than 2 μm is a good way to reach the maximum efficiency for the removal of zinc ions from the studied wastewater.

Keywords: kinetic, sorption, thermodynamics, wastewater, zeolite.

Source Identification of Hydrocarbons in Surface Sediments of Mangrove Forests of Khoran Strait, Persian Gulf

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Received: Nov., 2013

Accepted: Aug., 2014

Expanded Abstract

Introduction

Persian Gulf is one of the most important water pathways in the world. It has been heavily developed for crude oil production, transportation and export. It is clear that such activities result in contamination of the marine environment by petroleum and petroleum production industries. The Persian Gulf represents a highly stressful environment due to prevailing natural conditions and development pressures along its coastline. It has approximately two-thirds of the world's proven oil reserves and currently account for approximately one-fourth of the world oil production. The Persian Gulf is greatly intensified by oil spills with accidental discharges of various magnitudes.

One of the most valuable ecosystems of Persian Gulf is mangrove forests. Mangroves are perhaps the dominant and the most important intertidal habitat along tropical and subtropical coastlines and estuaries. These rich ecosystems are located in the areas of high risk in acute or chronic petroleum pollution. Furthermore, high levels of hydrocarbons may be expected to remain in mangrove sediments after occurrence of petroleum contamination because these environments are not favorable for hydrocarbon depletion by sediment transport or degradation by bacteria. These zones are critical areas in which valuable biological resources and rich biodiversity are threatened. These regions are continually exposed to anthropogenic contamination of hydrocarbons from different sources. Unique features of mangrove such as high productivity, abundant detritus and rich organic carbon may make it an advantageous site for uptake and preservation of hydrocarbons.

The studies about distribution and concentration of hydrocarbons were mainly performed in marine water and sediments. There are scarce studies carried out to assess the distribution and source of hydrocarbons in mangrove ecosystems. Straight chain alkanes (*n*-alkanes) and polycyclic aromatic hydrocarbons (PAHs) are common biomarkers that have been applied to assess the petroleum pollution in the marine environment. Therefore, the primary objective of this study is to investigate hydrocarbons in the mangrove forests of Khoran Strait (Persian Gulf) as well as to identify possible hydrocarbon sources in the area.

Materials and Methods

In order to determine the source and concentration identification of hydrocarbons in the Khoran Strait, 17 surface sediments were collected from mangrove forest of this strait. They were then analyzed for *n*-alkane and PAH compounds.

Sampling was conducted during low tide and any water was not overlying the sediments. Surface sediment samples were collected by using stainless spoon and then transferred into a stainless steel container to reduce any contamination. The containers were labeled and placed in icebox at 4°C then transportation to the laboratory for further analysis. The samples were stored in the Cold Room (-20°C) until further analysis.

The collected sediment samples were freeze dried for 3 days to get rid of any water contained in the samples. After the samples were freeze dried they were then stored frozen before proceeding with the analysis of the hydrocarbons.

About 10 g of each sample (dry weight) was used for extraction of hydrocarbons. The samples were extracted

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with a soxhlet extractor using 320ml dichloromethane (DCM) for 8 hours. In order to eliminate any sulfur in the samples, a few of copper chips were added into the samples and left overnight.

Volume of the solvents was reduced using rotary-evaporator to approximately 1 ml. The extracts were transferred onto the top of a 5% H₂O-deactivated silica gel column. The column was rinsed with 20ml dichloromethane/hexane (1:3, v/v). In this step, most of the organic pollutants including *n*-alkanes, PCBs, LABs and PAHs were separated from other polar compounds. The eluted sample was reduced in volume by rotary evaporator for the second step of column chromatography. Fully activated silica gel was used in the 2nd step column chromatography. The concentrated sample from the first column was added to the second column and charged with 4ml of hexane to get alkane fraction. To get PAHs fraction 14ml dichloromethane/hexane (1:3, v/v) was used. All fractions were evaporated to approximately 1ml and then transferred to glass ampoule and evaporated to dryness under gentle stream of nitrogen and alkane samples. They were re-dissolved into 100 μ l iso-octane and PAHs samples were re-dissolved into 100 μ l *p*-terphenyl-d₁₄ as an IIS (Internal Injection Standard) for PAHs.

Samples were analyzed by Gas Chromatography – Mass Spectrometry (GC – MS) using an Agilent Technologies 5975C quadrupole mass spectrometer coupled with an Agilent 7890A gas chromatograph. A 30m fused silica capillary column with 0.25 of internal diameter and 0.25 μ m film thickness, helium was used as carrier gas in the analysis.

Results and Discussion

In this study, *n*-alkanes in range of *n*-C₁₄-*n*C₃₃ and twenty-three compounds of PAHs were investigated. Total concentration of *n*-alkanes (mean \pm SE) was 2802 \pm 334 μ g/g and for PAHs was 1.918 \pm 0.267 μ g/g (dry weight).

The diagnostic hydrocarbonic ratios were used for source identification of hydrocarbon in this region. The sources of PAHs, whether from pyrolytic or from petrogenic origins, may be determined by ratios of individual PAH compounds based on properties in PAH composition and distribution pattern as a function of the emission source. The molecular patterns produced by each source, however, are like fingerprints, which make it possible to hypothesize which processes produce PAHs. For source identification of PAHs, ratio values of phenanthrene/anthracene (Phe/Ant) are widely employed. Pyrogenic source of PAHs are usually characterized with low amount of this ratio. Generally Phe/Ant ratios >10 and Phe/Ant ratios <10 demonstrated petrogenic and pyrogenic source, respectively. In the present study, mean value of this ratio was 19 and this indicates that the major source of PAHs in this region is petrogenic.

Ratio of Fluoranthene/Pyrene is one of the ratios that widely employed as characteristic tools. Similarly, Flr/Pyr ratios >1 and <1 indicate pyrogenic and petrogenic sources, respectively. The mean value of this ratio was 0.48. This suggests strong petrogenic input.

The benzo (a) anthracene/chrysene (BaA/Chr) ratio has also been suggested to identify PAH origins. This ratio tended to increase as petrogenic contribution decreased. In the present study, the mean value of this ratio was 0.22 and PAHs of molecular mass 178 and 202 are widely used to distinguish between petrogenic and pyrogenic sources. For mass 178, ratio of anthracene to anthracene plus phenanthrene (An/ An+Ph) are employed. Ratio < 0.10 and >0.10 indicate petrogenic and pyrogenic sources, respectively. In this study, the value of this ratio was 0.05 and the major source of PAHs in this region is petrogenic.

For mass 202, ratio of fluoranthene to fluoranthene plus pyrene (Fl/Fl+Py) has been suggested to characterize the source of PAHs. The value 0.40 for this ratio specified the petrogenic/pyrogenic transition point. Most of the petroleum samples have (Fl/Fl+Pyr) ratio below 0.40 while those with most combustion produced in PAHs are above 0.40. In this investigation, the mean value of this ratio was 0.35 and this indicates petrogenic source.

Among PAHs with molecular mass of 228, the ratio of benzo (a) anthracene to the sum of the benzo(a)anthracene and chrysene, BaA/BaA+Chr is also declarative of the PAHs sources. Values lower than 0.20 for this ratio suggests a petrogenic source, whereas values from 0.20 to 0.35 indicates a petroleum or combustion source, and any values higher than 0.35 signify a combustion source. For the present study the mean value of this ratio was 0.16. Accordingly, petrogenic sources may be identified by a ratio of indeno (1,2,3-cd) pyrene to the sum of indeno (1,2,3-cd) pyrene and benzo [g,h,i] perylene, IP/(IP+Bghi), lower than 0.20. A ratio between 0.20 and 0.50 may suggest liquid fossil fuel combustion, and a ratio higher than 0.50 indicates biomass and coal combustion. In this study, the mean value of this ratio was 0.17.

The samples were also calculated using methylphenanthrene/phenanthrene (MP/P) ratio to determine the source of PAHs. The value of less than 1 is from the combustion sources and more than 1 is consisted of petroleum sources. In the present study, the mean value of this ratio was 2.

The ratio of LMW/HMW is also employed for identification of PAHs source. The high amount of this ratio strongly indicated petrogenic source. The mean value of this ratio was 19.78, this amount is rather high.

We employed some ratios for source identification of *n*-alkanes in Khuran strait. Wide range of CPI, TAR and U/R for sediment samples of Khuran strait indicated that there are combined sources (biogenic and

petrogenic sources) for organic matter of surface sediments. Therefore, predominate petrogenic source in some of the Middle part stations and biogenic in some others could be explained for these reasons. Pr/Ph, Pr/ n -C₁₇ and Ph/ n -C₁₈ ratios are close to 1 and indicate background petrogenic source in surface sediments of Persian Gulf mangrove forests. In summary, the results showed that the main source of hydrocarbons in this region is mixed source of biogenic and petrogenic origins.

Keywords: hydrocarbon, Khoran Strait, mangrove forests, n -alkanes, PAHs.

Investigation about Accumulation of Heavy Metals (Zn, Cu, Pb and Cd) in Muscle of Great White Heron (*Egretta alba*) in Hara Biosphere Reserve

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Received: Dec, 2013

Accepted: Mar., 2014

Expanded Abstract

Introduction

Environmental pollution, particularly marine pollution, is one of the most complicated and harmful problems human being is faced with in these days. Many of human activities have irrecoverable outcomes that affect marine environment in a way that destruction of marine ecosystems becomes a threat.

Sea was an important resource with special advantages for human in all the times. Thus, it is necessary to protect the environment and its animal lives because of its significant role in human process of life.

Heavy metals are the most important materials entering into the sea through rivers and coastal areas and aggregate in aquatic body through food chain. Heavy metals can cause serious effects on ecosystem stability. As assessment of ecosystem changes and research about all the elements and relations is impossible, use of monitoring species can provide trustful information for quality evaluation environment. Biological monitoring of coastal areas is a substantial method to study pollution causes for waste water discharge and human wastes. The birds in comparison with other animals are very sensitive to environmental pollution. They may distribute chemicals like heavy metals through direct connection with or consumption of polluted water or foods. In other way, because of their indirect connection with polluted sources, they can determine the level of toxic element concentration in marine ecosystem food chain. Therefore, the pollution of bird for heavy metals can anticipate the pollution in food chains.

In this study, the Great White Heron (*Egretta alba*) selected for assessment of the heavy metal concentration. Among different tissues, soft ones are more used for monitoring activities so we use muscle of Great White Heron in this study.

Materials and Methods

Hara Biosphere Reserve is located in south Iran in the Straits of Khuran between Queshm Island and the Persian Gulf. Its latitude and longitude coordinates are 36°40' to 37° N and 55°21' to 55°52' E, respectively. Situated in Mehran River delta, it hosts the largest seabirds along the Persian Gulf shoreline and, therefore, represents a center of biodiversity in Iran. The variety of biosphere reserve with its unique mangrove trees provides a diverse habitat for birds like egrets, herons, pelicans, and plovers. In 2010, it was the host for 36 species and 13,000 water birds and wader birds. It also serves as a breeding and spawning habitat for fish, shrimp, and other crustaceans. On the other hand, this region is one of the protected areas in Iran and this region was introduced as one of the important bird areas by international organization of bird lives.

After primary survey about the study area, we collected 20 Great White Herons in November and Desember 2012 from Hara Biosphere Reserve. After that, they were transferred to laboratory. In laboratory, the birds were dissected, and one tissue sample of their muscle was taken from each bird with a steel scalpel and placed in oven in 105°C for 24 hours. After that, we weight samples by scale for 1 gram parts. In digestion phase, nitric acid (65%) and perchloric acid (60%) in ration of 4 :1 were added to each samples (one gram of weighted samples with 8 mil liter nitric acid and 2 mil liter perchloric acid) and in Hot Block Digester, first in 40°C for one hour and then in 140°C for 3 hours digested. The samples were screened by whatman screen paper and the volume of the solution reached 25 ml by distilled water. Each sample then kept in refrigerator in polyethylene jars in order

to later evaluate heavy metals. In this study, measurement of heavy metals concentration took place by atomic absorption machine, CONTRAA 700 model. For confidence of digestion process and accuracy and effectiveness of consume materials on heavy metal concentration in each digestion round, there were a control sample to achieve the sizable results from the concentration got from the metal in different samples. Mann Whitney U test was performed to compare the accumulation of heavy metals in male and female as well as in adult and juvenile birds.

Results and Discussion

The results of this study indicated that the maximum average concentration belongs to zinc and the minimum to cadmium. The results also showed that there was no significant difference in heavy metal concentrations between male and female except for lead. Furthermore, there was no significant difference in heavy metal concentration between adult and juvenile birds.

The average of zinc concentration in Great White Heron muscle in this study is 96.53 $\mu\text{g/g}$. This is much more than *Phalacrocorax carbo* in Anzali wetland studies of Karimi.

Essential metals like zinc and copper are necessary for body metabolism, but if their concentration in animal body is increased, it will have bad effects on animal health. Essential metals are necessary in all tissues. These metals play a basic role in growing chicks and their bone growth. Painting and scrubbing of ships in shipbuilding factories and their wastes in Bandar Abbas is the most important factor in increasing the concentration of zinc and copper in these birds.

The mean lead accumulation in this study is 0.72 $\mu\text{g/g}$ and this is more than that in the studies of Lucia in France. This is often present in relation to hunting activities, impairs in growth and survival of nestlings; causes haemolytic anaemia in wild Pb-poisoned birds; has adverse impacts on reproduction, such as decreased plasma calcium and egg production; and also causes behavioral problems. Human activities and development of oil refinery and petrochemical industry, zinc and lead factories in Qeshm Island and ship transportation in South Iran may play the most important role in absorption of this metal in muscle tissue of the bird.

The mean cadmium concentration in this study is 0.049 $\mu\text{g/g}$ and this is much more than the same value in the studies of Tsipoura on Canada geese in New Jersey. Cadmium has been described as one of the most dangerous trace elements in food in the environment, not only for its high toxicity but also for its persistence. Atmospheric cadmium deposited on the earth crust can be absorbed or retained by soil particles and become part of biological structures. Dissolved cadmium is readily absorbed by plants and leaches rapidly into the subsoil, contaminating deep and surface waters. The transfer of cadmium from soils to the edible portions of agricultural crops is significantly greater than that of other elements.

The most important factor in increasing cadmium in Hara region is due to oil pollutions, because cadmium is one of the elements of oil. If the oil pollution does not occur by accidents or sudden events, it causes exit of ship ballast water. This problem happens in Bahonar, Foad and Rajaei waterfronts.

We compared the mean concentrations of heavy metals with the current standards. The results showed that the average concentration of zinc is much higher than standards but the levels of lead, copper and cadmium in muscle tissues were below toxicity level. Nevertheless, high concentration of these elements in some samples shows the exposure of these birds to heavy metals. Generally, human activities and development and establishment of various industries around Hara region can be the basic sources of pollution and the effective cause for increase of these metals.

Conclusions

The results showed that there was no significant difference in heavy metal concentration between male and female, except for lead. There was also no significant difference in heavy metal concentration between adult and juvenile birds. The concentration of heavy metals in birds is affected by life place, rate of atmosphere pollution and diet of the birds.

The results showed that the levels of lead, copper and cadmium in muscle were below toxicity level except zinc. However, the high concentration of heavy metals in some samples indicates that the birds are potentially exposed to the threats of contamination by the heavy metals. They are at the risk of heavy metal pollution in their habitats.

Keywords: great white heron, Hara biosphere reserve, heavy metals, muscle, pollution.

Effect of Reed and Hydraulic Retention Time on the Lead Removal in Horizontal Subsurface Flow of Constructed Wetland

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Received: May, 2014

Accepted: July, 2014

Expanded Abstract

Introduction

Wetlands are classified into four kinds of flows as subsurface, surface, vertical, and hybrid flows. Wetlands are usually planted with common reed (*Phragmites Australis*), a rhizomatose plant of the Graminae which produces a good yield in green biomass. The roots of the plant can reach a considerable depth and play a significant role in the wetland self-purification. The treatment efficiency of these systems mainly depends on the wetland design, hydraulic loading rate (HLR), and type of contaminant, microbial interactions and the climatic factors. For the best treatment efficiency, these systems require a low hydraulic loading rate and a long hydraulic retention time. The hydraulic retention time, including the length of time the water is in contact with the plant roots, affects the extent to which the plant plays a significant role in the removal or breakdown of pollutants. Whereas the plants significantly affect the removal of pollutants in horizontal subsurface systems with long hydraulic retention times used to clean municipal wastewater, their role is minor in pollutant removal in periodically loaded vertical filters, which usually have short hydraulic retention times. With respect to the necessity of the research and above descriptions, the main purpose of this study was to evaluate the effect of reed and the increasing hydraulic retention time from 1 day to 10 days on lead removal efficiency in horizontal subsurface-flow constructed wetland to reduce the negative impact generated by lead in the environment.

Materials and Methods

Experiments of the research were conducted in the Agriculture Faculty of Islamic Azad University, Dezful, Iran (48°25'E, 32° 16' N) under ambient conditions. Climate of this region is warm with Mediterranean rainfall regime. Artificial reed-bed system was containing three metal boxes made of galvanized iron in mesocosm scale (1×0.3×0.35m). Dimensions of bed were 1 m long, 0.3 m wide and 0.35 m high. It was filled by river sand with a diameter of 0.01-5 mm and a depth of 30 cm. A large number of young and healthy *Phragmites Australis* seedlings were gathered from local irrigation canals and a number of 20 plants were immediately cultivated in each wetland in June 7, 2013. While planting of seedlings was carried out in at least a space 10 cm from each other and a depth of 20 cm between the roots. This increased the buds and shoots during the reeds growth and prevented them from dying out. The surface loading rate and hydraulic retention time were selected as four different retention time variables including 1, 3, 5, and 10 days. The wastewater containing lead with a concentration of 10 mg pb/l was selected because it was above standard of Iran Environmental Protection Agency, World Health Organization (WHO) and FAO for irrigation. This dose was also selected in similar studies in the range of 1-20 mgpb/l. All influent and effluent samplings and plant samples were measured by Perklm Elmer A Analyst 700 atomic absorption.

Results and Discussion

Models and Lead Removal Efficiencies

According to measurements, removal efficiency (RE) and relative concentration of inflow to outflow (c/c_0) in synthetic wastewater were calculated. In addition, removal time ratio (RTR) was calculated at different retention

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times. Accordingly, the relationship between the lead removal efficiency and HRT was examined and the relevant equation was derived as the exponential equation $RE = a.(b-e^{c.t})$ by using CurveExpert1.4 application, so that among the fitted equations it had the highest correlation coefficient ($r=0.975$) as presented in Table 1. Meanwhile, Measurements showed the more hydraulic retention time increases, the more removal efficiency increases. But the increasing rate of RE was decreasing in the range from 88.2% to 84.1 during different retention times.

Table 1. Regression coefficients of exponential equation of lead removal efficiency

a	b	c	r	n	Standard error
0.085	10.39	0.718	0.975	12	0.004

Effect of Hydraulic Retention Time

Changes in trend of removal efficiency in relation to HRT showed that the more retention time extended, the more removal efficiency increased. It seems that with the increasing HRT, the hydraulic loading rate and lead surface loading rate decreased. Thus, enough opportunity was provided for physical, biological, and chemical processes for lead removal in the reed-bed systems. In order to investigate the significance effect of HRT on the removal efficiency, observed means were compared using SPSS18 software and Duncan test which the relevant results are shown in Table 2. According to the results, a significant difference was observed between removal efficiencies at retention time 1, 3, 5 days ($P<0.05$) but no significant difference was observed between efficiencies at retention time 5 and 10 days ($P<0.05$). Therefore, 5-day retention time is suggested in optimum conditions (Table 2).

Table 2. Effect of retention time on the average removal efficiency

Duncan Test *	RE (%)	HRT(day)
A	84.1	1
B	87.2	3
C	88.1	5
C	88.2	10

* Different letters indicate significant difference between HRT at the level of $P<0.05$.

Similar studies have been done on the lead removal efficiency in constructed wetlands by different researchers. Similar results have been obtained by the researches, so that the lead removal efficiency was mainly concluded in the range from 76 to 95%. Moreover, the formation of insoluble sulfides, filtration of solids and colloids, sedimentation, combination with iron and manganese oxide have been reported as the main processes in lead removal from waste water in CWs. In a research conducted in subsurface-flow constructed wetland in a pilot scale by cultivating Typha and Phragmites, similar results were obtained. In this study, the lead concentration of influent was in the range of 1-20 mg/l and the removal efficiency was measured in the range of 75-96%. In another research conducted on lead and cadmium, it was observed that with increase of retention time from 2 to 6 days, removal of the heavy metals was also increased, and the maximum removal efficiency was 75%.

Bioaccumulation Factor

The linear relationship between HRT and bioaccumulation factor (BAF) in the dry tissue of reed was examined. Accordingly, a linear relationship with high correlation coefficient ($r^2=0.988$) was obtained based on the equation of $BAF=30.167 HRT$ in which HRT was hydraulic retention time in day and BAF was lead bioaccumulation factor in mg/kg of dry weight. The results showed that there was a significant relationship between hydraulic retention time and BAF so that with the increasing HRT, absorption of plant root increased up to 116 mg/kg d.w. of root tissue at 10-days HRT. Thus, reed is highly capable of absorbing and accumulating of Pb and plays an important role in the removal of lead in subsurface wetland system. Aquatic plants are among the main biological processes in wetlands because they not only directly absorb oxygen but also make it enter around the root zone which leads to nutrition absorption, oxidation and direct spoilage of contaminations and more activities of microorganisms. Consequently, different plant species play important roles in the heavy metals removal. With regard to the mass balance of lead in wetland, the percentage of bed and plant contribution in the lead removal was separately calculated. As a result, the contribution of reed in lead removal was examined during four retention times in the range of 8-22% of influent lead from 1 to 10 days so that the contribution of reed increased in relation to HRT but in contrast, the contribution of bed decreased in the range of 77 to 91% of

influent lead. It seemed that the contribution of bed at lower retention time was more effective due to higher HLR and when the hydraulic retention time increased, the storage capacity of bed decreased. Given that the used bed was made of fine sand and the sand lacked cation exchange capacity (CEC), the removal were carried out mostly by the biological and physical mechanisms resulted from plant and microorganisms uptake and hydraulic characteristics. Therefore, with the increase in reed bioaccumulation factor (BAF) in relation to HRT, a decrease in the contribution of bed seems to be reasonable. Biological removal is an important pathway for heavy metal removal in the CWs. It includes plant and microbial uptake. The rate of metal removal by plants varies widely, depending on plant growth rate, plant species and concentration of the heavy metals in the wastewater. Maximum concentration of metals in plants has been observed in under-ground organs.

Conclusions

The relative concentration of effluent to influent (C/C_0) decreased significantly due to the increase in HRT and the decrease in HLR from 19.8 to 3.5 cm/day and as a linear relationship with high correlation coefficient ($R^2=0.991$). Therefore, the more retention time increased and the surface loading decreased, the more time was provided for chemical and biological processes affecting the lead removal in subsurface wetland system. Moreover, statistical analyses showed that there was a significant difference between removal efficiencies at retention times 1, 3, 5 days ($P<0.05$) but there was no significance difference between the efficiencies at retention times of 5 and 10 at 5% level. Therefore, 5-day retention time was suggested as optimum conditions with the removal efficiency of 88.1%. Meanwhile, the results of the measurement of reed tissue showed that there was a direct relationship between HRT and BAF, so that the more retention time increased, the more bioaccumulation factor increased up to 116 mg/kg d.w. of below organs during experiment period. Moreover, the contribution of reed in the lead removal was in the range of 8-22% of influent lead from 1 to 10 days, respectively. This was so that the contribution of reed increased in relation to retention time. Consequently, reed played an important role in the removal of lead in horizontal subsurface wetland.

Keywords: constructed wetland, lead accumulation, reed, removal efficiency.

Investigation about the Effects of Solar Radiation Parameter on Radial Growth of *Quercus castaneifolia* in Astara Forests

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Received: June., 2014

Accepted: Aug., 2014

Expanded Abstract

Introduction

Climate change is due to abnormal changes of climate within the earth's atmosphere and their consequences. One of the most significant effects of climate change is irreversible damage to some floral species and forest ecosystems. Tree species reflect the impact of climate changes on their ring width. Generally, tree rings vary in size each year depending upon the environmental conditions or climate variables that the tree experiences. In fact, tree rings are severely dependent on the changes of climate variables. It is considered a basis for "dendrochronology" which is the scientific method of dating based on the analysis of patterns of tree rings or investigation on the effects climate variables on the width tree rings. Many national and international studies have been conducted on dendrochronology. However, national researches investigated the effects of temperature and rainfall changes on radial growth of trees. Unfortunately, due to lack of long-term solar radiation data in most of the meteorological stations in Iran, the effect of this parameter on the radial growth of trees has not been studied so far. Meanwhile, the solar radiation has a significant influence on the width of tree rings, particularly in tolerant shaded species like oak. One of the most important tree species of Iran is the Oak tree (*Quercus castaneifolia*), due to its being spread in different areas of the country and its high economic and environmental values. Unfortunately, because of climate changes and droughts, and also overcutting of *Quercus castaneifolia* for wood and live-stuck and food supply, this precious species has been subjected to serious threats in the recent years. Hence, the role of climate in addition to improper management is significant. To protect *Quercus castaneifolia*, the first and the most important step is the scientific planning for forest management, through knowing the effective parameters of climate change on the growth and physiology of the trees. Therefore, researches about the oak species and utilization of their results are essential for their protection.

Therefore, to solve the problem related to the lack of solar radiation data, in this study, an appropriate methodology was carried out based on empirical formulas for calculating the solar radiation. Thereafter, the incoming solar radiation in the Astara Forests was calculated. In the next step, by using seven discs harvested from *Quercus castaneifolia* trees, the chronology of this species for each disc in two perpendicular directions was obtained by using LINTAB tool coupled with TSAPWin software. Finally, the relationship between tree ring widths and climate variables was determined.

Materials and Methods

In this research, the seven discs were harvested from *Quercus castaneifolia* trees with mean tree ages of 35 to 78 years in the Astara Forests located in the north Iran. In addition, the climate variables were collected from the synoptic meteorological station of Astara. However, due to financial, technical or institutional limitations, the solar radiation data are absent, incomplete or inaccessible in most areas of the world particularly in developing countries such as Iran. This seriously hinders the progress of forestry researches such as chronology studies that require solar radiation as a key driving input. Therefore, various methods have been explored in order to estimate, with reasonable accuracy, the solar radiation from other available meteorological data. One kind of

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widely used method is based on empirical relations between solar radiations and commonly measured meteorological variables. Therefore, in this research, Angstrom-Prescott model (Eq. 1) was selected to estimate the monthly and yearly global solar irradiation (R_s) in the Astra Forests.

$$R_s = R_a \left(a + b \frac{n}{N} \right) \quad (1)$$

In the next step, the chronology of each disc in two perpendicular directions was obtained by using LINTAB tool coupled with TSAPWin software. The Gleichläufigkeit (GLK), Crossdate Index (CDI), and Signature GLK (GSL) were used to evaluate the obtained chronology for each disc.

Results and Discussion

According to obtained results on determination of a and b parameters of Angstrom-Prescott model for different regions of Iran, 0.404 and 0.204 were selected for Astra Forests, respectively. Then, using recorded meteorological parameters in Astara Synoptic Station, the monthly and annual global solar irradiation were estimated for Astra Forests during 1985 to 2005 (Fig. 1).

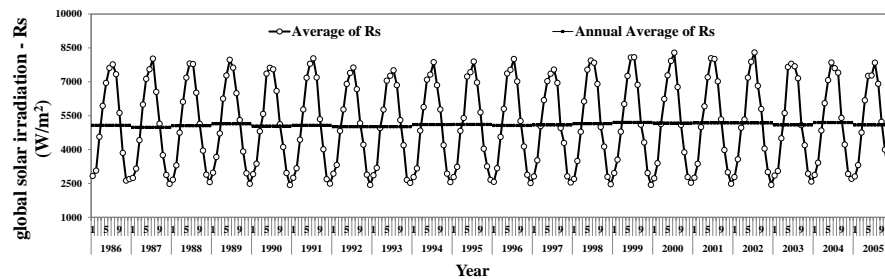


Fig. 1. Annual and Monthly Average of R_s

In the next step, the chronology of species for each disc in two perpendicular directions indicated that statistical indices had appropriate values. Findings showed that the average values of chronology for each disc which were derived from two vertical directions were significant. In other words, three useful parameters for assessment of the chronology quality of all seven discs, i.e., GLK, CDI, and GSL, were more than 73, 46, and 99.9%, respectively. Thus, the average sizes of two perpendicular directions for each of the seven discs were calculated and the chronology of the average values was carried out. Only four of the discs showed proper results according to their indices. Using the chronology of the four discs, the regional chronology of *Quercus castaneifolia* trees in Astara Forests was calculated (Fig. 2). Ultimately, a statistical relation was determined between the R_s and the chronology of these trees (Fig. 3).

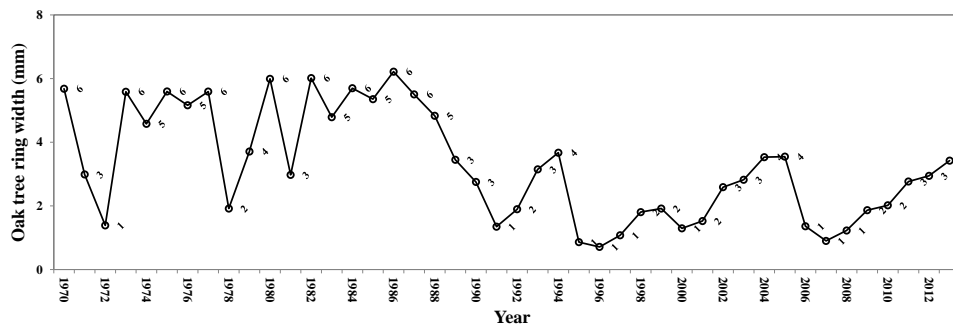


Fig. 2. Regional chronology of *Quercus castaneifolia* trees in Astra Forests

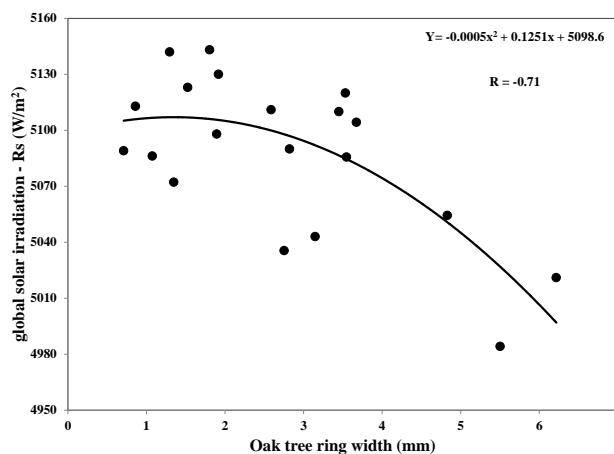


Fig. 3. *Quercus castaneifolia* trees ring widths vs R_s

Conclusion

The widths of *Quercus castaneifolia* tree rings vary with R_s by a second order polynomial function. The R value of this function (-0.71) is proper, which is an indicator of a strong relationship between R_s and *Quercus castaneifolia* tree ring widths. The negative value of R shows an inverse relationship, an expected fact which obviously reflects the shade intolerant quality of oak species. It can be concluded that the findings of the present research are reliable and justified based on the similarity of temperature and R_s and also according to the previous studies on the effects of temperature on tree ring widths, which resulted in negative R values.

Keywords: chronology, climate, radial growth, solar radiation.

Climatic Analysis and Tracking of Comprehensive Dust Storms in the South and Central Iran

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Received: April, 2014

Accepted: July, 2014

Introduction

Dust storms as one type of dust events are in most cases the result of turbulent winds, including convective haboobs. These winds can raise large quantities of dust from desert surfaces and reduce visibility to less than 1 km. This dust storm reaches concentrations exceeding 6000 mg/m³ in severe events. The major dust source regions are the areas of arid and hyper-arid, with mean annual precipitation of less than 100 mm.

The temporal and spatial investigation of dust storms shows the interference of various factors in their occurrence and expansion. These factors are divided into two groups; environmental and human parameters. The climatic (such as low rainfalls, high evaporation, intense wind, drought and atmospheric general circulation) and geological (for example lithology such as Quarts, Clay, Silicate and feldspar) factors are natural parameters, and factors such as over-grazing and crop production, degradation of vegetation, increasing growth of population, war and political problems are human parameters.

Much of the current interest in dust storms is related to their possible role in the systems and subsystems of the earth. Dust loadings may affect air temperatures through the absorption and scattering of solar radiation. It may affect cloud formation, convectional activity, sulphur and carbon dioxide levels in the atmosphere, and influence geo-chemistry cycle, soil evolution and desertification.

Dust storms are one of the destructive climatic phenomena affected by various climatic elements such as pressure, precipitation, wind, temperature and evaporation. These phenomena impose much damages to human health, industrial and agricultural installation, population centers and communication ways. The recognition of source regions, creation and expansion style of dust storms and their relation to atmospheric circulation patterns are fundamental factors in reduction of their damages. In the recent decades, trend of dust storms has been increased in Iran, particularly in west and southwest areas. This factor is also raised the necessity of dust study in these areas more than before.

Frequency and intensity of dust storms in west and southwest parts of Iran has made this phenomenon one of the most principal environmental hazards of these regions. According to the extent of dust storms and their enormous effects on health, economy, environment and agriculture and their increasing trend has drew the attention of many researchers. The recent study is carried out by data analysis of dust storms from Iran Meteorological Organization Earth Database.

Materials and Methods

In the research, environmental and circulatory databases were used to analyze the synoptic systems of Comprehensive Dust Storms in the South and Center of Iran. At first, the number of dust days was determined using climatic data of more than 30 synoptic stations in a 9-year period, from 2002 to 2009. Then, their

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circulation patterns were identified and plotted. The circulation patterns of extreme dust days was also identified and plotted in the study area. The meteorological data including the middle and upper atmosphere data such as the sea level pressure, level of 500 hPa geo-potential height, wind direction, vertical velocity, surface temperature and the subtropical wind profiles were received at 100-1000 hPa height from NCEP/NCAR database. They were drawn for 0-80 longitude and 10-70 latitude using GRADS software. Then, visibility, wind direction and velocity, relative humidity and precipitation were extracted for each day. WRPLOT VIEW VERSION 5.3 software was used for wind rose drawing by wind storms with direction and speed. HYSPLIT model was employed to recognize the origin of dust storms and wind flow routing in Shiraz, Fasa and Bushehr stations.

Results and Discussion

In the recent decades, the global effectiveness of dust storms has become increasingly apparent, so that, major advances have been occurred in sources, transport paths with many impacts both on humans and the environment, their frequency at different time scales. Earth database investigations show that one of the most extreme dust storms was occurred in year 2008 in terms of visibility reduction and durability of dust storm days in the period of this study. The June 10 in 2008 is the most extreme dust storm day with visibility of less than 500 meter in the stations. The mentioned dust storm as one of the most intense dust storms of the recent years can help recognize the atmosphere patterns causing this phenomenon and tracking of the winds transmitting aerosols.

The results of the middle and upper atmospheric circulation shows that the westerlies occurred in 2008 June 10 with a low pressure center in the east Iran and high pressure in the North Africa (Figs. 1 and 2). These conditions caused the entrance of dust into the study region.

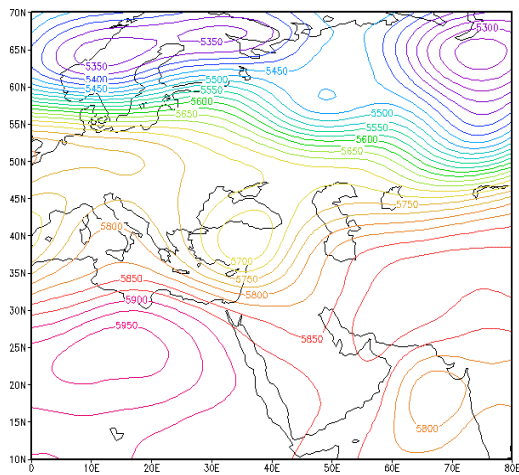


Fig. 1. map of 500 hPa at 10/6/2008

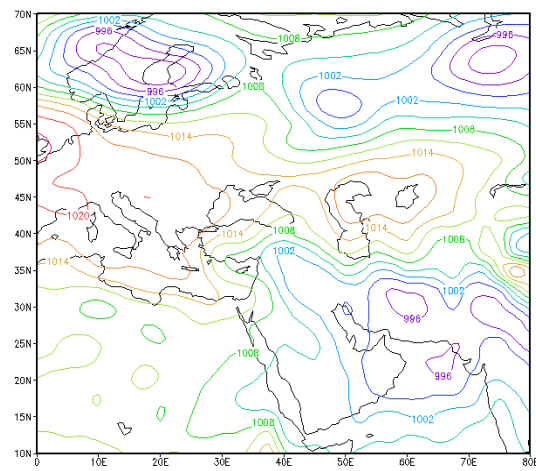


Fig. 2. map of sea level pressure at 10/6/2008

The isothermal map of sea surface represents the ascendancy of 50 degrees curve on the center of Iran. The isothermal map of 42.5 degrees is also on the East Saudi Arabia. The curves of 40 degrees have dominated on Iraq and Syria where causes temperature increase and drought air in the region.

Omega map of sea surface at June 10, 2008, indicates the -0.1 contour in Central regions of Iran. This shows the downward air flow in the area. Moreover, the central core of the upward flow, with contour of 0.2, is dominant in the North Saudi Arabia, Iraq and Syria. This illustrates an air mass with ascending movement in these areas.

The patterns related to humidity represent relative humidity of 10% in Iran. The specific humidity is also very low and is equal to 0.004 which represent minimum rates of humidity and very high drought causing or increasing dust storms in the studied day.

The results of wind flow routing by HYSPLIT model showed that the origin of dust storm mass had been in North West of Iraq and east Syria. They had entered Iran with a north west-south east direction (Figs. 3 and 4).

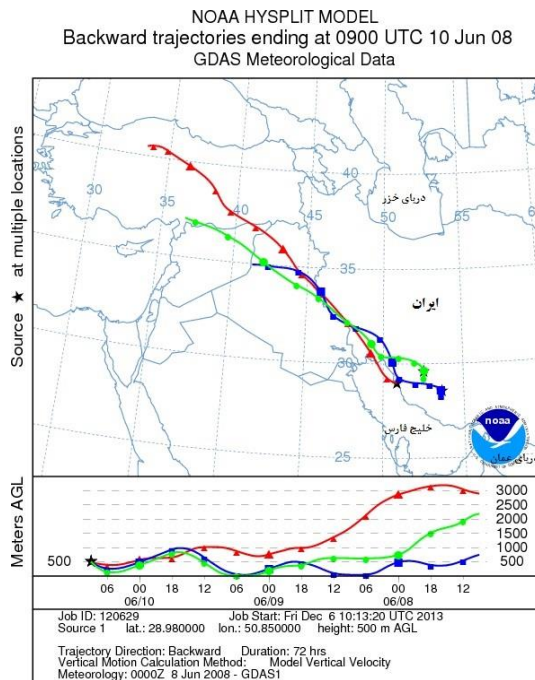


Fig. 3. Map of backward trajectories ending at 10/6/2008

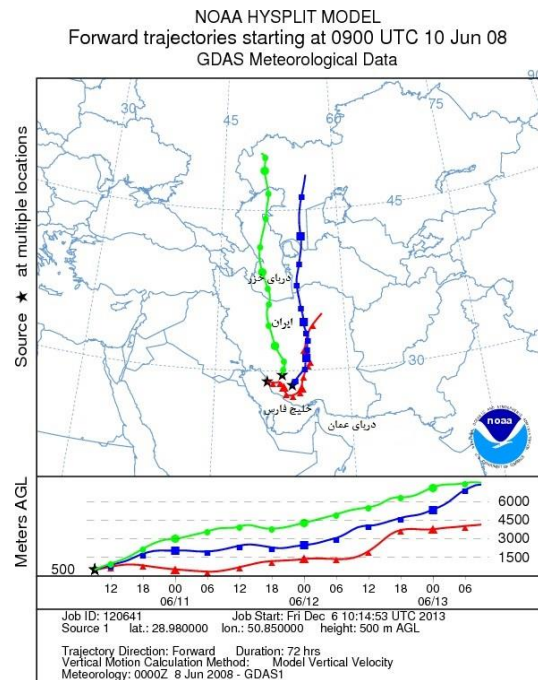


Fig. 4. Map of forward trajectories starting at 10/6/2008

Conclusion

The study about the circulation patterns transferring dust storms in the South and Center Iran is highly important. For example, the west region of Iran isn't a source of dust because of natural characteristics such as mountainous areas, high rainfalls and dense vegetation. But, dust storms of this region are non-local. This region is the transport path of climatic systems into Iran, and accepts the effectiveness of these systems. According to source regions of Iran, dust storms are usually dominated over hyper-arid lands of Iraq, Saudi Arabia, Syria and North Africa. This study is a connective step between large scale circulation patterns and temporal and spatial activities of dust storms in the South and Central parts of Iran.

This study has examined the relationship between large scale synoptic patterns and variability of space-time dust storm activities in Iran. The study has used synoptic maps of sea level pressure circulation patterns, 500 hPa geo-potential height, wind direction data, vertical velocity, and surface temperature with geo data of dust storms in the studied stations and wind flow tracking model. It can be concluded that dynamic models can be presented by consensus of various specialists for this destructive environmental phenomenon. Use of the capability of satellite imagery and dust storm investigation can be of great importance for the future studies. In general, the results of this research show that wind flow routing model and atmosphere studies have the suitable capability for recognition and monitoring of dust storm paths.

Keywords: dust storm, tracking, synoptic analysis, wind flow routing.

Assessment of Environmental Impacts Using Fuzzy Logic Inference Model (Case study: Kamal Saleh Dam)

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Received: Jan., 2014

Accepted: July., 2014

Expanded Abstract

Introduction

Determination of the importance of environmental impacts is one of the main issues and concerns in the process of Environmental Impact Assessment (EIA) of projects. Ecological impacts assessment is very complicated and requires estimates and anticipation of all environmental impacts and always associated with uncertainty. A major problem in assessment of ecological impacts is that they cannot be formulated in one algorithm, because the vital elements and their interactions cannot be completely identified (Crisp). On the other hand, the spatial heterogeneity of ecological systems and the complexity of decision making have made the impact assessment more difficult. Therefore, the concept of environmental impacts is often ambiguous. The main problem is that EIA models are incapable of managing qualitative data. Fuzzy inference will avoid these difficulties. Fuzzy logic brings a method for a broad range of objective data, quantitative data, opinions and subjective judgments to a natural language to describe the environmental impacts. Fuzzy logic is an especial, powerful technique for classifying and describing the environmental conditions, with both natural and human origins. Fuzzy logic has the ability to quantify and classify the environmental impacts with subjective nature. The main objective of fuzzy inference method for EIA is to calculate the significance of the effects based on fuzzy logic. In this study, fuzzy logic is used to determine and rank the significance of impacts, as a method to assess qualitative data. Therefore, the performance of fuzzy logic inference method in comparison with mathematical matrix method is discussed.

Materials and Methods

Kamal Saleh Dam basin is located in 49° 4' 2" to 49° 27' 11" east longitude and 33° 33' 13" to 33° 55' 55" North latitude, with an area of 655 square kilometers. It is located in south west part of Markazi province and North East part of Lorestan province in western Iran. This dam has been constructed at a distance of 74 km from the Arak city and 46 km to Shazand city on the Tireh River.

In this research, fuzzy logic (Kamal Saleh DAM) is applied in case study to assess the environmental impacts as a novel method for the environmental impact assessment. Therefore, an evaluation was done by two methods: mathematical matrix and fuzzy logic. The mathematical matrix method was used after indigenization, so that the matrix is composed of two parts: a complementary index and a basic index, each index includes three criteria containing six subordinate criteria overall (magnitude (M_{ij}), duration (D_{ij}) and occurrence Time (T_{ij}) as basic index parameters, and synergy effects (S_{ij}), cumulative effects (A_{ij}) & Probability of occurrence (P_{ij}) as complementary index parameters) along with the nature of impact (N_{ij}) showed by + and – symbols which indicate the desirable and undesirable effects of the impact (I_{ij}), respectively. Finally, using the mentioned mathematical relation, we achieved the importance of impact of each action on the environment.

$$MDT_{ij} = \frac{M_{ij} + D_{ij} + T_{ij}}{15} \quad (1)$$

$$SAP_{ij} = \frac{S_{ij} + A_{ij} + P_{ij}}{15} \quad (2)$$

$$I_{ij} = MDT_{ij}^{1-SAP_{ij}} \quad (3)$$

Then, the importance of the effects was classified as very low (VL: $0.2 \leq X < 0.36$), low (L: $0.36 \leq X < 0.52$), medium (M: $0.52 \leq X < 0.68$), high (H: $0.68 \leq X < 0.84$) and very high (VH: $0.84 \leq X < 1$).

Fuzzy logic

In the fuzzy logic method, above mentioned mathematical matrix indices were considered as fuzzy inference system input. The criteria got fuzzification. After determination of membership functions similar to the groups of mathematical matrix classification, and forming rule base center in the importance of impact, the criteria were calculated by the center of gravity method as defuzzification approach. The output of the fuzzy logic inference is actually measurement about the effect of each activity on the environment. Ultimately, the efficiency of two mentioned methods was compared with one another for assessment of the importance of the effects. These two methods have quite similar inputs. To do this, in mathematical matrix method and fuzzy logic, 6 criteria for 2 indices (complementary index & basic index) were used (magnitude (M_{ij}), duration (D_{ij}) and occurrence Time (T_{ij}) as basic index parameters, and synergy effects (S_{ij}), cumulative effects (A_{ij}) and probability of occurrence (P_{ij}) as complementary index parameters).

In the method of fuzzy inference system, Matlab Ver R2012a software and Mamadani execution method were used. The same mathematical matrix indices as system input was implemented.

Results and Discussion

According to the below chart review (Fig.1), the difference in the number of linguistic variables in mathematical matrix and fuzzy methods is quite obvious. These differences are arisen from the decision making method in Aristotelian logic and fuzzy logic. The importance of the impact calculated based on a mathematical matrix class can create uncertainty, which is more important in borders of classification (where X is increasing along with the value of impact from very low to very high), i.e. as we move towards increasing the variable X, the value of linguistic variable will increase. This can be seen as several classes in output matrix. For example, if the variable is $X=0.53$, it belongs to medium-class and if variable is $X=0.67$, it still belongs to the same class, even though there has been a major numerical increase; on the other hand, with the increase of 0.01 at 0.67 point, the importance of impact will change from medium to high.

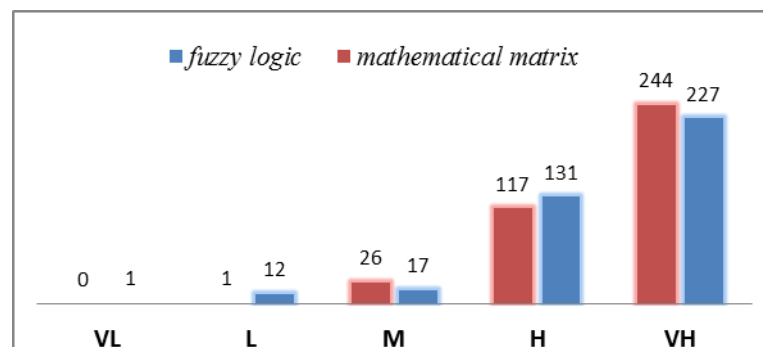


Fig. 1. Comparison of the numeric summation of whole impacts importance (positive and negative) in the two methods of mathematical matrix and fuzzy logic

However, fuzzy logic approach solved this problem and its output is defined based on membership grade. For example, if the output of fuzzy logic is $\bar{Y} = 0.67$, then the fuzzy logic determines a degree of membership for two membership functions, and thus the uncertainty in the mathematical matrix classification. Impact importance of $\bar{Y} = 0.67$ in fuzzy logic belongs to two membership functions with different membership levels, moderate linguistic variable with $\mu_M = 0.06$ degree of membership and high linguistic variable with $\mu_H = 0.94$ membership degree.

Conclusion

The concept of environmental impact Assessment is unambiguous and ecological effects cannot be explicitly defined. For this reason, the fuzzy logic has a very high performance in formulating the importance of each impact in an appropriate manner. Fuzzy logic is capable of using qualitative criteria or linguistic variables for assessment and solving of the problem of the variables formulation. It is simultaneously capable of using and synthesis of both qualitative and quantitative data derived from environmental assessors. As a result, the fuzzy logic method leads to modification of uncertainty which is always a problem in unambiguous and complicated

matters such as EIA. Since one of the main issues in environmental impact assessment (with project approval and determination of appropriate corrective solutions) is to define the impact significance correctly; the fuzzy logic with its spectacular capabilities is an appropriate method. Determination of the importance of environmental impacts is one of the main issues in the process of environmental impact assessment (EIA). Ecological impact assessments is very complicated and always associated with uncertainty because the assessment data are often qualitative. The common EIA methods are incapable of managing these kinds of data.

Keywords: environmental impact assessment, fuzzy logic interference, impact importance, mathematical matrix.

Participation of Environmental NGOs in Conservational Activities: Evidences from Kani Barazan Wetland in Mahabad

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Received: March., 2014

Accepted: July., 2014

Expanded Abstract

Introduction

Today, human society is faced with tremendous challenges such as the environmental problems. If same process continues and serious efforts are not made to resolve this crisis, it will turn into a disaster. Although NGOs have a long history, but unfortunately they have not yet found a suitable place in the field of environment and natural resources. There is always one concern: what factors can attract people to participate in environmental activities effectively.

In one hand, because of uncontrolled use and application of natural resources without any special plan, the rate of degradation and exploitation of these resources is much greater than their renewal ability and this issue has destroyed a wide range of resources. Therefore, strategy formulation for conservation and sustainable use of these resources as a fundamental necessity is felt more than ever.

On the other hand, environmental problems have become pervasive global crisis and if we do not make any attempt to solve this problem, human will be faced with an enormous disaster. Fiftieth principle of Iran's constitution and fourth program of economic, social and cultural development has emphasized on the environmental protection. This is the criterion for national and community participation to protect the country environmental assets. According to these issues, in the recent years, public participation in environmental decision making at the regional, national and international level is increasingly institutionalized.

Participation is resulted from a dynamic process in which the person knows his/her real requests. Participation is a goal and also a dynamic activity that enables people to increase their role in developmental activities. In this type of partnership, each individual has the right to express and intervene in processes of making decisions about his or her own live. Participation is an instrument to expand the purposes, ideological and normative development, like equality and democracy.

Wetlands can be called as the most beautiful aspects of life in the world. The combination of onshore and offshore ecosystems leads to the emergence of "Wetland" or "wetlands". These critical environments are the most fertile, complex and sensitive habitats of the earth. Wetlands commission in 1362 is defined "wetland" as follows:

Wetland is an area of the natural manifestation of God that in the process of emergence, the soil becomes saturated by surface water and groundwater and over time it is formed with normal and environmental conditions and has biological sequences.

This ecosystem includes the communities of plants and animals that can be adapted to the particular ecological conditions. The wetlands are considered as natural and untouched and pristine. To most people, the peace of a wetland preferred relative to the mountains and deserts and deltas. Many plants and animals of the wetlands are attracting the attention of people. Natural enthusiasts know that wetlands even have mental healing value.

In this relationship, non-governmental organizations play an undeniable role in protecting natural resources and the environment. To clarify the situation that shows the importance of this role, we need a systematic research. Therefore, this study aimed at investigation about the factors affecting on participation of environmental NGO's in conservational activities.

In the present study, we emphasize on the non-governmental organizations that are active in the area of Kani

Barazan Wetland. Three NGOs are active around Kani Barazan Wetland. The main problem of this study is to identify the major factors that influence participation of members in the concept of wetland protection.

Materials and Methods

A descriptive – correlation research was conducted in this study and data were collected through a survey. The study population were the members of three active NGO's in the field of environmental protection of Mahabad's Kani Barazan wetland (N = 120). Up to 92 people of them were selected as the sample. In this study, the factors affecting participation were assessed in five categories, including informational, economic, cultural, motivational and managerial factors.

A questionnaire was designed to collect the required data of the research. Its validity was confirmed by a panel of experts (Faculty members and PhD and MSc students of Department of Agricultural Development and Education of University of Tehran). The Cronbach's alpha coefficient was used to assess the reliability. The reliability values are ranged more than 0.7 for each part of questionnaire. This indicates its reliability was appropriate. The 92 questionnaires were distributed among the participants to collect data. After that, 85 sheets of them were used in the final analysis. For data analysis SPSS₂₁ software was applied. To investigate the participation rate of conservation measures between male and female, the mean comparison was performed by using Student's T test.

Results and Discussion

The results indicated that there is a significant difference between male and female and degree of participation ($t = 2.937$). To determine the effects of variables on participation rates, stepwise regression analysis was used. Stepwise approach is a method in which the most powerful variables enter into the regression equation, in order, and this continues until the significance test error reaches 5%. In this study, after entering the variables that were significantly correlated with the dependent variable (participation in conservation measures), make an equation, in 4 steps. Therefore, the variables of economic factor, informational factor, cultural factor and management factor were entered into regression analyses (Table 1).

Table 1. results of stepwise regression analysis

Variable	B	Beta	t	Sig.
Constant	5.466	-	5.217	0.000
F ₁ : economic factor	1.142	0.504	8.150	0.000
F ₂ : informational factor	1.187	0.488	7.966	0.000
F ₃ : cultural factor	0.774	0.251	4.134	0.000
F ₄ : management factor	0.415	0.144	2.349	0.021

According to the results presented in Table 1, the linear equation of the regression is as follows:
 $R^2 = 0.711$

$$Y = 5.466 + 1.142 F_1 + 1.187 F_2 + 0.744 F_3 + 0.415 F_4$$

The results showed that 71.1 percent of participation variance was determined by these variables. According to the values obtained for the Beta, independent variables that have the greatest effects on the participation rate are, in an order, as: economic factor, informational factor, cultural factor and management factor.

Conclusion

Based on the results, there is a negative and significant difference between male and female in line of participation rates at one percent level of significance. The significant relationship between age and participation rate at the one percent level was also observed. These results are consistent with research findings of some scientists.

Since the informational factor in this study showed significant and positive effect on participation in environmental activities and this is consistent with the results of previous studies, some activities such as exhibitions and conferences in the field of environmental pollution control and training workshops should be done to help people be familiar with the principles and objectives of the participations.

Another factor of significant effect in this study was cultural factor. This contains some items such as having the spirit of cooperation among community members, collective decision making in cooperative and public encourage toward the movement of participation.

Management is also another factor that has a significant effect on participation in environmental protection of wetlands. This is consistent with the results of some other studies. Therefore, improvement in the management

mechanisms from government and on behalf of wetlands board members can be followed by effective results. Another factor that has a significant impact on the participation is economic factor. Therefore, according to the results, this can be recommended that characteristics and their cultural and economic structure and level of their knowledge as well as their age should be carefully identified and evaluated.

We can apply this information in future planning to increase participation in conservation measures. Since the rates of women's participation in conservational activities are reported less than those of men, we must create necessary cultural and motivational background for increasing women's participation by doing measures such as festivals and seminars with educational purposes. People should be provided with the required information for enhancement of their science and knowledge in the field of environmental protection.

Keywords: conservational measures, environmental conservation, non government organizations (NGOs), participation.

Estimation of Economic Values of Recyclable Metals of Electronic Wastes (Case Study: District 6 of Tehran)

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Received: April, 2014

Accepted: July, 2014

Expanded Abstract

Introduction

In general, based on a simple division, the electronic wastes (e-wastes) can be considered as a subset of municipal solid waste. They are a combination of homemade, administrative, commercial and industrial wastes. Therefore, the electronic wastes have become one of the most important issues for global community. Because of the increase in these wastes, their collection and recycling are necessary. In economic terms, electronic waste recycling has high potential and today recycling of such materials is considered as a profitable business for many credible firms such as Bodian in Sweden, Vias in Norway and Catriana in England.

Some studies have been carried out to predict the e-waste production. Based on their proposed model, the time series of lifetime are used to estimate the e-waste production. In fact, they predicted lifetime process based on life cycle and disposal of electronic waste.

Materials and Methods

Case Study

The case study of this research is district 6, one of the oldest areas of Tehran located in the city center. The area of this region is 2138.45 hectare and covers about 3.3% of the total area of city.

Analysis Method

Calculation of e-waste production

As mentioned, the district 6 had an estimated population of about 215900 people in 2012. The population growth rate of this district is -0.1. Accordingly, the population was calculated for 2021 using population estimation formula (Eq. 1).

$$P_t = p_0 (1+r_0)^n \quad (1)$$

where, P_t is the final population, p_0 is the initial population, r_0 is rate of growth and n is the number of years.

Using the information and from equation 1 we can state that

$$P_{2021} = 217000 [(1+(-0.1))^{17}] = 213750$$

Sample size was calculated 380 people using Cochran's formula with confidence level 95% and allowable sampling error of 5%. The people were selected from residential, recreational, administrative and commercial centers by random cluster sampling model.

Results and Discussion

According to the method, the results of this research are presented. The weights of iron, aluminum and copper in e-waste for district 6 can also be seen in Table 1.

- The per capita e-waste production for district 6 of Tehran in 2011

- the electronic waste generated by the statistical sample \div the number of statistical sample \times the average number of family members = $5653 \div (380 \times 4.3) = 3.45$

- The e-waste production capita for district 6 of Tehran in 2021

- the electronic waste generated by the statistical sample \div the number of statistical sample \times the average number of family members = $8763 \div (380 \times 4.3) = 5.36$

- Total e-waste of the district in 2012

Total population of district 6 in 2012 \times production per capita = $215900 \times 3.45 = 744855$

- Total e-waste of the district in 2021

Total population of district 6 in 2021 \times production capita = $213750 \times 5.36 = 1145700$

Then, the contribution of each metal such as iron, aluminum and copper in total wastes should be calculated. For this purpose, first e-waste components and the share of them are determined and finally Table 1 show economic value of metals contained in e-waste for district 6.

Table 1. Economic value of metals contained in e-waste for 6th district

metal	production in 2012	Economic value for each ton of metal in London Metal Exchange on July 2012	Total economic value	Production in 2021 (ton)	Economic value for each ton of metal in London Metal Exchange on October 2012*	Economic value in 2021
Iron	357	136	48552	569	151	85919
Aluminum	35	1832	64120	54	1992	107568
copper	52	7421	385892	80	8210	656800
Sum of the total economic value in 2012=				Sum of the total economic value in 2021=		
498564\$				850287\$		

* Given that the prices of these metals for 2021 are not available, we assumed the price is fixed until the year 2021, the prices of these metals in October 2021 have been considered.

Conclusion

Electronic waste is a new kind of municipal solid waste that attracted much attention in the last decade. Based on the United Nation Environmental Program (UNEP), electronic waste has the fastest growth of waste streams among other kinds of municipal solid waste.

Two aspects of the electronic wastes are more important than other aspects. One is existent heavy metals and materials in the waste such as nickel, cadmium, lead. These materials without recycling or informal recycling can have detrimental impacts on the environment and human body. These materials contain 2.7% of the total weight of the e-wastes.

The existence of valuable and recyclable materials such as gold, silver, aluminum, copper, iron and etc. in the electronic waste has caused the electronic waste to be called as urban mines. The valuable metals that exist in the wastes include 60% of the total weight of the e-wastes.

This study estimated the total economic value of the metals iron, aluminum and copper in electronic waste generated in the district 6 of Tehran in 2013 and forecasted it for the 2023. It was shown that these wastes was very valuable and should be recycled and used. To control and manage large quantities of e-waste, we need to integrate electronic waste management system (Fig. 1).

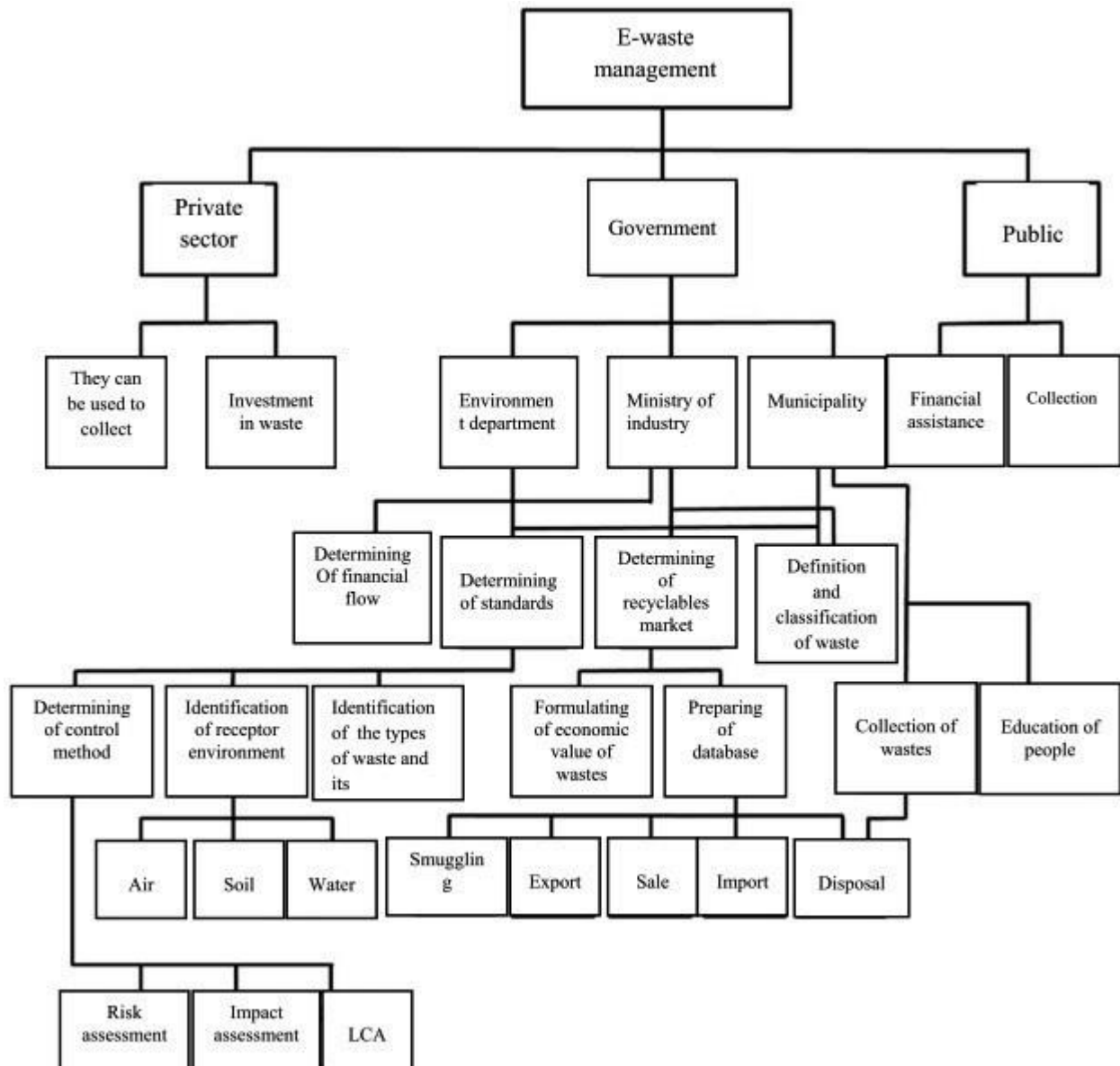


Fig 1. Comprehensive e-waste management system

This system is a combination of waste streams, waste collection, recycling and disposal methods. Its aim is to achieve the environmental benefits, economic utility and social acceptability. Such system will lead to a waste management system applicable in each area.

However, to achieve such a system, we need to consider all stakeholders and influential agents in the production and management of the electronic wastes. We should also consider the role of private and public sectors in the management of electronic waste, and the environmental issues economical for the public, in particular.

Keywords: economic evaluation, e-waste, management system, recyclable metals.

Influence of Optimization of Energy Consumption on Indoor Air Quality (Case Study: Educational Building)

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Received: Jan., 2014

Accepted: Aug., 2014

Expanded Abstract

Introduction

Reduction and optimization of energy consumption and consequently environmental pollution reductions, besides improving building performance, can provide occupants with comfort conditions. This makes the concept building closer to the concept of green sustainable building. Once the decision has been made to build green structure, one of the first steps in the green design process is establishment of firm environmental goals for the project.

In the recent years, much research has been carried out in the field of energy efficiency in buildings. Indoor air quality issues are also on debate these days due to its direct effect on the health of the people.

The sources of indoor pollution that release gases or particles into the air are the primary cause of indoor air quality problems in homes. Inadequate ventilation can increase indoor pollutants by not bringing enough outdoor fresh air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the home. High temperature and humidity levels can also increase concentrations of some pollutants. Carbon dioxide is often measured in indoor environments to assess quickly but indirectly the amount of outdoor air entering a room in relation to the number of occupants. Replaces of oxygen in the blood-exposure to concentrations of 40,000 parts per million (ppm) are immediately dangerous to life and health. CO₂ poisoning, however, is very rare.

In this research, a building as a case study is selected. One of the most characteristic energy audit software is modeled to estimate the amount of its energy consumption. It is estimated with calculating building heating and cooling loads in different seasons. The ventilation rate of the building as one of the factors in energy consumption is assessed. The concentration of gases in closed environments will be reviewed since all these standards are directly and indirectly trying to improve the human's life condition. Then, some optimization strategies were applied on the building to investigate the relationship between energy consumption and indoor air quality.

Materials and Methods

Energy Modeling

At first, the educational building was modeled in the DesignBuilder Software and its energy consumption was calculated. Building characteristics such as occupancy, number of persons living in each sector, heating and cooling systems, fuel type, materials used in the construction of the building, and openings and its typewas imported into the software as input to the model. As seen, the highest rate of heat dissipation through the air in the building is from ventilation.

Indoor air quality modeling

Contam software is used for indoor air quality modeling. This program does not fully draw a geometric model, it can just draw external walls and partitions as a general plan. It can define airflow and show the location of doors and windows. The environmental factors such as air temperature outside and inside, wind speed and direction, wind speed ratio and outside pollutants can be introduced as an input to the model.

General characteristics of building

The case study is an educational building. Various parameters including U values of external walls, window to wall ratios, and orientations are investigated in this parametric study. Different U values of external walls ($U=1.798[\text{W}/\text{m}^2.\text{k}]$, $U=1.976[\text{W}/\text{m}^2.\text{k}]$) and U value of roof ($U=1.256[\text{W}/\text{m}^2.\text{k}]$) are employed to analyze heating

and cooling loads for the educational building. In the simulation, the heating setpoint is 21 C and cooling setpoint is 25 C. The energy consumption of the house is taken as the criterion for the optimal sustainable facade design. Building heating is served by the central system and cooling system of the building is independent. The building's lighting system is served by fluorescent light bulbs. Geometry is drawn in the model space. Doors and windows and all openings in accordance with their actual proportions in the same location and orientation of the main building were drawn in the software.

Results and Discussion

To assess the efficiency of buildings ventilation, carbon dioxide concentration is evaluated in the simulated building. Carbon dioxide is a byproduct of respiration. When breathing, people inhale oxygen into the lungs and exhale carbon dioxide. This will increase the carbon dioxide levels in buildings over the next several hours to reach a maximum value. In the model Carbon dioxide content in fresh air is approximately 400 ppm and human inspiration rates is equal to 0.1m³/h. According to the Figure 1, the class was supposed to start at 8 AM and finished in noon. Time period is considered from 8 AM to 14 PM.

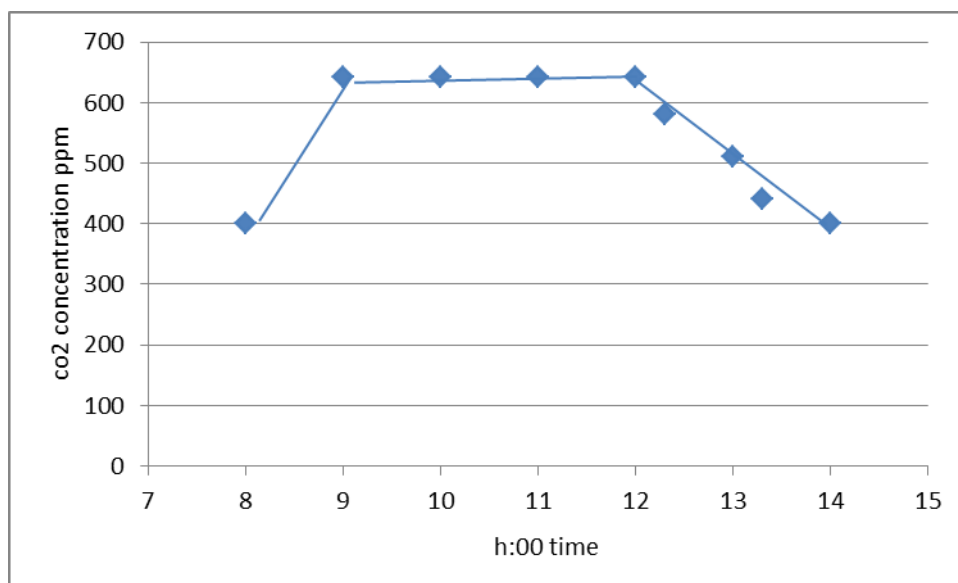


Fig. 1. Carbon dioxide concentration changes over time

The results clearly indicate that the CO₂ concentrations can give an indication of the indoor air quality in these indoor and enclosed environments. At the start of the class, CO₂ concentration was 400 ppm. It is clear that the CO₂ concentration increased immediately at 8 AM until it reached a steady state condition at 9 AM, as shown in Figure 1. The maximum CO₂ concentration was constant at 642 ppm for the entire duration until 12 AM. The maximum concentration of carbon dioxide is 642 ppm which is consistent with the existing standard allowance. But the increase in number of individuals in the model to 30 people, it increases nearly up to 800 ppm. The situation will require increasing ventilation within the class.

Building ventilation rates were 2.4 hours and the heat load of the building is estimated at 64,508 kWh. To investigate the effect of air changes in energy consumption, all the parameters affecting energy consumption are assumed to be constant at any given stage. The amount of air changes in the building start from 0.2 to 3 times at the time ended. We can see that the building heat load carrier ratio increased linearly. Thus, the amount of air changes is one of the most important factors affecting energy consumption of heating in the building. But the behavior of the building cooling load is different from the heating load and the effect of air changes and it is limited over time. Increasing the ventilation rate reduces the amount of carbon dioxide in the building. This is essential to improve indoor conditions. The amount of air changes vary in the studied buildings. For example, in the corridors and rooms air change rate per hour is high, and this matter will increase energy dissipation.

In order to optimize building energy consumption, a set of optimizing actions including wall insulation, roof insulation, replacing windows are applied in the model. It can be seen that heating and cooling load are decreased. However, the concentration of Co₂ is increased due to decrease in ventilation rate. To solve these problems, air conditioning systems can be used.

Conclusions

Evaluation of carbon dioxide as an indicator of indoor air quality was assessed. It is found that with the

increasing number of people in the class with the rates of air change is equal to 2.4 times per hour. The amount of carbon dioxide from respiration is increased to 800ppm. To solve this problem, it is necessary to increase the rate of air changes. It was observed that increase in the rate of air changes can greatly increase the building heating loads. It will increase energy consumption in the building. Performance of cooling loads is different and the rate of air changes has very little impact on the building cooling loads. Then, some optimization strategies are applied to the building and 67% of building heating loads and 39% of cooling loads are reduced. After these actions, leakage and penetration rate will be reduced. This can increase the amount of carbon dioxide in stable condition and breathing through people. Therefore, reduction in the rate of air changes should consider the measures to ensure indoor air quality.

Keywords: energy saving, indoor air quality, ventilation rate.

Prioritization of Reclamation Criteria during Mines Closure, in Iron Mines of Golgohar, Sangan, Chadormalu

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Received: May., 2014

Accepted: June., 2014

Expanded Abstract

Introduction

Development of natural resources and mining activities are prerequisite for economic and industrial growth in many countries. In some cases, such mining areas lie within residential or agricultural lands or natural habitats. These are intensifying the contradiction between land use and environmental protection.

Different components of mining activities including exploration, extraction and processing impose extensive physical, chemical and biological impacts on the environment due to nature and characteristics of the activities. Nowadays, mine owners are strongly urged to do their activities in line with environmental standards and regulations. Therefore, in the contemporary world with increasing knowledge of environmental impacts of projects, development of mining industries must be accompanied with welfare as well as effective and continual protection of the environment and of human and financial resources. Implementation of environmental management for mines to minimize the adverse effects of mining activities and mining wastes on the environment as well as planning for reclamation of mine sites after completion of mining activities is of great importance.

Materials and Methods

Reclamation and environmental characteristics

In general, reclamation refers to the activities carried out for the preparation of mined out lands for re-use and rehabilitation of the lands. Such activities do not necessarily restore the land to its former or original form and conditions (prior to mining). Reclamation activities cover different parts of the mining area including pit, waste dumps and tailing dams. In fact, reclamation is not considered as an activity separated in design, planning and mining, but it is regarded as a component of mining activity. It begins from design and planning stage and continues to mining stage.

The major objectives of mine reclamation are risk mitigation and safety enhancement, rehabilitation of lands (affected by mining activities) and water resources, environmental impact mitigation, ensuring the protection of environmental and socio-economic resources of the area after completion of mining activities, creation of new land-uses, stimulation of the proper use of energy resources, and ensuring sustainable exploitation of mines.

In this research, Golgohar, Sangan and Chadormalu as the three largest iron mines in Iran are located in Sirjan, Khaf and Bafgh, respectively. These mines were selected for definition of reclamation criteria. These three large mining-industrial complexes are located in arid warm regions with similar ecosystems.

Study Areas

Golgohar Mine

Golgohar deposit in the form of six separate anomalies lies in Kerman Province at longitude 55° 19' E and latitude 29° 7' N. Golgohar orebody is located over an elevated pastureland within a semi-arid area surrounded by mountains with an elevation over 2500m. There is no perennial stream over the area. Dry and arid climate has caused extensive fluctuations in temperature during different seasons and during daytime and nighttime.

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Sangan Mine

Sangan iron ore mine lies in Khorasan-e Rasavi Province, Khaf town at longitude 60° 16' E and latitude 34° 24' N with three anomalies. The project site is located over a semi-arid area with predominant warm and dry climate.

Chadormalu Iron Mine

Chadormalu Mine lies in Yazd Province, at longitude 55° 30' E and latitude 32° 17' N . Due to vicinity to Markazi and Lut Desert, the area has warm and dry climate with an average temperature of 20.8°C.

Methods

As it mentioned, three large iron mines in Iran named Golgohar, Sangan and Chadormalu were selected for this research. Since the reclamation criteria were qualitative, using mathematic models was impossible. To utilize the collective opinions and existing experiences, Multi-Criteria Decision-Making (MCDM) system and Fuzzy Delphi Analytical Hierarchy Process (FDAHP) were used. Reclamation criteria were defined based on the studied documents, type of ecosystem of the study area, and advice of mining and environmental specialists and executives. Up to 40 criteria and sub-criteria were defined and tabulated for collection of the opinions of professors and specialists in three categories including natural, social and economic environments as bellows:

A) Natural Environment including:

Criteria	Sub-Criteria
Topography and Landform	Slope and land relief
Vegetation	Density, composition, economic value, medicinal value, cultivation method and final land use
Water	Drainage pattern, quality and quantity
Climate	Precipitation, temperature, wind and humidity
Soil	Texture, water retention in soil, pH, organic matter percentage, nutrient percentage, physical and chemical properties, fertility, solubility and erosion
Mine Location	Remoteness from residential areas, protected areas, sensitive ecosystems and historical heritage, former land uses, access roads and the extent of destructed land

B) Social Environment including native inhabitants, immigration, land ownership, employment, values of inhabitants' properties, safety, sanitation and health

C) Economic Environment including losing jobs, income, improvement of individual skills, and cost

After collecting the completed criteria tables, the required data were extracted and the criteria were prioritized based on Delphi Fuzzy Methods.

Result and Discussion

We distributed some questionnaires among the experts. Up to 20 questionnaires out of the total 30 questionnaires were filled out by the experts. The information received through these questionnaires were extracted, classified and used as the input data for FDAHP method. The Fuzzy pair-wise comparison matrix was computed, and the given value to each criterion was compared between different experts; then, the Minimum, Geometric Mean, and Maximum of each criterion were calculated. In the next stage, the relative weight of parameters were computed and shown as fuzzy weight and non-fuzzy weight and the criteria were classified based on their priority.

Based on conducted investigations, reclamation criteria priority has been shown in below table:

In the next step, considering the frequency and distribution of the criteria, another classification was made in terms of different expert groups and the given preference. Ultimately, 16 criteria were selected out of 40 criteria and sub-criteria with the highest preference and priority in iron mine reclamation for the purpose of compilation of reclamation model and instruction. The selected criteria are as follows:

- In topography and landform category: slope and relief
- In vegetation category: vegetation density and vegetation composition for cultivation
- In water category: water quality and drainage pattern
- In climate category: wind blow and precipitation
- In soil category: soil erosion and soil pH
- In mine location category: extent of destructed area and access roads
- In social environment category: indigenous inhabitants of the area, and safety, sanitation and health
- In economic environment category: reclamation cost and income

The results of the research indicate that 16 criteria have priority over other criteria in iron mine reclamation in

Iran. The prerequisite for preparation of an executive plan for iron mines reclamation based on the criteria studied in this research depends on mining method and mine decommissioning and mine closure plan.

Conclusion

The investigations revealed that due to diversity and multiplicity of reclamation criteria, Multi-Criteria Delphi-Fuzzy Decision-Making Method could be applied for defining the priorities of the criteria. In this research, 16 sub-criteria were selected out of 40 sub-criteria with the highest preference and priority in reclamation of the mined out area in the iron mines of Golegozar, Sangan and Chadormalu. These prioritized sub-criteria provide a suitable framework to prepare the reclamation program. This method can be applied for prioritization of reclamation criteria for all mines. However, it should be noted that time restriction, cost, available facilities and equipment as well as ecosystems of the mining areas define the order of priorities of the criteria for reclamation programming. In fact, the reclamation program should be compiled in the form of an integrated management plan taking all criteria into consideration at the same time.

Therefore, reclamation of mining areas is significant for policymakers and authorities of the country due to extensive use of natural resources in mining activities. The rules and regulations related to reclamation of mining areas have not been standardized and administrated in Iran and the duties and commitments of the owners and beneficiaries have not been properly defined. The quantitative and qualitative development of the mines reclamation program should be properly planned.

Keywords: mine reclamation, prioritization, reclamation criteria.

Application of Plan - Process - Results (PPR) Method in Evaluation of Urban Plans

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Received: March 2014

Accepted: July 2014

Expanded Abstract

Introduction

So far, many evaluation methodologies for assessing urban plans have been introduced, but comprehensive and systematic evaluation methodologies up to now have received little attention. In the recent years, the Plan - Process - Results (PPR) approach as a comprehensive and systematic evaluation methodology based on the Policy- Plan/Programme-Implementation-Process (PIIP) method has been used in the assessment of urban plans. The PIIP model criteria - conformity, rational process, optimality ex-ante, optimality ex-post and utilisation – in planning the subsequent questions of policy, plan or programme, or the planning process under study and its results are considered. Despite the importance of PIIP model in the planning literature, from the early 1990s to the best of our knowledge, PIIP has not been used in real case studies, or not reported but PPR methodology are applied in Lisbon and Porto.

In this study, we outline the key elements of Plan - Process - Results (PPR) methodology, including criteria, sub-criteria and evaluation techniques/data sources introduced and its application in evaluation of urban plans using this methodology in ex-ante evaluation of Abshar (2) land development plan in Mashhad.

Materials and Methods

Plan - Process - Results (PPR) methodology was developed in 2009 by Oliveira and Pinho for comprehensive evaluation of urban plans. It will take into consideration all dimensions of urban plans with greater emphasis on the physical dimension and it used in ex-ante, ongoing, and ex-ante evaluation of urban development plan. This methodology exploits the positive aspects and fixes some weaknesses in the ex-ante evaluation methods to scrutinize criteria of the Policy- Plan/Programme-Implementation-Process (PIIP) methodology.

In this study, PPR methodology is used in the ex-ante evaluation of Abshar (2) land development plan in Mashhad through a number of criteria related to the ex-ante dimension of the Plan.

Results and Discussion

The specific criteria on which the Abshar (2) land development plan attains the highest scores are the internal coherence and interpretation of planning system (Table 1). The specific criteria on which the plan attains the lowest scores are the participation in plan making.

Table 1. Abshar (2) land development plan: Evaluation results

Criteria	Sub-criteria	Score	Evaluation techniques / data sources
Internal coherence	Relationships between the objectives and the land uses of the plan	● ●	A Reading of the plan Impact matrices
	Relationships between the objectives and the urban systems of the plan	● ●	
	Relationships between the objectives and the plan implementation mechanisms	●	
Interpretation of planning system	Interpretation in terms of form	● ●	A Reading of the different versions of the plan and its regulation
	Interpretation in terms of substance	● ●	
Relevance	Relationships between the needs of the city and the objectives of the plan	●	B Reading of the plan SWOT analysis Impact matrices Reading of the newspapers
	Relationships between the needs of the city and the land uses and urban systems	●	
	Relationships between the needs of the city and the plan implementation mechanisms	●	
External coherence	Relationships in terms of objectives	●	B Reading of the plan and of other plans for that territory
	Relationships in terms of territorial	○	
	Relationships in terms of implementation	●	
Participation in plan making	Quantity of participants	○	C Reading of the plan Interviews
	Quality of participants	●	
	Promotion of public participation by the local authority	○	
Plan utilisation	Influence of the political power in the plan, as well as in other planning products, processes and structures	●	B Reading of the different versions of the plan (during the period of its preparation) Interviews
	Influence of the plan and of the planning practice in the political power	●	
Commitment of resources	Evolution of the availability of resources	●	B Reading of the plan Interviews
	Type of resources available	●	
	Relationships between planning performance and utilization of resources	● ●	

Conclusion

This study aims to demonstrate that despite the difficulties and the complexity in the evaluation of planning action, it is possible to evaluate urban planning practice in a comprehensive and systematic way. In this paper, Plan - Process - Results (PPR) methodology and its application in the ex-ante evaluation of Abshar (2) land development plan was applied in Mashhad. Overall, the results indicate that with a greater emphasis on the physical dimension and giving more criteria and data sources, this methodology differs from others. It also helps managers and urban planners provide a more favourable evaluation of the planning and implementation of urban plans. Moreover, the comprehensive character of PPR is identified by selection of general and specific criteria, the corresponding evaluation questions, the assessment techniques, and data sources.

Application of the PPR provided not only a sound and substantiated judgment in the case study under

evaluation but also provided the basis for identifying a number of singular and important features in planning practice of Abshar (2) land development plan.

According to the characteristics and framework of urban planning system in Iran, greater emphasis is on physical dimension rather than other dimensions of economic, social, environmental dimensions. The country's urbanism system can be applied as a comprehensive and systematic evaluation method in assessment of planning and implementation of urban plans in Iran. Finally, the main challenge of evaluation can be described as a dilemma that planning is faced with uncertainty and evaluator must at the same time be able to judge the plan, process and their results.

Keywords: evaluation methodologies, Plan-Process-Results (PPR), Policy- Plan/Programme-Implementation-Process (PPIP), urban plans.

Campus Landscape Design Based on Resilience Approach in Water Shortage State (Case Study: Campus of Malayer University)

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Received: April, 2014

Accepted: Sept, 2014

Expanded Abstract

Introduction

Water shortage is a crucial challenge threatening future of landscape development in Iran. Naturally it can be intensified by climate change that will lead to water stress of ecosystems. The water stress have confronted university campus landscapes with serious challenges especially those that located in arid and semi-arid areas such as center of Iran. Malayer University has experienced serious challenges due to water shortage in green space development in spite of fast growth. Local adaptation and mitigation actions have a high priority in dry context.

Successful adaptation and mitigation need to increase ecological resilience and provide appropriate water resources without threaten to other places and species in meeting their needs. Adoption strategies emphasize on ecological resilience and mitigation strategy stress not only on improvement of ecological functions against climate change but also on reduction of the intensifying climate change agents such as greenhouse gases (GHG). Thus, ecological resilience improvement will assist the continuation of ecosystem functions and will support mitigation movements. Therefore, it is an essential and vital role of planning to cope with wicked problems due to the climate changes.

Climate change has faced our society with complex problems and simultaneously increasing uncertainty. Resilience is an ideal option to cope with the uncertainty. It attempts to recover systems from disruption. As Friend and Moench (2013) pointed, the goals of development is resilience or "an aspect of what development is". But resilience here is defined as the ability of absorbing shocks and increasing system ability to cope with challenges and retain the system integrity and sustainably, although it may pass from one situation to a new one. This does not mean as bouncing back the system. The emphasis is on continuation of sustainability of ecological structure and functions. However, the system could experience some changes.

Iran has experienced great dryness challenges. Thus, water shortage change into an ongoing threat of a dry country is a sign of wide spread crises through the country in the near future. Malayer University founded in 2005 has been developed rapidly. It tackled with water limitations for all kind of uses. Water limitation is also a main obstacle in green landscape design of the university campus. The article attempted to review resilience concept in water shortage conditions and present solutions for water deficit by rain harvest and reuse of gray water in campus landscape design in one side and to increase efficiency in water use by wise and ecological planting and reduce water needs by selection of the appropriate plant species requiring low water on the other side.

Materials and Methods

University of Malayer is located at Malayer County (Malayer) in northwestern part of Hamadan Province. The area has a semi arid climate. The area receives about 300 mm annual precipitation in average. The average of minimum temperature is -4 and the average of maximum temperature is 34.7 degree of centigrade. Total area of the campus is about 55 hectare. It was established in 2005. Total built area is about 46000 square meters up to now. Slope of campus fluctuate between 3 to 7 percent. Up to 70 percent of 55 hectares is in cult. Soil tests indicated the presence of clay soils in combination with organic materials. The soil salinity is low and without restrictions. The existing vegetation cover can be divided into two categories:

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1. Herbaceous species, mainly in under developed parts of the campus, have the following characteristics: wild plant, seasonal growth and short growing period. The plants are drying by beginning of warm season with increased water stress. These plants include species such as: *Peganumharmala*, *Achilleamillefolium*, *Descurainia Sophia*, *Gundeliatournefortii* and *Fritillaria sp.*

2. planting trees and shrubs include limited species such as: black pine, cedar and cypress, *sycamore*, *mulberry*, *willow usual*, *walnuts*, *grapes*, *Cotoneasternummularia*, *Crataegusaronia*, differenttypes of roses, lavender, and rosemary.

The main problems of green space of the campus are: Planting of the vegetables sensitive to drought, water resources shortage and low efficiency in water irrigation systems.

This research has been done based on ecological design principles that expressed by Van der Ryn and Cowan in 1996. The study tries to use the ecological resilience based on global warming trend and water shortage in order to design more effective green landscape for the campus.

Results and Discussions

The results can be presented in four steps:

1. Analyses of water resources in campus
2. Analyses of water irrigation efficiency
3. Analyses of plane species resilience against water shortage, ecological diversity and diversity in ecological functions.

The result shows that the area could annually reserve about 19000 cubic meters of water from precipitation. This volume is enough for irrigation of the green space during the year. Moreover, harvest runoff is possible from pedestrians and streets. We could receive up to 90000 cubic meters of water by construction of primary waste water treatment systems.

In addition, change of traditional irrigation system is necessary to promote irrigation efficiency. Meanwhile, mulching can reduce surface evaporation and decrease water needs. The flexibility of main dominant plant species has been analyzed based on Hunter Model (2008). As a result, vulnerable species have been identified and new native species has also been chosen. The native species were selected that have following characteristics: Resistance against water stress, adopted by ecosystem conditions, diversity in ecological function, quality of growth and reproductive with less water requirement. Finally, campus landscape has been designed based on rain harvest and reuse of gray water (Fig. 1).



Fig. 1. Strategic design of campus green space based on rain harvest and reuse of gray water

Conclusion

Landscape design is an alternative and additional tool to keep green spaces sustainable against climate change and global warming. Landscape design could apply ecological principles in order to cope with climate change

threats especially in arid areas. Campus landscapes of Malayer University as sample is selected to examine the ability of ecological design. The results showed that the green space of the campus could be developed by utilization of potential water resources. Campus landscape could be improved by wise selection of plant species. The species should be resistant against water stress and climate changes. As a result, ecosystem service will be improved by wise development of campus landscape through ecological design principles. Is this experiment applicable in more complicated places such as urban landscape? Simultaneously other approaches such as carbon sequestration are applicable? These two questions are new subjects for further practical research especially in the arid areas faced with climate change threats.

Keywords: climate change, landscape design, Malayer University, resilience, water resources, water shortage.

Evaluation of Isfahan's "Mâdies" as Greenways, with Sustainable Development Approach (Case Study: Niasarm Mâdi)

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Received: Feb., 2014

Accepted: Aug., 2014

Expanded Abstract

Introduction

Using greenways could be helpful to promote the improvement of urban streets. Greenways, as they are known, improve the pedestrianism and related qualities like climatic comfort, visual complexity and desirable serial visions. The objective of this research is to evaluate the capacity of *Mâdies*¹ network in *Isfahan* to function as greenway. This research aims to assess in what extent they can play as main part of a vast green network. *Mâdies* are several streams divided directly from *Zayandeh-Rood* River. They constitute the main part of the historic-natural structure of *Isfahan*. There are about 250 km of these manmade streams which are perfectly planned, designed and constructed according to the topographic characteristics of the plain of *Isfahan*. Originally, *Mâdies* were created to irrigate the farmlands surrounding the river in the plain of *Isfahan* since the *Safavids* period. Today their role is completely changed in one hand due to the drought of *Zayandeh-Rood* River (source of water in *Mâdies*) and expansion of city and land use changes from agricultural into different urban land uses on the other hand. By the way, today *Mâdies* could play a vital role in improvement of environmental qualities despite their changing role. They are fundamental elements of urban structure in the city and reinforce the organic and natural aspects of urban planning and design as basic parts of greenway characteristics. Therefore, they could be considered as main structure of green network in the city of *Isfahan*. As it is known, greenways enhance quality of environment, aesthetic, recreation, education, relaxation, and preservation of habitation. Greenways can help the protection of ecological continuity. They are managed, planned and designed for several functions such as environmental, recreational, cultural, aesthetic and other purposes. Thus, we can extract greenway characteristics from existing definitions such as their linear form, organic design, social inclusiveness and their perfect adaption to the urban environment. *Mâdies* can play a central role as part of a structure which is greenway network. To do this, it is necessary to know in what extend they are appropriate to this function. This paper tried to identify the strengths and weaknesses of *Mâdies* to fulfill the task of being greenways.

Materials and Methods

The first step of the method consists of description and definition of *Mâdies* and greenways as the two principal parts of this study. The identification of the two above mentioned concepts was necessary to establish the categories of indicators which make it possible to compare them with one another. Describing and categorizing the main characteristics of greenways were the next step of the research. In this part, greenways are summarized across principal sources and expert in the field. The next step was definition of the criteria and indicators to evaluate in what extent the *Mâdies* could play the role of greenways in *Isfahan*. In order to determine the indicators, the main axis of precedent tables constitutes the categories in which the indicators are extracted from different sources. The data is gathered through observation, noting and measurement. Table 1 shows the criteria, sub-criteria and indicators.

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Table 1. Criteria and indicators for assessment of Madies as greenways

Criteria	Indicators	Niasarm	Unit	Quantification and Measurement
A. Pedestrianism	A1. Interconnection of pedestrians and cars	96%	Length (m).	Length of common path (pedestrians and cars) transportation.
	A2. Pavement facilitating pedestrian	34%	m ²	More convenient pavement covered percentage among 3 types identified.
	A3. Efficient width of pedestrian way	45%,	Width (m).	Width variation along Score of <i>Niasarm</i> .
	A4. Noise pollution rate	34%	dB	Average noise pollution recorded in one week with <i>Noise Dosimeter</i> and <i>Sound Label Meter</i>
B. Security	B1. Nightlife uses	5%	Number/ unit of length	Land uses having nightlife potentials
	B2. Social control	35%	Individual/ unit of surface	Number of individuals in space over 2 Hours (2 times a day), (+10→4 pts; 10-6→3 pts; 5-4→2 pts; 3-1→1pt; 0→0 point)
	B3. Night lighting	45%	Lux /unit of length	M ² of alighted spaces/total space along <i>Mâdi</i>
	B4. Sense of security and control	40%	Number of positive responses	Positive responses in questionnaires
	B5. Transparent fronts	25%	Unit/ length	Opening surfaces in m ² /total surface
C. Safety	C1. Accident prone spots	90%	Number/ unit of length	Number of prone spots in length
	C2. Sense of security in pathways	100%	Number of positive responses	Positive responses in questionnaires
D. Sociability	D1. Equipment and facilities	5%	Number in unit of surface /total	Average areas of the equipment and facilities measured in unit of surface/ total surface
	D2. Programmed socio-petal spaces	5%	m ² of programmed spaces / m ² total	Average areas of the programmed socio-petal spaces measured in m ² /total
	D3. Public participation in maintenance	5%	Number of positive responses	Positive responses in questionnaires
	D4. Place attachment rate	70%	Number of positive responses	Positive responses in questionnaires
E. Viability	E1. Inclusivity of space	25%	Percent	Diversity of the different groups (sex, age) recorded in a week (2 times per day)
	E2. Climatic comfort of space	100%	Percent	Creating a list and determining score of <i>Mâdi</i>
	E3. Permeability of space	5%	Block length (m).	Length of blocks measured by GIS

F. Physical aspects	F1. Geometry	100%	Percent	Linear form (of green way)→Best point; semi-linear→0.5 point; non-linear→0 point
	F2. Structural elements	50%	Number in length	Elements of greenway (Corridors and pause points); <i>Mâdi</i> has no visible pause point
	F3. Network character	50%	Percent	Structure of <i>Mâdi</i> is branching, so is part of a network.
G. Place quality	G1. Adventure	5%	Number of positive responses	Positive responses in questionnaires
	G2. Fun of space	100%	Number of positive responses	Positive responses in questionnaires
	G3. Biodiversity	70%	Percent	Creating a list and determining score of <i>Mâdi</i> according to obtained information from the Park organization.

As it is shown in Table 3, the indicators are grouped in seven categories: pedestrianism, security, safety, sociability, viability, physical aspects and qualities of place. Then the *Mâdi* of *Niasarm* has been evaluated through the set of indicators. Quantification and measurement of each indicator is explained and several techniques like questionnaire, mapping, observation and survey are used.

Results and Discussion

The results of the research show that to become greenway, *Mâdi* of *Niasarm* needs to be improved. In seven established categories, the situation is satisfactory in just one category of Safety. In two other categories (pedestrianism and physical aspects), the results is above the average of 50%. Concerning the rest, the situation is not satisfactory. For example, the category of Security is below the total average. Figure 1 shows seven categories and their respected indicators.

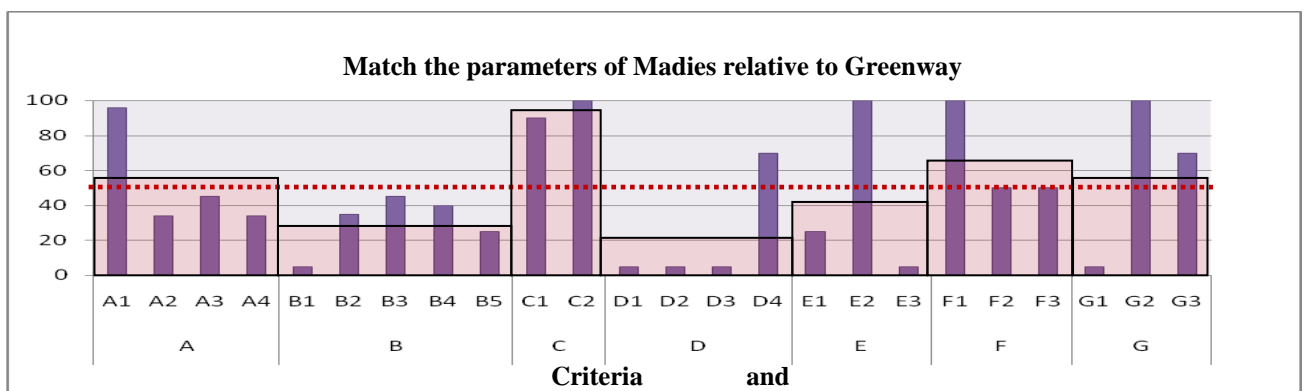


Figure 1. seven categories and their respected indicators

Conclusion

The physical, functional and spatial similarity of *Mâdies* in Isfahan and greenway are proved by the results of the research. However, according to this study, *Mâdies* do not function perfectly as a standard and greenway. The evaluation of *Mâdi* of *Niasarm* in this study in seven groups of criteria and 24 indicators shows that it involves many efforts to make the existent *Mâdies* good greenways even if they are suitable. In some criteria such as C (Safety), *Mâdi* of *Niasarm* has approximate condition for a standard greenway. In three groups of A (Pedestrianism), F (Physical aspects) and G (Place quality), the score is above 50% and it could be considered as acceptable.

Keywords: green infrastructures, greenway, Isfahan, *Mâdi* of *Niasarm*, *Mâdies*.

The Necessity of Identification and Protection of Green Spaces Based on Local and Regional Condition in Iran (Case Study: Akbarieh Garden of Birjand)

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Received: April, 2014

Accepted: July, 2014

Expanded Abstract

Introduction

Iranian traditional cities represent a real symbol of stability and health. These conditions indicate that such urban planning design and program have been done thoughtfully and wisely. In these cities, the natural resources are used with minimal damage to existing endowments with the highest efficiency in management. However, it is often destroyed due to some people's ignorance and legal rules. For this reason, identifying and describing the position of such infrastructure and spaces can affect their conservation and sustainability. This paper is to discuss one of these spaces-the Akbarieh Garden of Birjand - and identify its location in this desert town. It is considered internationally as one of the nine important Iranian gardens. For this reason, this study is set out to provide and identify new information for people who are interested in this case. As the matter of fact, lack of winter and summer rainfall increasingly reduced green spaces and natural green areas. This concerned the public greatly. In addition, the politician traffic had been increased after Birjand were regarded as gate of East and India. Some countries such as English established a political office in Birjand. This traffic makes the political representatives try to consult with local authorities before central government conservation. Such meetings and traffics required particular situations. Thus, the proper condition is designed and constructed for natural and social condition in different eras. Various reasons caused the garden to remain ordinary or be destroyed over time. Undoubtedly, the remained cases have a particular condition. Introducing these attractions could improve their maintenance and it encourages some creative people to build such gardens.

Materials and Methods

This study has descriptive and analytical approach and the required information are compiled through field visits, expert opinions and use of historical documents. For this purpose, individuals and groups have been questioned related to restoration of the historical garden of Birjand in Iran. Finally, the gathered information was summarized and categorized accurately. According to the type of data collected, the analysis was based on the content type and on the view of experts. Because there is no single opinion about damage kind and destruction process, all commands have been studied and the elements which overlap in the cases under study have taken into account in final analysis. For example, among functions of the garden, after Iran revolution, the item which was accepted plentifully was considered. Therefore, only one function was analyzed. Other cases should be used based on the context.

Akbarieh Garden is located in the south of Birjand, an ancient city near the Bagheran foothills. According to the available information, the construction of the complex was started in the late Zandiye era and continued in early years of Pahlavi era. More ancient part of Shams Al Moluk building is in easternmost part of the garden. It is built on two floors. Before constructing the garden and the building, some structures were connected to the surrounding residential context. We can see some composition in the new space now. Last part of the complex is a building known as ceremonial building constructed by Shokat Al Moluk at the final Ghajar era. This part of the building is decorated with beautiful views and currently considered as the central part of the complex.

Results and Discussion

According to geometry regularity in tabulation and adaption of entrance axes with palace axes and entrance portal, Akbarieh garden involves absolute regularity geometry. It is a great example of Iranian gardens. Based on situations and functional requirements for various purposes, several different buildings are added to it. They are

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formed between the main and south gardens organically. Efficiency, hierarchy, view quality, and creating movement path with a beautiful perspective of the garden and buildings were regarded in the next development. Existing the wide terrace and porch caused dominated perspective and increased its visual quality.

The main courtyard of the garden is rectangular with dimensions of 217×94 m located along north-south side and its building located on the south side. Like most Iranian gardens, the main axis of the garden is located on the longitudinal axis and the two rows of old age pine trees with boxwood shrubs are demonstrated in the outlook. In the end of the garden path and in front of the building, there are pools as the main element. In addition, the garden image is beautifully reflected in water. The harmonious relationships between the carved form of main building view and the sky line and main terrace are very appealing. The garden area is 35000 m² surrounded by mud-brick wall. Architectural space is divided into three parts: main structure, service space, and stable.

Generally, the buildings are extended from East to West. The first building is in the eastern area in the main Street. Other buildings have arisen according to the demands coordinate with the previous structure. Although Akbarieh garden and its buildings were not constructed in a particular time and in a specified period, but it is considered a full complex due to the similarity in construction and architecture.

The most visible garden space is the main floor located in the middle of the fence. This space includes tabulate, main and sub streets, general road and pools. Tabulate are considered a section to build the original garden space. The main space was created with replicates. Although these units include an order internally, it includes the total garden space externally. In relationship with other spaces, they formed wider space.

The streets are enumerated as other garden body. There is a main street branched in sub-street. It is related to the main garden portal into central structure. There are various spaces and scenes in the main street. Such scenes and spaces are the main street wall consisted of shadowy green tree and a pool in the middle of the garden. There is also an extended scene in which the main building with a pool in front of it and flowerbeds with ornamental flowers were appealing.

The important structural elements of the garden can be studied in three main sections. Garden fence is constructed from the brick surrounded with farms. Urban development is changing it into residential area. Fence is the most important element of garden space and can be affected by internal and external view.

All the elements of garden are water movement, tree, and plants and other spaces. These were displayed with a bed called ground. Against the sky, ground creates a space heated with garden fence. Some factors such as slope, required area, the water presence time, geometry and order of organizing the garden and climate influenced the forming floor.

Entrance façade and central building are the most important elements in garden. Although, structures such as main garden façade, court building, main building, and service building and overhead stair are considered a little scale, they have spatial performance.

In Akbarieh Garden, the specific performance was identified for the main streets and main façade. Nevertheless, it is used for reception of some quests. Other performances are also defined for the main building. The defined performances are as following:

First section: external space is for service and special functions located along the main building.
Second section: Some sub spaces are defined as a set of performance related to the habitation located around the main space.

Third section: Some service performance and guard house such as stable are located out of the main space.

Conclusion

Due to terrible heat and dust resulting from warm and flaring wind and lack of proper water, availability of green space is inevitable in desert and semi desert areas. It was important in Birjand, because this city was the path for traffic of political representatives. Such necessity formed various gardens such as Akbarieh which had been identified a territory of horizontal development by extending town forward over the proper farms.

In fact, such space corresponds with nature as well as show planning and formation of habitants. However, relationships and factors of such a garden survival can be used as guidance for new generations in post modernism in which people suffer from lack of green space. The issue may seem interesting; if we know some gardens got destroyed intentionally or not intended. In fact, documenting the garden history can be an entrance to maintain and regenerate them. Because the garden is a dynamic organ, it can change over time. Thus, it should remain unchanged permanently.

If early garden plot is changed and some elements removed or added, it could find the different schema in various eras by distinguishing the natural and historical layers of the garden. Based on the obtained data, historical structure or initial plan is improved. To this end in view, current study has emphasized on explanation of Akbarieh garden's position as one of the elements affecting the structure and performance of Birjand, particularly the green space supply and their performance.

These gardens as a complete structure indicate a close relationship between the cultural and natural bed and it

is a sign of aligned needs of humans and nature. Manufacture can create the garden based on experience resulted in survival of natural bed. Survival of this garden is important because Birjand is located in the desert area of Khorasan where encountered challenges of green and natural space. Birjand is developed in Safavids era. Some of the historical gardens are developed in the last Zandie, Ghajar and Pahlavi eras. The Birjand City affected by the Sistan 120 days winds could not survive without these spaces. For this reason, this garden was registered in Cultural heritage list in 35th UNESCO meeting, 2011.

In addition, creation of this garden was based on special bed corresponding with principles and methods of Iranian architecture. Proper site selection for preparing the early bed, choosing appropriate plant species, and the method of agriculture demonstrated the Iranian creativity for planning and implementation with limited sources. The plot of this garden plays an important role in developing Birjand because all geometric principles such as symmetry, view extent, water axle, and rectangular geometry were used. In fact, regarding to position and localization is resulted from environmental ability and affected development of the city. Therefore, this caused internal development and keeps originality of the city.

Finally, it can be stated that Akbarieh garden is highlighted due to its special conditions, historical construction period and bed design, in addition to various features of other gardens. This special feature affected Birjand structure and any destruction threat the originality of Birjand. In addition, the mentioned garden demonstrated a close relationship between cultural and natural bed. It also corresponds with human being and nature.

Keywords: Akbarieh Garden, Birjand, Persian garden, sustainability, traditional cities.