Journal of Environmental Studies

Vol. 41, No. 2, Summer 2015

Table of Contents

Electrochemical Treatment of the Textile Wastewater Containing Acid Red 14 by Aluminium Electrodes

Amin Hooshmandfar[1], Bita Ayati[2*], Ahmad Khodadadi[3]

1. MSc Student in Environmental Engineering., Tarbiat Modares University, Iran
   (amin.hooshmandfar@modares.ac.ir)
2. Associate Professor, Civil and Environmental Engineering, Tarbiat Modares University, Iran
3. Associate Professor, Engineering Faculty, Tarbiat Modares University, Iran
   (akdarban@modares.ac.ir)

Expanded Abstract

Introduction

Textile industry has a significant impact on the environment because it uses large amount of water and chemicals in various processes such as sizing, scouring, washing, bleaching, dyeing, printing and finishing. This leads to production of plentiful hazardous wastewater. This wastewater contains dying substances which remain visible even at low concentrations. Water clarity and dissolved oxygen decreases in the presence of even a small amount of dye. Azo dyes are considered to be carcinogenic and they can pollute groundwater and surface water (Khandegar and Saroha, 2013; Morshed et al., 2012; Merzouk et al., 2009).

Dye removal could be possible by different physical, chemical and biological methods or a combination of them. Physical methods such as adsorption, membrane filtration and ultrasonic waves, chemical methods like ion exchange, electrolysis, coagulation, flocculation, conventional and advanced oxidation and biological methods by algae, fungi and bacteria have been mentioned in the previous researches (Wang et al., 2014; Oliveira and Airoldi, 2014; Pajootan et al., 2012).

Recently, electrochemical method is considered as a convenient method for purification of industrial wastewater due to its versatility and adaptability to the environment. This method has advantages ,for decolorization, such as simple operation, high performance and short retention time for removal of pollutants, and requires less chemicals (Yildiz, 2008; Yuksel et al., 2011). Electrocoagulation is a method in which coagulants are dissolved into solution from anode electrode (Fe or Al) by applying electric current. Besides, by electrolysis of water, hydrogen bubbles are generated at cathode. This tiny bubbles move upward and collide with flocs and form a sludge blanket on the surface. Furthermore, these bubbles are very active and can alter the surface and cause buoyancy properties of the solids. These changes are known to be electrochemical effects that do not exist in the other flotation techniques (Matis and Peleka, 2010; Parsa et al., 2011).

Electrocoagulation has been used successfully for treatment of various industrial wastewaters such as plating (Adhoum et al., 2004), chemical and mechanical polishing (Drouiche al., 2007), textile (Khandegar and Saroha, 2013; Wei et al., 2012; Pajootan et al., 2012; Yuksel et al., 2011), olive oil (Tezcan et al., 2006), laundry (Wang et al., 2009), tannery (Feng et al., 2007), dairy (Şengil, 2006), pulp and paper (Khansorthong and Hunsom, 2009), and oil refinement (El-Naas et al., 2009).

For instance, Khandegar and Saroha (2013) treated textile wastewater by electrochemical method. Under Optimum conditions, with dye concentration of 10 mg/L of Acid Red 131 and using aluminum electrodes, dye removal efficiency of 98% was obtained. Pajootan et al. (2012) studied removal of Acid Black 52 and Acid Yellow 220 from wastewater by electrocoagulation. With dye concentration of 200 mg/L and aluminum electrodes, the removal efficiency was 90 and 98%, respectively, in the mentioned dyes.

The aim of this study was to assess the simultaneous performance of electrocoagulation and electroflotation techniques in an electrochemical system by using aluminium electrodes for removal of Acid Red 14 from aqueous solution. It was expected that the need for a gravity settling unit and as a consequence the treatment cost would be reduced. In this study, the design of the reactor in a manner intended to take advantage of electrocoagulation and electroflotation methods simultaneously. This research investigates the effects of four important parameters on the performance of electrochemical systems, including electrode surface area, interelectrode distance, electrical conductivity and current density. The optimum values of these parameters were

---

∗ Corresponding Author: E-mail: ayati_bi@modares.ac.ir

determined based on the amount of electrical energy and aluminium consumption and the best performance of coagulation and bubble generation.

Materials and Methods

In this study, electrochemical process was developed at room temperature in a 5 L rectangular plexiglass cubic reactor which included two pure aluminium electrodes with monopolar and horizontal arrangment and a PM-3005D Megatek power supply. Since the generated hydrogen gas at cathode plays the main role in floating suspended particles, the cathode was placed above the anode. Before each experiment, the electrodes were sanded and then washed by diluted acidic solution and distilled water. The experiments were performed in batch mode.

An Anionic dye, Acid Red 14, as the main pollutant with structural formula of $C_{20}H_{12}N_2Na_2O_7S_2$ contains an azo group and molecular weight of 502.4. It was used to prepare the synthetic wastewater. The concentration of dye in solution was measured by using a Hach DR-4000 spectrophotometer at the wavelength of maximum absorption of the dye (λ_{max}=515 nm). The other instruments used in this study are a Mettler PJ300 digital scale with accuracy of 0.001, Metrohm 691 pH meter, a Martini MI805 EC meter, and an IKA RH-Bassic2 magnetic stirrer. NaCl (Merck) was also used to obtain electrical conductivity in solution and synthetic wastewater was prepared with double distilled water. All measurements including dye concentration, EC and solids were according to water and wastewater standard methods (APHA, 2012).

Parameters including electrode surface area (24.86, 52.86, 80.86 cm^2), interelectrode distance (1, 1.5, 2 cm), conductivity (800, 1600, 3000, 4000, 5000 µS/cm) and current density (10, 20, 30, 40, 50, 60 mA/cm^2) were examined. Specific energy and aluminium consumption were calculated in terms of kWh/kg dye $_{removed}$ and kg Al/kg dye $_{removed}$, respectively. These two responses and TSS of the separated sludge were the basis for determination of parameters optimum value.

Results and Discussion

Effect of electrode surface area

Experiments were carried out at electrode surface area of 24.86, 52.86, and 80.86 cm^2. Other parameters were kept constant. By increasing electrode surface, generated oxygen bubbles were trapped under anode and continued to stick together and form large bubbles. When these large bubbles were released from under the anode, they collided with hydrogen bubbles on their path upward and form larger bubbles that were not capable to float the existing flocs. By increasing the electrode surface, the voltage required to achieve a constant electric current was reduced due to lower electrical resistance of the system. It has to be noted that the lower anode dissolution cause less production of sludge, hence, lower disposal management costs. Thus, the electrode surface of 24.86 cm^2 with dye removal efficiency of 99% within less than 120 minutes, specific energy consumption of 193 kWh/kg dye $_{removed}$, anode dissolution of 3.908 kg Al/kg dye $_{removed}$ and sludge TSS of 15050 mg/L was selected as the optimum value. Compared with conventional gravity settling tanks, this system has higher sludge TSS values.

Effect of interelectrode distance

Experiments at interelectrode distances of 1, 1.5, 2 cm were carried out to assess the influence of this parameter. By increasing the distance between the electrodes, dye removal efficiency decreased due to the delay in forming coagulants and less mobility of the ions produced at the electrodes. By reducing the distance between the electrodes, the voltage required to achieve a constant electric current was reduced due to the reduction of electrical resistance. Aluminium dissolution with different interelectrode distances had close values; interelectrode distance of 1 cm was selected as the optimum value for the following experiments.

Effect of electrical conductivity

The electrical resistance decreases with increasing conductivity of the solution. Typically, the voltage required to achieve constant electric current is decreased. Salts and ions are used to provide electrical conductivity. The deposition and corrosion caused by these ions on the electrodes make problems in the process, increase the electrical resistance and impose additional costs. It was observed that by enhancing the electrical conductivity and needing more time to completely separate the pollutant, the amount of aluminum in the separated sludge is increased, regarding turning of the sludge more into gray. The increase of the aluminum flocs containing water in the sludge causes the TSS to decrease. Therefore, the electrical conductivity of 1600 µS/cm with dye removal efficiency of 90% within less than 90 minutes, specific energy consumption of 130 kWh/kg dye $_{removed}$, anode dissolution of 2.615 kg Al/kg dye $_{removed}$ and sludge TSS of 15050 mg/L was selected as the optimum value.

Effect of current density

The rate of dye removal by increasing the amount of current density is high. This phenomenon is because of the

higher rate of production of coagulants and gases with increasing current density, the event that leads to faster coagulation, flocculation and separation of contaminants (Zodi et al., 2013). The lower current density leads to lower bubble generation. According to the observations, at low current density, due to the low volume of produced gases, the sludge was not floated well and after floatation it returned into the wastewater and the process of pollutant removal was more dependent on continuous separation of sludge. Thus, at low current density, the efficiency of the process will be low in high pollutant concentration and load shock (Kobya et al., 2006). Optimum system performance was achieved at current density of 60 mA/cm^2.

Conclusion

This research has considered the electrochemical treatment of an azo dye (acid red 14) with electrocoagulation and electrofloatation simultaneous processes. The experimental results showed that electrocoagulation and electrofloatation system has good performance for rapid removal of dye, so this system can be used for treatment or pre-treatment of wastewater containing toxic and non-biodegradable materials, especially textile effluents. The process can easily be controlled and the equipment are safe. Tiny bubbles of the same size are generated. There are few needs to add chemicals. Furthermore, good efficiency in hydraulic, organic and toxic shocks, reduction in the number of process units and, as a result, decrease in the required area for treatment plant, and lower operation cost are the other advantages of this technique.

The effects of electrode surface area, interelectrode distance, electrical conductivity and current density were also investigated. From the obtained results, after 90 min of electrolysis, 90% of dye removal was achieved under optimum condition with electrode surface area=24.86 cm^2, interelectrode distance=1 cm, electrical conductivity=1600 μS/cm and current density=60 mA/cm^2 with specific energy consumption=130 kWh/kg dye$_{removed}$, anode dissolution=2.615 kg Al/kg dye $_{removed}$, and sludge TSS=15050 mg/L.

Cadmium Removal from Aquatic Environment by Zero-Valent Iron Nanoparticles

Sahar Makari[1*], Gholamreza Nabi Bidhendi[2], Hossein Nayeb[3]

1. MSc Student in Environmental Engineering, Faculty of Environment, University of Tehran, Tehran, Iran
2. Professor of Environmental Engineering, Faculty of Environment, University of Tehran, Tehran, Iran
   (ghhendi@ut.ac.ir)
3. PhD Candidate in Environmental Engineering, Shahid Beheshti University, Tehran, Iran
   (pirnia.nayeb@gmail.com)

Expanded Abstract

Introduction

Cadmium as one of the toxic heavy metal has attracted a lot of attention in researches because of harmful effects on health and the Environment. The main sources of cadmium emissions are the environment, the waste of electroplating, melting, alloyed manufacturing, pigments, plastics, batteries, extraction and refining processes. This metal can easily be accumulated in different machines of people and has negative effects such as renal disorders, lung insufficiency, bone lesions, cancer, high blood pressure, harmful impacts on the health.

The adsorption process as an effective method for removing heavy metals from soil and water has spread in the environment. Various adsorbents such as clays, zeolites, the dry plants, waste pile of agricultural, biopolymers, metallic oxides, microorganisms, sewage sludge, ash and activated carbon are employed for the removal of the cadmium. The absorbed is known as an economic and efficient way with significant potential for removal, recovery and recycling of the heavy metals of waste.

In study of transmission and absorption of minerals and compounds on the adsorbent, equations and relations must be existed between concentrations and remaining of the absorbed matter in constant temperatures. These equations are isotherms, Langmuir and Freundlich models.

Materials and Methods

In this study, iron nanoparticles in size of 8-18 nm and the effective level of 59-79 m^2/g was used. To prepare soluble cadmium salt of cadmium chloride $H_2O(2/5)CdCl_2$ was also used NaOH hydroxide and HCl For was also used for changes in Ph .

Testing method

This research investigates the experiments conducted as batch reactor and all the changes in pH, the amount of nanoparticles, the initial concentration of soluble, the test time, and Sedimentation time. The initial concentrations of the soluble are equal to 60, 30, 15, 5 mg/L. This is the value of 60 mg/L as the initial concentration of the soluble in other tests. To prepare 250 mm of 60 mg/L soluble, amount of 0.0035 gr of the cadmium chloride salt is needed.

At first, 250 ml of the concentration of cadmium is prepared and certain amounts of particles with the weight of 0.75, 0.5, 0.25 and 0.13 g was poured into 100 ml test tube containing cadmium soluble. Then, the Solubles were placed in an ultrasonic device to identify the uniform distribution of nanoparticles in soluble to increase the contact between pollutants and nanoparticles and also to enhance the efficiency of adsorption.

After washing with distilled water, magnet was poured into a test tube. It was also adjusted onto a magnetic stirrer at high speed in a specified period of 60, 45, 30, 20 and 10 minute. Then, sedimentation time was given to the desired soluble. Furthermore, normalized profits of 0.1 were used to adjust the pH of concentrated nitric acid.

Assessing the effects of changes in pH on the removal efficiency of cadmium by iron nanoparticles

The results of the cadmium absorption in different pH at room temperature was performed with an initial concentration of 60 milligrams per liter, 0.25 g of nanoparticles in 100 mg of soluble testing time in 45 minutes.

∗ Corresponding author: E-mail: civil.engineer_85@yahoo.com

With increasing pH, removal rates were increased and from pH= 5.8 to pH= 7.2 the removal efficiency is increased about 60%. However, cadmium soluble in pH=8.4 was tested under identical conditions without the presence of nanoparticles. It became clear that without the presence of nanoparticles at this pH, removal efficiency is also 80%. But in pH=7.2 without the presence of nanoparticles, the removal efficiency was 34%. This indicates that in pH= 7.2 the presence of nanoparticles increases removal efficiency.

Assessing changes in the amount of iron nanoparticles and its performance in the removal of cadmium

The results of the cadmium absorption was performed in varying amounts of iron nanoparticles at room temperature, with initial concentration of 60 milligrams per liter, a pH value of 7.2 with different values of 0.13, 0.25, 0.5 and 0.75 g in 100 ml of nanoparticles with time-tested 45 minutes.

Removal efficiency increases with increase in the amount of nanoparticle and the removal efficiency is increased with increase in the amount of nanoparticle from 13.0 to 25.0 g. While the removal efficiency of cadmium with increasing amount of nanoparticles from 5.0 to 75.0 g has been increased only 3%. About 0.75 g of nano has the best performance, but given the proximity of the result with 0.5 g of nano, this value has been selected as optimal nano, because of the lack of affordable higher amount of nanoparticles.

Assessing changes in testing time and the performance impact of nanoparticles in removal of cadmium

The results of Cadmium absorption was performed in varying amounts of testing time at room temperature, with an initial concentration of 60 milligrams per liter, a pH value of 7, 0.5 g nano-particles in 100 ml soluble at various times experiments in 60, 45, 30, 20 and 10 minutes. Of the testing time of 10 min to 20 min, the removal efficiency increased to 10% and the efficiency increased only 3% for the time from 20 minutes to 30 minutes.

Assessing various amounts of initial soluble concentration and the performance of nanoparticles in the removal of cadmium

The results of the cadmium show the performed absorption at different values of the concentration of the initial soluble at room temperature, with initial concentrations of 60, 30, 15 and 5 mg l, and pH value equal to 7.1, 0.5 grams of nanoparticles per 100 ml of soluble and time-tested of 30 minutes.

The more the soluble concentrations increase, the higher the removal efficiency is reduced. Thus, the maximum absorption of the soluble has happened at a concentration of 5 and 15 mg/L, which this is equal to 98%. In fact, the removal efficiency for both samples was the same. As it can be seen, the speeds of absorption process for all four cases are very close together.

Assessing Change in settling time and the performance of particles in the removal of cadmium

The results of the cadmium absorption was performed at different times of sedimentation at room temperature, with an initial concentration of 60 milligrams per liter, pH value equal to 7, 0.5 grams of nanoparticles per 100 ml of soluble, test time of 30 minutes and the sedimentation time of 90, 60, 30 and 15 minutes.

Increases in the retention time can be increased if the maximum of percent absorption occurs at the retention time of 90 min. With increase in the retention time from 15 to 30 minutes increases will be observed in the percent absorption, but rate of increase is negligible. In the retention time of 60 to 90 min, the removal efficiency is increased to 20%.

Results and Discussion

In this research, it was found that nano-zero valent iron particles are as an appropriate adsorbent for cadmium reduction. Increases in the amount of nanomaterials can increase the absorption. The optimal value is obtained 0.5 gr per 100 ml of solution volume. In the study by Bahrami and his colleagues about removing the cadmium from aquatic solution by nano-magnetic materials, it has been found that the removal efficiency can be increased with increasing amount of the adsorbent. They concluded that the increase in the amount of the adsorbent can raise the available adsorption sites for better adsorption of cadmium.

By increase in the pH from 3 to 9, the removal efficiency can be increased but as it is clear on the diagram, the promotion rate of this efficiency in pH from 7 to 9 is insignificant and only experienced 10% of increase. Deposition has an important role in the removal of cadmium ions in the alkaline range. The likelihood of precipitation of metal hydroxides in the pore spaces around the particles is very low, because the adsorption process is faster than the precipitation process.

Cadmium removal, at the pH value lower than 7, is mainly controlled by adsorption process and this value at pH greater than 7 is significantly increased by cadmium hydroxide precipitation. In the study by L.V and his colleagues about the Chrome removal by nano zero valent iron, it has been found that at pH greater than 7 the

removal efficiency is decreased.

At the time of testing at 20, 30, 45 and 60 min, the removal efficiency is also increased, but the rate of absorption is reduced and the absorption rate is fixed at 30 and 45 minutes. Thus, 30 minutes was considered as the optimal time. In this research, by Alqudami and his colleagues about removal of Cadmium and Lead by nano-zero valent iron, it has been found that the best adsorption is occurred in 20 minutes. This may be due to the rapid accumulation of nanoparticles which reduce the active surface and thus reduce the absorption capacity.

Maximum adsorption in the entire optimal situation is occurred in a 5 mg/L solution. In the research by Bahrami and his colleagues about removal of Cadmium by nano-magnetic materials, it has been found that the increase in the concentration of the solution may cause a decrease in removal efficiency. At low concentrations of the cadmium, specific surface areas and adsorption sites are more and cadmium ions can have interaction by surface of the adsorbent particles. Therefore, this lead to increase in absorption efficiency value.

Keywords: absorption isotherm, adsorption process, cadmium, zero-valent iron nanoparticles.

Investigation on the Dispersivity Coefficient of NaCl in Laboratory Columns under the Influence of Different Textures and Lengths

Omid Bahmani[1]* , Mohammad Ghabaei Sough[2], Seyed Moin Oldin Rezvani[3], Atefeh Mahdavi Najafabadi[4]

1. Assistant Professor of Science and Water Engineering, Bu-Ali Sina University, Hamedan, Iran

2. PhD Candidate in Science and Water Engineering, Bu-Ali Sina University, Hamedan, Iran
   (ghabaei.m63@gmail.com)

3. PhD Candidate in Science and Water Engineering, Bu-Ali Sina University, Hamedan, Iran
   (moin.rezvani@gmail.com)

4. PhD Candidate in Science and Water Engineering, Bu-Ali Sina University, Hamedan, Iran
   (a_mahdavi83@yahoo.com)

Extended Abstract

Introduction

The movement and fate of solutes in the subsurface are affected by a large number of physical and chemical processes requiring a broad array of mathematical and physical sciences to study and describe solute transport. The dispersion is an important parameter in the advection– dispersion equation. This is used in assessing and solving the problems related to the contamination and protection of the groundwater resources. The study of solute transport in porous media in the small scale (laboratory columns) and the large scale (farm) has been started since the recent decades. In recent years, relevant studies have significantly increased about the physical and chemical phenomena in porous media, such as dispersion, diffusion, anion desorption, and adsorption or exchange processes. The characteristics of processes such as transport, advection and diffusion in soil and groundwater flow is essential for predicting and modeling of solute movement in the soil.

Researchers in their experiment showed that the small and large scale affected the dispersion and this difference is related to the length of the scale. Based on their results, the average dispersion (α) was determined to be 0.8 and 0.87 cm for tritium and chloride tracers in small columns soils, respectively; while it was 5 cm in large columns.

Evaluation of dispersion coefficient can be used in different texture and scales to protect and manage the pollutants in groundwater resources and aquifers. Thus, the main objective of this study is to evaluate the effect of soil texture and sample scale on the dispersion coefficients and the compliance model to predict solute transport in different laboratory columns. For this purpose, the amount of sodium chloride was measured in the output drainage water in 12 laboratory columns with 4 textures of sandy soil of 50, 80 and 110 cm long. Then, the breakthrough curve was drawn. Finally, transport parameters and thrust curve were estimated using the analytical Brigham model and the CXTFIT program through inverse method.

Materials and methods

Advection–dispersion equation:

The advection–dispersion equation (CDE) is one of the models governing solute transport in soil. This is used for non-reactive ions and solutes. In this model, the transition process was governed with the mass flow and diffusion and tow phenomena, including flow velocity in the pores and dispersion coefficient (1). They can represent the transmission characteristics. For one-dimensional steady flow equations, it can be written as follows:

$$\frac{\partial c}{\partial t} = D\frac{\partial^2 C}{\partial x^2} - V\frac{\partial c}{\partial x} \qquad (1)$$

Where, C: the concentration of salt in the liquid phase (M/L^3), x: the distance along the flow direction (L), V: the average water pore velocity (M/L) and D: dispersion coefficient (L^2/T).

---

* Corresponding author: E-mail: Omid.bahmani@basu.ac.ir

In order to address analytical solutions of CDE, various methods have been proposed that involving partial differential equations based on different boundary conditions and initial values. In this case, there is a column of sand saturated with water and a steady flow of water into the soil column. The tracer with known concentration enters into the soil column and at time t the value of the output of the column (C) is measured.

Inverse method

In equation (2) the C value is measured for different values of U, the initial values are assigned to the parameters V, D, and R, theoretical and measured breakthrough curves are drawn, and the error value is calculated based on statistical criteria such as root mean square error. Then, the difference between the measured and simulated sodium chloride breakthrough curves become minimal while the optimal values of the parameters V, D and R are found using an inverse optimization method based on the Levenberg-Marquardt algorithm.

Brigham model

This model developed a graphical method to calculate dispersion coefficient using data from miscible displacements in short laboratory cores. In this model, we must measure C for different various values of U (U is the pore volumes injected). The breakthrough relative concentration, C/C_o, was plotted versus $(U-1)/U^{1/2}$ on linear probability paper. If the data are fit a straight line, then the use of the diffusion equation was validated, and the dispersion coefficient could be calculated from the slope of the line. This model indicates that the flow system can be broken into segments in which width was a linear function of distance.

Test Method

The 12 samples, including four sandy soil textures (100, 90, 80 and 70 percent blown sand and remain percentage natural sand) and three lengths (50, 80 and 110 cm) were selected and NaCl was used as injection with EC 5.5 mmohs/cm. The salinity of the output drainage water was measured at different intervals. This process was continued until reaching constant concentration in the drained water.

Results and discussion

Inverse method

According to the results of this study, the obtained breakthrough curves are coincided and the delay factor is close to 1 with the increase in the percentage of natural sand at different lengths of soil columns. The treatment for the length of 110 cm and 100% blown sandy soil has delay factor of 1.805. That is lower from other ones with different lengths. Delay factor reaches about one in 90% of blown sandy soil and 110 cm long. It was not seen in other ones with different lengths.

According to the results, delay coefficient decreases to 100% of blown sandy soil treatment for increasing length. This reduction was seen slight in other treatments.

Diffusion coefficient is also decreased in increasing amounts of natural sand. Due to the length of the samples, changes can be seen over the length only in 100% blown sandy soil treatment. The average values of the diffusion coefficient are 0.387, 0.276 and 0.496 cm^2/min in soil columns with 50, 80 and 110 cm long, respectively.

In 100% natural sandy soil treatment, the velocity is bigger than the other treatments. The amount of natural sand in soil treatments is more; the difference between velocities in all of the lengths is low. The average velocity is 0.402, 0.397 and 0.344 cm/min in various tissues in lengths of 50, 80 and 110 cm, respectively, and it changes slightly.

Brigham model

The results of this study show that the dispersion coefficient values are increased when the length of the sample is increased by 80% blown sandy soil. This indicates that the dispersion coefficient is dependent on the sample length. But this process of texture 100, 90 and 70% of sand and the lengths of 80 and 110 are correct (table 1), but the dispersion coefficient of the sample is greater than 50 cm in length and somewhat greater. For samples of the same length and different textures in this study, there is a clear trend.

Table 1. The amount of dispersion coefficient, diffusion coefficient and speed of solutes in treatments using Brigham model

70% blown sand 30 % natural sand			80 % blown sand natural sand 20 %			90 % blown sand 10 % natural sand			100 % blown sand			Texture
v	D	α	v	D	α	v	D	α	v	D	α	Length(cm)
0.390	0.215	0.551	0.276	0.130	0.473	0.247	0.128	0.519	0.309	0.292	0.945	50
0.283	0.113	0.400	0.254	0.140	0.548	0.409	0.139	0.338	0.268	0.075	0.279	80
0.332	0.165	0.496	0.459	0.339	0.740	0.392	0.192	0.465	0.233	0.669	2.868	110

Conclusion

Comparison of the values obtained for the coefficient of α with the results of other researchers show that the range varies less than 1 cm, which corresponded to the reported results, except for 100% blown sand texture sample 110 cm in length of 2.868 cm. The results also showed that the estimated dispersion coefficient of CXTIFT has been changed from 0.524 to 3.282 cm in treatments that were more than the corresponding estimated values with Brigham. Increase in the percentage of sand in the soil and sample length leads to decrease in delay coefficient. In addition, the dispersion coefficient can decrease with increasing the percentage of natural sand. However, the average value of the dispersion coefficient has not many changes in soil columns with lengths of 50, 80 and 110 cm. The minerals velocity of 100% blown sandy soil was higher than other treatments. The amount of natural sand increases as the velocity difference in various lengths will be lower.

An Investigation on Flocculation, Adsorption and Desorption Process During Mixing Of Saline Water with Fresh Water (Caspian Sea)

Abdolreza Karbassi[1], Mojtaba Fakhraee[2*], Alireza Vaezi[3], Abolfazl Bashiri[4], Mehdi Heidari[5]

1. Associate Professor, Environmental Engineering, Graduate Faculty of Environment, University of Tehran, Iran (Akarbasi@ut.ac.ir)
2. PhD Candidate in Water Resources Science, University of Minnesota, USA
3. PhD Candidate of Environmental Engineering, Graduate Faculty of Environment, University of Tehran, Iran (al.vaezi@ut.ac.ir)
4. MSc Student of Environmental Engineering, Graduate Faculty of Environment, University of Tehran, Iran (ab_bashiri@ymail.com)
5. MSc Student of Environmental Engineering, Graduate Faculty of Environment, University of Tehran, Iran (Mehdiheidary@ut.ac.ir)

Expanded Abstract

Introduction

Estuaries are very important aquatic systems as they preserve the coastal biota, are considered as a highly dynamic ecotones that include the mixing or transition zone between freshwater and saline water, and are fairly appropriate places for living a wide variety of fauna and flora. An estuary is a semi-enclosed coastal area where freshwaters from rivers and streams are mixed with saltwater from the ocean. Estuaries have a very reactive system through which heavy metals pass, as they are transported, into the seawater.

Many animal species rely on the estuaries for food and as a place to nest and breed. Estuaries are both chemically and physically dynamic ecosystems that, due to their location at the river-sea interface, act as buffer zones between the continent and sea. Thus, it is essential to study carefully and closely the overall geochemical cycle of trace elements during mixing of freshwater with saltwater from seas in estuaries.

The chemistry of seawater and freshwater is greatly variable. It is essential to find out estuarine process to predict the geochemical behavior of each individual element and its potential effect on different organism as well as the important role of these processes in the chemical mass balance between rivers and seas. It is generally known that, during estuarine mixing, the partitioning of metallic species between solution and suspended particles is governed by two important, contractive and non–biological mechanisms. These mechanisms are desorption of metals from re-suspension riverine particle matters and metal removal through flocculation of humic and fulvic acids-metals complexes. Flocculation process is one of the most important processes that occur in estuary and contributes to the concentration of heavy metals that has long lasting detrimental effects on environment to be on the decline remarkably. It also plays a vital role in reduction of the pollution load. In the present study, flocculation, adsorption and desorption process of such a wide variety of heavy metals as copper, zinc, nickel, lead and manganese during estuarine mixing of Karganrud River water with Caspian Sea water is investigated in relation to the diverse parameters such as pH, salinity, dissolved organic carbon, NO3 and Sodium hypochlorite that is a chemical compound with the formula NaClO.

Materials and Methods

The Caspian Sea covers an area of about 371,000 Km^2 that lies between the Caucasus Mountains and Northern Iran. It is the largest lake all across the world and contain a huge number of living organisms and the salinity of the sea waters is ranged from 4 ppt in the northern parts to almost 13‰ in the southern parts. The Karganrud River has a length of 42.5 km with an average annual discharge of about 252×106 m3/year. The catchment area of the river is about 615.4 km^2 with an average annual precipitation of 1150 mm. River water and suspended materials were collected in pre-labelled and pre-cleaned 25L polyethylene bucket from the surface of Karganrud River at a point (Ca. 16 km upstream) where ensure no saline water can penetrate the fresh water. On the same day fresh water was filtered through 0.45μm Millipore AP and HA filters. The suspended material samples were also dried at 50C° for 29 hours. Approximately 1L of filtered fresh water was acidified with concentrated nitric acid (HNO_3) to a pH of 1.8 and kept in polyethylene bottles in a refrigerator prior to the analysis of dissolved

trace metals. It should be noted that 5gr of riverine suspended materials were used for metal analysis. Similarly on the same day saline water samples from Caspian Sea were collected approximately 20 km away from the shore where no seawater diluted by river water (salinity = 0.21‰). The flocculation process was conducted by adding the appropriate volume of filtered seawater to the constant volume of filtered river water at room temperature in eight proportions yielding salinity of 0.5-3‰.To recognize the effects of NaClO on flocculation of metals, the increasing amounts of NaClO were also added to each aquarium in the laboratory condition. The eight mixtures were kept for 24 h with occasional stirring. The resulting flocculants were collected through 2.5 cm diameter Millipore membrane filter. Finally, after digestion of the filters, the concentration of metals was determined using inductively coupled plasma (ICP-AES).To determine the capacity of adsorption and desorption of metals, the constant volume of fresh water sample was also mixed with seawater sample to obtain a series of mixture with various salinity regimes (0.5-3‰). It should be pointed out that 5gr of suspended particle materials (SPM) are added to each aquarium. The eight mixtures were kept for 24 h with occasional stirring. Accordingly, the physicochemical parameters (DOC, NO3, Salinity, pH) of each aquarium were measured prior to the metal analysis. Particulate samples were collected on 0.45μm Wattman filters and the concentration of Cu, Ni, Pb, Zn and Mn was determined using ICP-AES. In addition, four-step chemical partition studies were done for any aquarium which adsorption process is observed. Of the existing clustering techniques the weighted pair group (WPG) method described by Davis (1973) was used in this study.

Results and Discussion

Based on the results of this research, the maximal removal of Cu and Zn occurs between salinities of 0.5-1.5‰. About 36% of Ni is removed at the first step of mixing experiment (salinity = 0.21-0.5‰). Nickel shows the minimum flocculation tendency in comparison to copper, zinc, lead and manganese. It can be noticed that Mn undergoes maximum flocculation during mixing experiments. As presented, the maximal adsorption capacity of all studied metals except for pb, occur between salinities of 0.5-1.5‰. The flocculation rate and maximal adsorption capacity of metals by suspended materials during estuarine mixing are in the following orders, respectively: Mn(94.8%) > Zn(60.04%) > Pb(36.63%) > Cu(30.32%) > Ni(14.84%) and Cu(13.68 mg/kg) > Zn(10.41 mg/kg) > Ni(6.58 mg/kg) > Mn(5.96 mg/kg) > Pb(0.146 mg/kg). In the present study, Cu shows maximum adsorption capacity between all studied metals. Based on the results, the concentration of NO3 is decreased with an increase in salinity in the study area. The concentration of total dissolved organic carbon (DOC) in the fresh river water was about 1.92 mg/L that increased to 22.34 mg/L at a salinity of 3‰. Such an increase is indicative of a marine origin in the estuarine zone. Cluster analysis shows that Mn, salinity, DOC and NaClO are joined together with high similarity coefficient. This shows that the flocculation of Mn is governed by NaClO, salinity and DOC. In the present study, pH doesn't play any role on flocculation and adsorption processes of studied metals (Figure 1).Based on the cluster, it can be inferred that adsorption rate of Mn, Zn and Cu is controlled by NO3. According to the chemical sequential extraction, it can be noted that approximately 25% of the total heavy metals (Cu, Ni, Zn, Mn) contents were in the form of sulfide ions.
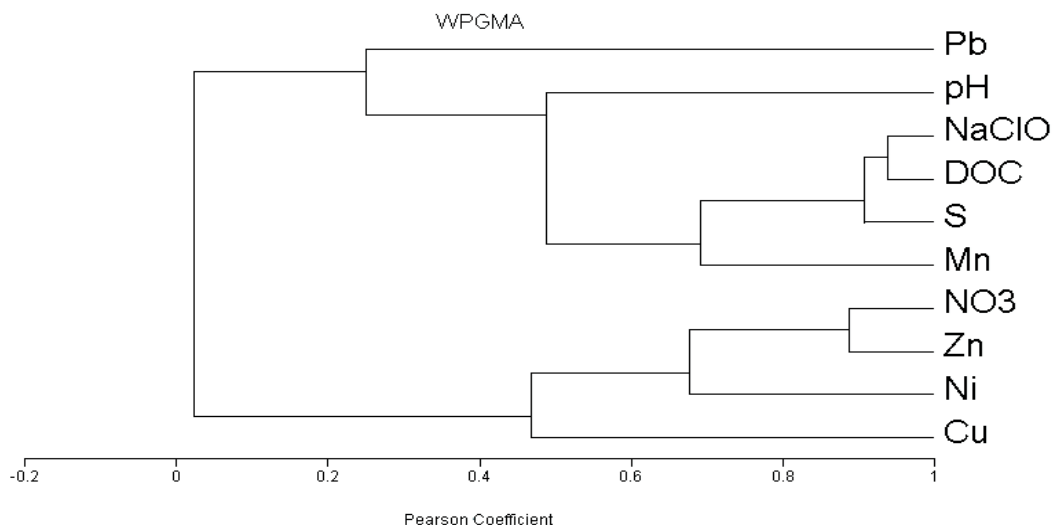
Fig. 1. Dendrogram of cluster analysis for metals and other physic-chemical characteristics of Karganrud River and Caspian Sea water

Conclusion

In this study, flocculation, adsorption and desorption processes of copper, zinc, nickel, lead and manganese during mixing of Karganrud River water with Caspian Sea water were investigated at a wide variety of salinities from 0.5 ppt to 3 ppt. The highest percentage of flocculation was observed for manganese in comparison with copper, zinc, nickel and lead. The Pb showed desorption behavior from suspended particulate matter during estuarine mixing. It can be clearly seen that the maximum adsorption capacity belongs to Cu compared with other studied metals. Among the studied physicochemical parameters of mixing samples, DOC shows a linearity increasing behavior toward salinity. Based on the cluster analysis, the flocculation process of Zn, Cu and to lower extent Ni is controlled by NO3. On the other hand, the flocculation process of Mn is mainly controlled by NaClO. According to the chemical partitioning study, it should be noted that about 63% of the concentration of the adsorbed Cu is found in carbonate fractions. Generally, the highest percent of metal contents found in sulfide and carbonate compounds. The flocculation and adsorption rate of the studied metals showed that overall colloidal metal pollution loads can significantly be reduced by various percentiles at different salinity regimes.

This not only states the importance of these processes in natural self-purification of estuarine ecosystems, but also shows the ecological importance of the estuarine process. Future investigations should focus on the role of seawater in the treatment of trace metals during industrial wastewater purification.

Estimation of the Cardiovascular and Respiratory Mortality Rate Resulted from Exposure to Sulfur Dioxide Pollutant in Ahvaz

Sahar Geravandi[1], Gholam reza Goudarzi[2], Mehdi Vousoghi Niri[3], Mohammad javad Mohammadi[4*], Saied Saeidimehr[5], Sara Geravandi[6]

1. Islamic Azad University, Tehran Medical Sciences Branch and Razi Hospital, Ahvaz Jundishapur University of Medical Sciences, Iran (sahargeravandi934@gmail.com)
2. Environmental Technologies Research Center and Department of Environmental Health Engineering, School of Public Health, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran (Rgoodarzy@gmail.com)
3. Department of Environmental Health Engineering, School of Public Health, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran (mvn_20@yahoo.com)
4. Department of Environmental Health Engineering, School of Public Health and Razi Hospital, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
5. General Manager of NIDC, Naft Grand Hospital, the health affaire organization of oils and refineries industry, Ahvaz, Iran (ebnsaid@yahoo.com)
6. MSc Student of Health Economics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran (cati7nk@yahoo.com)

Expanded Abstract

Introduction

Sulfur dioxide has been widely studied among the anthropogenic pollutants. Air pollution is a major environmental risk to the health. The less air pollution, the better is the cardiovascular and respiratory health of the population, both on long- and short-term effects. several studies have demonstrated the relationship between the short and long term effects of exposure to air pollutants with human health. The exposure to sulfur dioxide is extremely risky for people health because these compounds enter the circulatory system directly through the airways. Sulfur dioxide can be absorbed into your body through your nose and lungs. The most important effects of sulfur dioxide air pollution are increase in the rates of hospital admissions, asthma attacks, cardiopulmonary disease, death and number of the years of life lost. Sulfur dioxide can be dangerous to the respiratory system and the functions of the lungs and it can also lead to irritation of eyes. Ahvaz as the center of east khouzestan province in southwest of Iran is one of the most populated and polluted cities of Iran. Ahvaz city, with a population of approximately 1 millionpeopleand an area of 8152 square kilometers, as the capital city of Khuzestan Province is located between 48 degree to 49°29′ East of Greenwich meridian and at 31 degrees, northern hemisphere. Ahvaz is located in an arid area in southwest part of Iran with long and hot summertime. Temperature reaches to 50 degree of centigrade on June and July. Keep in mind, high density of industries (steel, oil and gas) makes Ahvaz as one of the most important centers of pollusion emission. With the rapid economic growth in Ahvaz, the level of air pollution has drastically increased from both motor vehicles and industrial emissions. Furthermore, health effects of air pollution in terms of Sulfur dioxide, ozone and particulate matter were reported in most of megacities, particularly Ahvaz. This research aims to estimate the health effects (total of death, cardiovascular and respiratory mortality) related to Sulfur dioxide pollutants in 2011.

---

* Corresponding Author: Email: Mohamadi.m@ajums.ac.ir
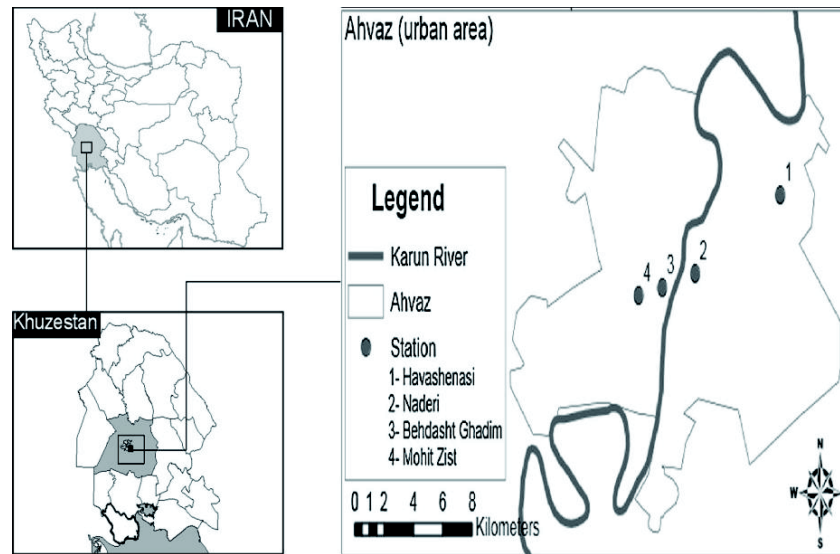
Fig. 1. Location of the study area and sampling stations in Khuzestan Province (Ahvaz), southwest Iran

Materials and Methods

In this retrospective study, we attempted to assess the potential effects of Sulfur dioxide exposure to the poluttants on human health in Ahvaz city (located in south-western Iran) during 2011. The concentration of Sulfur dioxide pollutant was measured in 2011 in four stations in Ahvaz. The most important part of analysis is data processing that encompasses modification of temperature and pressure, primary processing (the deletion, spreadsheet and synchronization), secondary processing (writing code and condition correction), formulation and filtering. Finally, Estimates of the health effects is related to Sulfur dioxide pollutant in Ahvaz. We calculated the health effects related to Sulfur dioxide by $AirQ_{2.2.3}$ based on relative risk andproportions and baseline incidence from WHO data. This model includes four screen inputs (Supplier, AQ data, Location, Parameter) and two output screens (Table and Graph). To estimate the health impact attributable to the exposure of air pollution on the target population using AirQ model, it is required to estimate the these impacts from specific air pollutants on the resident population in a certain area and period.

Results and Discussion

The primary and secondary standard of sulfur dioxide, according to national ambient air quality standard (NAAQS) 24-hour, is 150 $\mu g/m^3$. Table 1 shows that annual average of sulfur dioxide in Ahvaz was 157.5 $\mu g/m^3$ in 2011 which is higher than WHO air quality guidelines and also much higher than NAAQS values. In view of sulfur dioxide concentrations, Mohitzist and Havashenasi were the highest and the lowest stations during this year. The annual average, summer mean, winter mean and 98th percentile of sulfur dioxide concentrations in these stations are presented in Table 1.

Table 1. The highest and lowest concentrations of Sulfur dioxide ($\mu g/m^3$) corresponding to the stations

Stations / Parameter	Average Ahvaz	lowest stations (Havashenasi)	highest stations (Mohitzist)
Annual mean	157.5	69.63	212.26
Summer mean	53.12	27.54	82.32
Winter mean	172.32	89.44	267.1
98 percentile	192.71	105.21	295.47

Sum of total numbers of death attributed to Sulfur dioxide was 194 cases and the number of cardiovascular of death in centerline relative risk was 156 cases that 67 percent of them happened when the Sulfur dioxide concentration was less than 90 $\mu g/m^3$. Relative risk and estimated attributable proportion percentage for total numbers of death, cardiovascular of death, respiratory mortality and myocardial infarction were calculated as in table 2. Baseline incidence (BI) for this health effect for Sulfur dioxide were 1013, 497, 66, 132 and per 10^5.

Thus, the total number of death was 194 (RR=1.0040 and AP=1.7265%), the number of cardiovascular mortality was156 (RR=1.0080 and AP=3. 3216%), the number of respiratory mortality was also 25 (RR=1.010 and AP=4. 0236%) and the number of myocardial infarction was 33 (RR=1.0064 and AP=2.8652%) at centerline of relative risk.

Table 2. The estimation relative risk indicators and the component attributable to Sulfur dioxide cases attributable to total numbers of death, cardiovascular of death, respiratory mortality and myocardial infarction

Health effects attributable to Sulfur dioxide	RR (relative risk)	Estimated AP (%)	Estimated number of excess cases (persons)
total numbers of death	1.004	1.7265	194
cardiovascular death	1.008	3.3216	156
respiratory death	1.01	4.0326	25
myocardial infarction	1.0064	2.8652	33

Based on the results of this study, we found that in Ahvaz number of respiratory mortality attributed to Sulfur dioxide were 25 cases and number of myocardial infarction in centerline relative risk was 33 cases. In this study, we estimated the total numbers of death, cardiovascular of death, respiratory mortality and myocardial infarction associated with the short and long term fluctuations in concentrations of Sulfur dioxide pollutants in people, using AirQ model in Ahvaz, Iran. In a similar work, Gudarzi et al in 2009 estimated the Sulfur dioxide hygienic effects in Tehran (capital of Iran). Based on their results, almost 7.82 and 3.6 percent of all cases of whole respiratory deaths and hospital admissions respiratory diseases were attributed to Sulfur dioxide. In another study, Mohamadi et al., 2009, calculated health effects of air pollutants in Ahvaz. Based on their results, approximately 4.03 percent of total respiratory deaths and 1.8 percent of hospital admissions respiratory diseases was related to Sulfur dioxide. Zalaghi et al in 2010 investigated the health effects of air pollution of Ahvaz, Bushehr and Kermanshah. Based on their results, approximately 4.4 percent in Ahvaz, 8.64 percent in Kermanshah and 3.33 percent of total respiratory deaths were attributed to Sulfur dioxide.

Conclusion

Findings of the present research identified the relieving effects of potential total number of deathes, cardiovascular deathes, respiratory mortality and myocardial infarction as a result of exposure to Sulfur dioxide on human health in Ahvaz city (located in south-western Iran) during 2011. The results indicated that Ahvaz with approximately 5 percent is one of the most polluted cities. The analysis of statistics and comparison of mean and maximum concentration of Sulfur dioxide in four stations in Ahvaz during 24 hrs with air pollution index show that the higher percentage of deaths could perhaps be the result of higher average Sulfur dioxide or because of long time staying in Ahvaz.

Keywords: Ahvaz, cardiovascular death, health effects, respiratory death, Sulfur dioxide.

Biomonitoring of Air Pollution in Urban Regions by *Platanus orientalis* and *Fraxinus excelsior,* Case study: Shiraz City

Ali Reza Pourkhabbaz[1*], Zohreh Shirvani[2], Mohammad Ghader Ghaderi[3]

1. Assistant Professorof of Environment, Faculty of Natural Resources and Environment, University of Birjand, Iran
2. MSc Student in Environment, Faculty of Natural Resources and Environment, University of Birjand, Iran (z_shirvani@yahoo.com)
3. Assistant Professor of Agronomy and Plant Breeding, Faculty of Agriculture, University of Birjand, Iran (Ghaderi@yahoo.com)

Expended Abstract
Introduction

Environment as a great and complex collection is composed of a process and evolution of live existences and the elements of ground area. It affects human activities and is also affected by that. Industrialization and modernization has let lots of heavy elements to enter into the atmosphere. Elements of the atmosphere will be located on the surface of soil and plants as dry or wet deposit, lastly. Usage of heavy metals in industry and the necessity of some of them to influence some physiologic activities for plants and animals are different directions that more information about them seems important in environment. The plants are capable of absorbing some pollutants by using their air organs, especially leaves, and reserving them in. Thus, biomonitoring through plants is a useful way for finding the pollutants. Shiraz city is one of the populated cities that involve air pollution. Due to the position of the city among high Zagros Mountains, high population growth, and also increase in pollutant quantity and quality, it seems that the pollution problem has increasing trend in time. The objective of the present study is to estimate the air pollution tensity for some heavy metals as cu, cd and Pb in high traffic points of Shiraz City using fraxinus and platanus as nonactive biomonitors.

Matherial and Methods
Study area
In this study, four green spaces in different traffic points were selected as the stations to determine heavy metal concentration in the trees in Shiraz City. Then, the samples of leaf and bark of fraxinus and platanus were common in the stations as the studied tree samples were selected in two times in June and September.
Sampling, preparing and analysis of plant samples
In each station, sampling from leaf and bark of the tree was carried out in three random repetitions and two combinations. Plant samples were first dried on clean paper plates and then all leaf and bark samples were dried in 60˚c, for 72 hours. The samples were became powder by mill and prepared for acid digestion tests. Lead and copper concentration in samples were measured by using atomic absorption device.

Results and Discussion
The density of cadmium in all samples was less then device diagnosis. Average concentration of heavy metals (Pb, cu) in washed and unwashed leafs of fraxinus and platanus plants in different stations is brought in Tables 1and 2. Although different stations show different amount of elements, but the results show that there is not a significant difference between the metal Pb in washed and unwashed samples.

Copper and lead concentrations in leaf and bark of fraxinus tree in different stations and times are presented in Table 3. Maximum density of lead in leaf and bark of platanus tree in September was observed 2.80 and 4.16 µgg -1 and for copper was 18.27 and 7.85 µgg -1, respectively. This amount in leaf and bark of fraxinus tree in September was computed to be about 1.79 and 3.50 µgg -1 for lead and 14.43 (September) and 7.95 (June) µgg -1 (Table 4) for copper, respectively. The maximum density of lead and copper in bark in Azadi station (with high traffic) was, respectively, 10 and 11.14 for fraxinus and 4.33 and 15.58 µgg -1 for platanus. However, the

---

∗ Corresponding Author: E-mail: Apourkhabbaz@ birjand.ac.ir

minimum amount for each metal and tree was observed in Golestan station as witness zone.

Table 1. Heavy metals concentration (µg g^{-1} DW) in washed and unwashed leafs of platanus tree

Site	pb			Cu		
	unwashed	washed	T-Test	unwashed	washed	T-Test
1	4.25	1	n.s	16.83	10.56	n.s
2	0.61	0	n.s	22.83	15.51	n.s
3	1.58	0.66	*	10.68	6.08	❋
4	1	0.33	n.s	9.18	5.1	❋
mean	1.86	0.50	n.s	14.88	9.31	❋

Table 2. Heavy metals concentration (µg g^{-1} DW) in washed and unwashed leafs of fraxinus tree

Site	pb			Cu		
	unwashed	washed	T-Test	unwashed	washed	T-Test
1	0.75	0	n.s	9.68	5.88	n.s
2	2.58	0.58	*	6.36	3.95	n.s
3	1.41	0.25	n.s	7.08	3.83	n.s
4	0	0	n.s	5.9	3.35	n.s
mean	1.18	0.2	n.s	7.25	4.25	❋❋

Table 3. Heavy metals mean concentration (µg g^{-1} DW) in platanus tree

Site	n	pb		Cu	
		leaf mean ±S.D	bark mean ±S.D	Leaf mean±S.D	bark mean±S.D
1	6	4.24 ± 5.06	10 ± 12.02	16.83 ± 5.27	11.14±10.58
2	6	0.61 ± 0.77	9.58 ± 2.71	22.83±10.22	8.99 ± 4.47
3	6	1.58 ± 0.35	1.91 ± 1.29	10.68 ± 2.57	50.61 ± 0.82
4	6	1 ± 2.52	0.41 ± 0.58	9.18 ± 1.10	1.06 ± 0.47
mean		1.85 ± 2.52	5.47 ± 6.60	14.88 ± 7.31	6.70 ± 5.96
June		0.91 ± 1.63	3.7±6.37	11.49 ± 5.45	5.56 ± 7.10
September		2.80 ± 3.26	4.16 ± 6.60	18.27 ± 9.27	7.85 ± 12.36

Table 4. Heavy metals mean concentration (µg g-1 DW) in fraxinus tree

Site	n	pb		Cu	
		leaf mean±S.D	bark mean±S.D	Leaf mean±S.D	bark mean±S.D
1	6	0.75 ± 0.82	4.33 ± 3.13	9.68 ± 1.92	15.58 ± 6.11
2	6	2.58 ± 1.62	4.08 ± 3.64	6.36 ± 1.42	11.13 ± 8.29
3	6	1.41± 0	3.91 ± 2.41	7.08 ± 2.24	6.80 ± 3.22
4	6	0 ± 2.13	0 ± 0	5.90 ± 1.31	0.08 ± 0.04
mean		1.18 ± 1.62	3.08 ± 3.10	7.25 ± 2.22	10.93 ± 6.46
June		0.58 ± 0.9	2.66 ± 2.90	7.95 ± 2.02	14.43 ± 6.79
September		1.79±1.98	3.50± 3.34	6.56 ± 2.27	7.11 ± 3.23

The amount of absorbed lead and copper by leaf and bark in platanus sample is more than farxinus. This difference can be due to the age of platanus samples respect to fraxinus. This was also confirmed by Haghighate Khadem (1991). The lead and copper concentration in leaf of the study trees is significantly lower in stations with low traffic (Golestan and Kholdebarin) than those with high traffic such as Azadi Park and Valiasr. The same results were also reported by Sawidis et al. (1995). The most important lead pollution of tree leafs specially

in cities is because of vehicles traffic. Copper concentration is statistically significantin unwashed leafs than washed leafs in both trees. Heavy metals concentration in barks is more than leafs of the same tree. Generally, the lead and copper elements in bark of platanus and fraxinus are studied in Shiraz city. They are very lower than the results of the studies done by El-Hassan et al (2002) and the standard given in this study.

Conclusion

The present study indicated that the difference between the densities of lead and copper elements in stations 1 and 2 with 3 and 4 in tree leaves and barks is because of heavy traffic in these zones. Urban development and industrial and commercial activities in city center is the main source of many heavy metal pollutions. However, both indicator species are suitable for comparative studies on bioindication of urban air pollution.

Potential of Reed, Typha and Bermudagarss on the Translocation Index and Bioaccumulation of Lead

Saeed Taheri Ghanad[1]*, Hadi Moazed[2], Saeed Boroomand Nasab[3]

1. Assistant Professor of Water Engineering, Islamic Azad University, Dezful Branch, Dezful, Iran
2. Professor of Water Sciences Engineering, Faculty of Water Sciences Engineering, Shahid Chamran University, Ahvaz, Iran (boroomandsaeed@yahoo.com)
3. Professor of Water Sciences Engineering, Faculty of Water Sciences Engineering, Shahid Chamran University, Ahvaz, Iran (hmoazed955@yahoo.com)

Expanded Abstract

Introduction

The lead is considered as one of the most toxic heavy metals in the environment mainly in developing countries. Therefore, purification of the soil and water contaminated by this element is considered as the most important environmental policies of these countries. Lead metal is unnecessary for the body and indicate contamination with this element. Lead can be substituted for calcium in the cells and disrupt the activities of the body. It can also cause liver and kidney dysfunction, genital organs and reproductive system, anemia, loss of intelligence interest and occurrence of the metabolic complications. Removal and control of the pollution by heavy metals is very difficult due to their multiple and different sources of pollutions, because each pollutant requires its purification process. Until now, different methods have been developed for the purification of sewage including the chemical precipitation, reverse osmosis and ion exchange of organic. Each method has its own advantages and disadvantages. Moreover, Phytoremediation is as the optimal method of biological process for the removal of pollutants from water and soil. The phytoremediation is physiological potential of the green plants (variety of weeds, aquatic and marsh plants, crops and trees) for the control and absorption of organic and inorganic pollutants of wastewater along with other treatment methods. In other words, phytoremediation is a technique for the using of plants to control and clean up pollution elements such as metals, pesticides, oils, and etc. In this method, different species of plants can be considered as biological filters and play main role in the elimination of environmental pollutants. Some heavy metals such as lead and cadmium can be accumulated in leaves or branches. In general, plants are employed in five main processes to clean up the environment. These processes are phytoextraction, phytodegradation, phytostabilization, phytovolatilization and rhizofiltration that contain accumulation of the nutrients and heavy metals in the plant roots and rhizomes.

Materials and Methods

Project preparation and cultivation of plants

In order to implement this study, plastic pots were prepared with 60 cm in diameter and 40 cm in height. Therefore, from sand with grains diameter of 1 to 5 mm and 30 cm deep was used as the growth bed in pots. After preparation of the pots and planting, they were placed with a suitable interval from each other. Plants species selected are including Phragmites, Thypha and Bermudagrass based on their abundance in the region. Young plant samples were collected from margins of Dez River and immediately were transferred to the site of the research in experimental field of Islamic Azad University of Dezful. After preparing the bed and adding nutrients to the cultivation medium, each pot was randomly assigned to a treatment in three replicates. The youngest seedlings were selected for the cultivation in each medium sample. Three plants were cultivated at regular interval with the minimum distance of 5 cm from the container wall and at a depth of 10 cm (density of 25 plants per square meter) after washing the seedlings with water. After preparing the pots and planting, the desired species were irrigated with the common water in 40 days because irrigation with synthetic wastewater in the early stages of cultivation caused stress to the plant due to lack of root stability and compatibility with the new culture medium. Thus, after elapsing of this period, irrigation is performed with simulated wastewater in different concentrations of 5, 10 and 15 mg lead/l.

∗ Corresponding Author: E-mail: staheri2007@yahoo.com

Results and Discussion

Results of the research showed that significant difference was observed at 5% level between the mean square of lead accumulation in ground organs of the studied species with low-level concentrations of wastewater. Therefore, ground organs of the studied species in the treatment of low levels of lead had a significant effect on the lead accumulation. Additionally, comparison of the means by Duncan test was performed for the levels of lead concentration using $SPSS_{18}$ software. The mean accumulation of lead in under-ground organs of Bermudagrass, Reed and Typha was measured to be 0.106, 0.179 and 0.096 mg/g in low-level concentrations of wastewater, respectively (Table1). The results also indicated that the difference between the mean of accumulation in the three species was significant at the 5% level. The maximum accumulated amount was in the root of Reed and the lowest amount was also in the root of Bermudagrass. Comparison of the squared means of the lead accumulation in above-ground organs showed that difference of the means was not significant at the 1% level in low-level concentration of wastewater.

Table 1. The effects of plant species on the lead accumulation in different levels of concentration

Above-ground organ	Under-ground organ	Treatment
C_1=5 mg/l (low level)		
0.015±0.066 [a]	0.025±0.106 [a]	Bermudagrass
0.013±0.028 [a]	0.029±0.179 [b]	Phragmites
0.026±0.044 [a]	0.026±0.096 [a]	Typha
P>0.01	P<0.05	Result
C_2=10 mg/l (mean level)		
0.024±0.103 [a]	0.036±0.183 [a]	Bermudagrass
0.021±0.069 [a]	0.043±0.397 [b]	Phragmites
0.027±0.109 [a]	0.038±0.27 [a]	Typha
p>0.01	P<0.01	Result
C_3=15 mg/l (high level)		
0.033±0.151 [a]	0.041±0.27 [a]	Bermudagrass
0.042±0.127 [a]	0.055±0.544 [b]	Phragmites
0.035±0.164 [a]	0.047±0.316 [a]	Typha
P>0.05	P<0.01	Result

Interaction of plants and concentration levels on the bioaccumulation and translocation index

The results indicated that there was a significant difference at 5% level, according to the analysis of variance, between the mean square of lead accumulation in different treatments. Therefore, air and ground organs of different species and different levels of concentration had significant interaction at 5% level on the lead accumulation. The highest accumulation of lead was found in the ground organs of Reed in the treatment of high level of lead with concentration of 0.544 mg/g. The lowest value found was in Typha and in the treatment of low

level of lead with concentration of 0.096 mg/g. The highest accumulation of lead was found in the above organs of Typha in the treatment of high level of lead with concentration of 0.164 mg/gr. The lowest value found in Reed and in the treatment of low level of lead with concentration of 0.028 mg/g. The results also revealed that the ground organs of Reed by more biomass than the other two species had a higher potential for the lead accumulation. The results also showed the highest accumulation of above-ground organs in Typha due to more absorption of water and minerals in the aerial parts. In addition, the index of translocation is also calculated which expresses the ratio of accumulation of root to shoot. The results of translocation index in the Bermudagrass, Reed and Typha were 1.7, 5.5 and 2.2, respectively. Therefore, the main mechanism of phytoremediation in Reed was mainly as rhizofiltration whereas in Typha and Bermudagrass as rhizofiltration and phytoextraction. According to the study, the Reed tends to the lead accumulation in the root and rhizome at low concentration levels whereas it used all its capacities especially in the above-ground organs with the increasing concentration levels of wastewater.

Environmental Impacts of Iran Khodro Diesel Factory Using Combined Entropy and LINMAP Method

Seyed Ali Jozi[1]*, Sadaf Ataee[2]

1. Associate Professor of Environment, Department of Environment, Islamic Azad University, North Tehran Branch, Iran
2. MSc in environmental sciences, Islamic Azad University, Sciences & Research Branch, Tehran, Iran (sadaf_ataee@yahoo.com)

Expanded Abstract

Introduction

The automotive industry is one of the largest industries in the world. It is also very important in Iran. According to the World Bank, the automotive industry can be classified as the projects with many environmental impacts. Therefore, the review and analysis of the environmental impacts is conducted to identify the significant effects of the pollution caused by the activities of the operation phase to propose reasonable solutions to minimize adverse impacts, and improve the quality of the environment with the aim of ensuring proper and correct implementation of activities in a factory.

With its approximate area of 50 hectares including production, warehouse and building spaces, Iran Khodro Diesel Factory is located at 51 degrees, 81 minutes east and 35 degrees, 37 minutes north, 8 kilometers away from Savehroud, eastern north of Chahardongeh City, Islamshar. We have placed the production of all kinds of trucks, buses, minibuses and vans with different uses on the agenda; and using the capabilities of more than 5000 efficient workforce in advanced production lines, paint lines, and the active departments of quality, education, engineering, and etc. We expect to be able to make the name of Iran proud on the boundaries of domestic and foreign markets with high quality products.

Materials and Methods

To analyze the impacts of the factory, the Delphi method was used. To do this, the questionnaire of the first phase was prepared by the research team. After the questionnaire was developed and finally amended, a Delphi 14-member group was formed. The group includes seven environmental specialists and five senior safety experts from the factory and two environmental specialists of Islam Shahr's Environmental Protection Agency. Then, the questionnaire of the first phase was distributed among them. The main parameters affecting water, air, noise and particulate matter were identified and, then, the experts were asked to rank the impacts of all indicators on the whole environment, the biological environment and the health of individuals, and to express their opinions about its environmental impacts.

As the intended indicators have large dispersion, Entropy method was used to weight the indicators. This method shows the amount of system information reflected by the criteria and the extent of uncertainty of the criteria. In other stages of the analysis, all 14 questionnaires were firstly combined together by using the geometric mean and, then, a final matrix of 20 columns (indicators) and three rows (environments) was obtained. This is referred to as decision matrix (matrix D). The three environments were prioritized using the LINMAP method.

Results and Discussion
Analysis and prioritization of indicators based on Entropy method

The studied indicators were analyzed and prioritized using Entropy method according to which for indicators of water pollution, the washing baths weighed 0.318 had the first priority and importance. In the department of stain removal, the washing baths was the last priority of water pollution with the weight of 0.044, due to less use of chemicals. The results of this method are given in Table 1.

Table 1. Prioritization of indicators using Entropy method

Parameter	Firstpriority	Weight	Lastpriority	Weight
Water	Washing bath	0.318	Stain removal	0.044
Air	(skeleton and chassis assembly) -(PVC enclosure and insulation)	0.268	Welding point - Stain removal and welding	0.017
Particulate matter	Iron washing	0.342	mould making	0.002
Noise	Roll test	0.279	mould making	0.014

Prioritization and analysis of the studied environments based on LINMAP method

Finally, as shown in Table 2, this result was obtained that the chemical and physical environment has the first priority with a weight of 0.6, then; the biological environment is in the second rank with a weight of 0.38; and social, economic, and cultural environment in the final ranking with a weight of 0.1.

Table 2. The first to third priorities of environments determined by LINMAP method

Options	Weights
Chemical and physical environment	0.6
Biological environment	0.38
Social and economic environment	0.10

Table 3. The Environmental Control Program for pollutants of Iran Khodro Diesel Factory

The control period	Solutions to decrease the effects	Source emissions	Type the sprawling	Environmental influence
Continuous	-Equipping the factory to long chimneys.	Stain removing, metal washing, PVC tank and insulation, human wastes, roll test, painting bath, structures and assembly of the chassis,	H_2S ،SO_2 ،	Air Quality
Continuous	-Use from the absorbent filters inside the chimneys for the poisonous materials and compounds.		NO_X ،CO_2،CO	
Continuous	-Use from the air pollution control equipments such as vortex collectors, electrostatic precipitants, cyclones, wet dust collection method according to the pollutants			
Continuous Every six month	-Removing the out of work conditioners and substituting the new conditioners -Installation of the special sensors in the saloons in order to alarm in case of leakages more than the normal and allowable limits	، metal washing, PVC tank and insulation, dispersion of the sealer,	Particulate	
Continuous Periodic Inspection	-Prevention and supervision on the used material which enter the outlet wastes and wastewaters -Prevention from leakage of the chemicals and using from safer materials	Stain removing, metal washing, human wastes, roll test, washing bath	BOD، COD، TDS، TOC، ss، pH،TSS ، Turbidity, Detergent	Water Quality

Table 3. The Environmental Control Program for pollutants of Iran Khodro Diesel Factory

The control period	Solutions to decrease the effects	Source emissions	Type the sprawling	Environmental influence
Continuous Continuous	-Installation of the big panels and sheets under the welding machines -Isolation of the chemicals tanks and ensuring from lack of their leakages in the site	Stain removing, metal washing, PVC tank and insulation	Chemicals and Lubricants	Soil Quality
Continuous Continuous Continuous	-Insulation the around of the noisy motors and machines -Construction of barriers around the installed machines which produce many noises -Removing the vibrations by installation of the Canvas or Glass Wool in the distances between the machines, pipes and attachments	molding, furnace, decorations, roll test, welding, structures and assembly of the chassis	Noise Pollution	Auditory environment

In Table (3) the most important environmental effects of the Factory and the plans and activities in order to decreases these bad effects are summarized. The period of these studies and evaluations is a 3-month period and they include the control activities of a reliable laboratory and the Environment Protection Organization. The responsible body for delivering the reports is the environmental sector and HSE of the factory.

Conclusion

Chardange town is one of the regions where are affected by the population increase and changes in the agricultural applications to other applications and sectors such as industry. The distribution and dispersion of the industrial organizations and complexes in different areas of this town and their locations inside the residential urban regions or around the populated and crowded regions lead to many environmental effects and consequences. One of these industrial complexes is Iran Khodro Diesel Company.

When we use the evaluation methods, it is important that only one parameter is not taken into account, but the effects of all the parameters and their associated environmental impacts are considered simultaneously. In this study, with the development of evaluation methods, especially the use of mathematical methods, two Entropy and LINMAP methods - as the latest methods applied in environmental issues - were employed for weighting and prioritization of the environmental parameters in the three affected environments. As each of the above indicators have a relative importance, the weights of the indicators were obtained using the Shannon's Entropy method, to show the results of the prioritization in more accurate manner. To prioritize the options, the LINMAP method was used because of its ability to simultaneously weigh and prioritize the indicators.

Finally, this can be concluded that the most important solution to reduce the identified impacts is the creation of an environmental management system based on cleaner production, including the continuous use of a comprehensive environmental strategy for the prevention of pollution in processes, products and services. This is to increase efficiency and reduce risks to humans and the environment. There are three-month periods of monitoring, in which the trusted lab of the factory and the Environmental Protection Agency are responsible for control activities. Environment and HSE Department of the factory is also responsible for monitoring and reporting.

Keywords: entropy method, environmental impacts, Iran Khodro Diesel Factory, LINMAP method, Multi Attribute Decision Making (MADM) method.

Forecasting the Effects of Global Warming on Biologic Territories (Case Study: the Eastern Part of Mid-Zagros and the Western Central Desert, Iran)

Faramarz Khoshakhlagh[1*], Mohammad Amin Moradimoghadam[2], Mohammad Amin Heydari[3], Shirin Safaee[4]

1. Assistant Professor of Physical Geography, Faculty of Geography, University of Tehran, Tehran, Iran
2. MSc Student in Climatology, Faculty of Geography, University of Tehran, Tehran, Iran (moradi.m.a@ut.ac.ir)
3. PhD Candidate, Faculty of Geography, University of Tehran, Tehran, Iran (heydaryamin@yahoo.com)
4. MSc Student in Climatology, Faculty of Geography, University of Tehran, Tehran, Iran (shirinsafaee67@ut.ac.ir)

Expended Abstract

Introduction

Today, climate change is one of the most important scientific and even political–social issues of the world. The causes of climate change can be divided into natural and human-made. Natural factors have the long-term performance and long history, such as the cycle of solar activity, dusts and gases of volcanic eruptions, geodetic and static agents and etc. Human-made factors was mainly formed and accelerated in recent decades. They are resulted from human activities such as industrial, agricultural, land-use changes, and in special emissions of greenhouse gases. Increasing trends in emissions resulted from various causes, especially due to the consumption of fossil fuels and industrial activities was so fast that the temperature changes in the current decades is equal to the natural changes of mean temperature in many centuries. On the other hand, increase in the average global temperature will lead to changes in the amount, type and pattern of spatial and temporal distribution of precipitation. Changes in precipitation and temperature are variabe in different geographical areas with different intensity as important inputs of systematic nature of environment. This means that there is a period of rapid environmental changes, and therefore, severe consequences for human manipulation of the natural system. More governments and policy-makers are interested in short-term phenomena and effects of climate change, for example, drought, flood, frost and etc. But the long-term effects of climate change caused by the slow mechanisms are non-visible and less monitored by the governments. Climate is the most important factor to determine the plants distribution and their properties so that most of climatic divisions in the past has been based on the type of vegetation. Any changes in the components of the climate will affect the ecosystems, displacement of the border of ecosystems and different biomes and will disrupt the existing environmental equilibriums. In this paper, the impacts of global warming have been studied on biological zones in central parts of Iran.

The study area consists of a limited corners between cities of Khoramabad (48°17' East and 33°26' North), Kashan (51°27' East and 33°59' North), Yazd (54°17' and East 31°54' North) and Yasooj (51°41' East and 30°50' North). This area was chosen due to the wide range of temperature and precipitation and also a variety of biological zones.

Materials and Methods

In this study, the Holdridge model was used to determine the areas of biological zone (Fig. 1). By using three climatic parameters such as annual precipitation, annual ratio evapotranspiration and bio-temperature, Holdridge has prepared the biological zones in form of a chart. Based on the Holdridge classification, the biological zones are divided into 16 areas of various zones. The bio-temperature is the measure of necessary heat which is utilized in the biological zones. The bio-temperature mean is an average of Celsius (°C) at which vegetations growth takes place in annual period. The range of temperatures within which vegetations growth occurs is estimated to lie between 0°C as minimum and 30°C as a maximum.

∗ Corresponding Author: E-mail: fkhosh@ut.ac.ir

As far as possible, positive temperatures in the range must be averaged for all the years of the period. A more accurate mean annual bio-temperature is obtained by adding up the daily bio-temperatures and dividing that sum by 365 or the total days of year. The bio-temperature may also be obtained by summing up the positive monthly temperature means and dividing them by 12, the number of months in year. Evapotranspiration and annual precipitation form another sides of Holdridge's triangle of biological zones. Above parameters are appropriately sufficient to determine the biological zones.
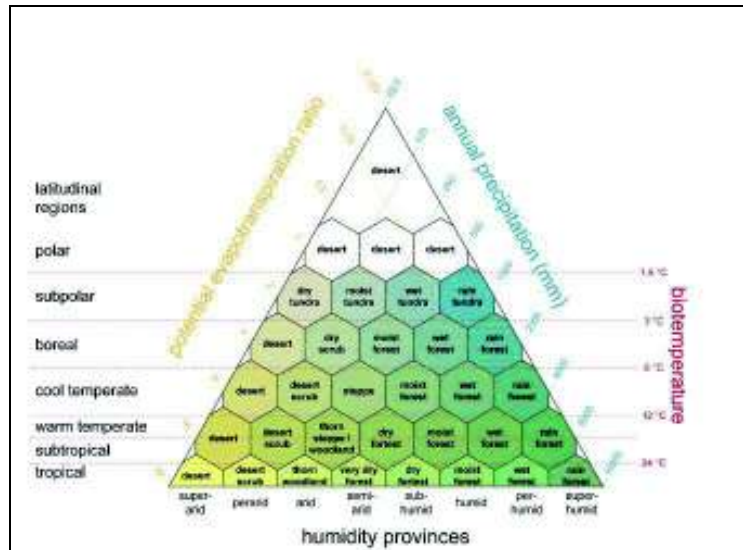

Fig. 1. Diagram for classification of world biological zones (Holdridge, 1984)

In this study, we have used 22 synoptic stations. Due to deficit of stations with sufficient data in the study area, the data of some neighboring stations has also been used. Two common scenarios of A2 and B2, and four atmospheric general circulation models including UKHADCM3, ECHO-G, GISS-EH, and GFDLCM20 were used for temperature and precipitation prediction. Scenario of A2 that focused on the local nature leads to an increase in population. Thus, economic and technological development in this scenario is slower and more incomplete than other scenarios. As a result, this scenario predicts the highest greenhouse gas emissions. Then, according to this scenario, the Earth's average temperature increase between 2.1° to 4.2°C until 2100. The B2 scenario describes a state with the greatest emphasis on local and regional strategies on sustainable economic, social and ecological issues. This scenario predicts a steady growth in population of the global and moderate economic development. According to this scenario, the Earth's average temperature increases from 1.5° to 3.1°C by 2100. This four general circulation models are the most widely used for forecasting climate in Iran and other countries in many cases. In addition, the data simulated by these models for the observed data have shown better correlations than other models.

The model of MAGICC SCENGEN was used to predict temperature and precipitation under global warming conditions. This model is a hybrid model and a model for assessment of the climate change caused by greenhouse gas emissions. MAGICC SCENGEN is not a GCM model; this model combines the results of the scenarios of greenhouse gas emissions defined in the MAGICC model and the GCM results defined in the SCENGEN model to assess the impact of these scenarios. This hybrid model involves software that merged both SCENGEN and MAGICC models. The version 5.3 of this Model contains 49 kinds of emission scenarios, optimistic, pessimistic, and moderate and their subdivisions. This also contains 20 general circulation models. According to the resolution 2.5×2.5 degree of this model, the study area is divided into six sub-zones and representative stations in each zone were determined to select the above-mentioned scenarios and models. Monthly temperature and annual rainfall of this zone for the years 2050, 2075 and 2100 was calculated. These changes were applied to the stations located in each zone.

Results and Discussion

To determine the biological zones according to the Holdridge model, we used two climatic parameters of monthly bio-temperature and annual precipitation. Initially for these subjects, the holdridge method was used by 22 synoptic stations mean monthly temperature of the recent years (2000-1980) and the future decades, e.g., 2050, 2075 and 2100. Then, through the IDW in Geographical Information System (GIS) zoning of bio-

temperature and precipitation was executed. Using GIS and the two zonation layers of annual precipitation and bio-temperature as well as the ranges defined in the holdridge biological zones diagram, biological zonation for the study area was performed for the current period and then the future period. According to holdridge zonation for the current period, from 16 various biological zones defined by holdridge, seven zones are marked in the study area. Eastern parts of the study area is covered by the plains of central desert of Iran, but western edge of those plains has desert conditions severely reduced and there is limited conditions for growth of plants and scrubs. According to holdridge classification, this is desert scrub biological zone. The severity of the dryness is extremely reduced in the mountainous areas of Zagros. This situation has been created by relative increase in precipitation and decrease in temperature. Thus, the east part of the mid-highland of Zagros Mountains is marked by steppe and steppe woodland in holdridge classification. Because of the high frequency of precipitation in most of the areas of Zagros Mountains, there are conditions for tree growth to create biological zones of wet forests and moist forests. The mean annual precipitation in the highlands of central Zagros Mountain is more than 1400 mm and under these conditions moist forest biological zone was created. Nevertheless at lower altitudes annual bio-temperature is approximately equal to this height, because the average annual precipitation is less than 1000 mm, and they are classified as wet forests biological zone according to the holdridge. The results showed that global warming reduce biological zones diversity in this area at future so that seven areas of the biological zones, today, will be reduced to six areas at the future. Biological zones of moist forest and steppe areas will undergo most of the effects by global warming. The whole of moist forest biological zone will be lost at future and wet and dry forests will be occupied. The changes and shifts in the boundaries of the biological zones will be significant by the effects of global warming.

Developing the desert and desert scrub biological zones to the west part of the study area is significant. Therefore, the biological zone of desert is covering the areas of Yazd and Naain in the current period and only covers 1430 square kilometers of the study area. It will be considerably extended to the west. All models show that the borders of the desert and desert scrub biological zones in 2100 will develop an average of 90 to 110 km toward the West. The GISS-EH model showed the most advance of this biological zone in the other models. The model ECHO-G predicts the extending trend of desert and desert scrub less than other models. According to this model, the influence of the biological zones located in the eastern half of the central Zagros Mountains is less than the other models. Among these, the UKHADCM3 and GFDLCM20 models showed moderately the affection of biological zones relative to the other two models.

In all models, the shift in the biological zone boundaries can be seen by the optimistic scenario; B2, less than the pessimistic scenario A2. The results of this study showed that the biological zones located in Zagros Mountains would be affected by global warming. Therefore, the steppe, dry forest, and the moist and wet forests will be subjected to the reduction.

Conclusion

More governments and policy-makers are interested in short-term responses of climate change. While the long-term impacts of climate change such as global warming is more important. For example, the effects of global warming influence the ecosystems and displacement of the border of biological zones and biomes.

The results of this research indicate that global warming can reduce diversity of biological zones in the study area. Biological zones of wet forest and steppe will encounter serious impacts by global warming. Whole of the moist forest will be lost at future and wet and dry forests extend into the area and dry forest will be replaced by some areas of the moist forests. This study revealed that the biological zones located in the Zagros Mountains are greatly suffering from global warming and the biological zones of this area, including steppe, dry forest, moist and wet forests will be reduced. Extension in the borders of desert and desert scrub zones to the west and eastern slopes of the Zagros Mountains will be significant.

Contribution of Desert Areas to Production of Falling Dust by Discriminate Analysis; Case Study: Yazd City

Mitra Al-Sadat Esmaeilzadeh Hosseini[1]*, Hamid Reza Azimzadeh[2], Mohammad Reza Ekhtesasi[3], Hamid Sodaeizade[4]

1. MA in environment, Department of the Environment, Faculty of Natural Resources, University of Yazd, Iran
2. Associate Professor of Environment, Department of the Environment, Faculty of Natural Resources, University of Yazd, Iran (hazimzadeh@yazd.ac.ir)
3. Professor of Environment, Department of the Watershed, Faculty of Natural Resources, University of Yazd, Iran (mr_ekhtesasi@yazd.ac.ir)
4. Assistant Professor of Environment, Department of Arid and Desert Management, Faculty of Natural Resources, University of Yazd, Iran (hsodaei@yazd.ac.ir)

Expanded Abstract

Introduction

Dust haze phenomenon is dust mass covering large distances and originated from arid and semi-arid areas. Environmental effects of dust including erosion, transportation, and sedimentation was great concerns in the early 1990s. The researches associated with the frequency of dust days showed that most dust day's frequency is related to central holes of Iran. The major impacts of source areas are created via wind erosion. The Yazd province with more than fifty percent of desert and sand is located in Yazd- Ardakan plain. Therefore, the areas are always exposed to wind erosion and the problems of dust storms. The critical landforms of wind erosion in Yazd-Ardakan plain are Sebkha, Kalut or Yardang, Hill, Glacis Epandage Plain and water sediment. To determine sediment source using traditional methods is very difficult and fingerprinting is as an appropriate and alternative method based on sediment properties. In this method, most important principle is use of chemical, physical and organic properties to compare these characteristics with those in the sediment samples. The method does not contain the problems of traditional methods. The main advantages of this method are including high speed, economic and the ability to obtain information about the type of sediment sources and location of sediment sources. Investigation about the literature showed that many studies are associated with the dust source using fingerprinting.   The aim of this study is to determine sources of falling dust using fingerprinting in Yazd-Iran.

Materials and Methods
Study area

Yazd, the largest city in Yazd Province with the latitude of 31° 53' 50" N and longitude of 54° 22' 3" E. The population of the study area is over 582682 people and approximately within 140 km2. The climate of this area is arid and semi-arid. Yazd city and Yazd – Ardakan plain are selected for sampling of the falling dust and to determine the dust sources, respectively.

Sampling and chemical analyses

Falling dust samples were collected from 33 different locations almost covering Yazd city area (roofs of buildings with a height of 4 meter were selected for the fixing of the dust collectors). The dust particles were sampled using Marble Dust Collector (MDCO) method for six monthes from January 2012 to June 2013 (winter and spring seasons). The sampling of falling dust source was including Sebkha, Kalut or Yardang, Hill, Glacis Epandage Plain and water sediment of top soil (5cm) by plot (20*20 cm) with 3-8 repeat in Yazd – Ardakan plain. Then, ten heavy metals including Cr, Pb, Cu, Ni, Bi, Zn, Ag, Cd and Se were analyzed by Atomic Absorption Flame Spectrophotometer (Analytic jene-350 model, Germany).

To determine the origin of dust areas we used discriminant analysis method. Each heavy metal was investigated in separation b statistical analysis such as One - Way ANOVA and Kruskal-Wallis ($p < 0.05$) and criteria of strong linear multivariate (Tolerance ≥ 0.1 and VIF≤ 10). Then, using Discriminant analysis was selected as the

---

optimal combination of tracers with the ability to separate dust sources.

Determination of the contribution of dust sources

In new fingerprinting, it is assumed that the combination of tracer proprieties is linear. Therefore, the combination model can be wrote for each of tracer specifications according to Equation (1).

$$Xi = \sum_{j=1}^{n} aij\ bj \qquad (1)$$

Where, Xi: estimated valueof i tracer (i-=1, 2… m), aij: mean value of i tracer in j source (j= 1, 2… n), bj: j source contribution, n: source number, m: number of tracer characterizes.

The equation is repeated for each of the tracers. Therefore, a multivariate mixing model was subsequently used to estimate the relative contribution of the potential sediment sources to a dust sample. Optimization methods can be used to obtain the optimal results to determine the sources contribution. In this method, the proportions of P are contributed by m individual sources and s is established by minimizing the sum of the squares of the residuals (Res) for n tracer properties involved:

$$(Res = \sum_{i=1}^{n} (\frac{cssi - (\sum_{s=1}^{m} csi\ bs)}{cssi}) \qquad (2)$$

where

Cssi: the concentration of tracer property i in the dust sample,
Csi: the mean concentration of tracer property i in source group of sediment
bs: the relative proportion from source group of sediment
The optimal results for sediment sources are achieved by the minimum of above equation and repeat, trial and error operation with the following two conditions:

1. The values of contribution coefficient between zero and one for each of the deposition sources
$$0 \le bs \le 1$$
2. Total coefficients equal to one for each of the deposition sources
$$\sum_{i=1}^{n} bs = 1$$

Evaluation of the results of a multivariate mixing model

The measure of the relative error, Coefficient of Performance Model and field observation was utilized in order to investigate the model accuracy.

$$\frac{\sum_{i=2}^{m} (x_1 - x_i)^2}{\sum_{i=1}^{m} (x_1 - M)^2} ME = 1 - \qquad (3)$$

The ME values are closer to one that indicate the High Performance Model.

Results and Discussion

Determination of the origin by Discriminant Analysis Method
The results of statistical analysis and criteria of strong linear multivariate analysis showed all the heavy metals, except Fe (VIF>10). The stepwise Discriminant function analysis was employed to select the optimum composite fingerprinting.

The comparison of different means was significant for Ag and Zn between the groups.

Table 1. Various steps of import elements to the model

Step	Element	Wilks Lambda	Sig	Cumulative %
1	Zn	0.208	0.004**	100.00
2	Ag	0.091	0.000**	100.00

** Significantly in the 0.01 level

The results of Table 1 indicated that each element was unchanged in cumulative percentage but wilks

Lambda was declined and significant level was better. Therefore, it was increased in separation ability between groups.

The power of detection function is evaluated with the results of the audit function canonical (Table 2).

Table 2. Results of the audit function canonical

Canonical coefficient	correlation	% cumulative of variance	Percentage of variance	Eigenvalues	Function
0.77		100.00	100.00	1.42	1

Table 3 b of linear regression coefficients of functions is presented.

Table3. Aud it functions canonical coefficients

Function	Tracer elements
0.919	Zn
-0.849	Ag

Finally, Discriminant function was defined according to Canonic Discriminant Function Coefficients (Equation 4).

$$F1 = 0.919 \, Zn - 0.849 \, Ag \qquad (4)$$

To determine the role of each of the resources of the falling dust using the results of the detection function, n the function average concentration of heavy metals was in assessed in the monthes. The results showed that most of the dust is associated with Sebkha in the six months. Therefore, the contribution of falling dust of origin suburban area is Sebkha in Yazd – Ardakan plain.

The best result was obtained by the scenario with two groups including Sebkha - Kalut (Yardang) and Hill - Glacis Epandage Plain. Therefore, discriminate analysis was defined based on the scenario.

The source contribution in sediment production

The mixed multivariate model obtained the sources contributions of 99.9 and 0.1 percent. Therefore, major contribution of falling dust is related to Sebkha and Kalut. The result of minimizing the sum of the squares of the residuals is indicative of the best portion for falling dust sources. The results showed that the contribution of the groups for production of falling dust is 100 and 0 percent. These results almost are corresponded with the results of mixed multivariate model. The assessments of this model showed that percent of the relative error are from 0.0001 to 3.41 for all samples. The coefficient of performance model variable is between 0.71 – 0.99 for the samples.

Conclusion

The occurrences of severe sand storms and the winds with speeds more than 100 km/h are mainly severe in February to June and these events have sometimes the black storms and thick clouds of dusts in Yazd Province. Thus, winter and spring seasons are selected for the research.

The investigation of low relative error and high coefficient of performance model indicates the accuracy and performance of the model. The results of this model are completely in agreement with field observation. The high sensitivity of Sebkha and Kalut against the wind and fine soil in this area are indicating the major role of this area in production of the falling dust. The results of wind erosion analysis in faces of Yazd – Ardakan plain showed Sebkha and Kalut – Yardang among other faces as the highest contributio in production of falling dust. As Sebkhas are Crust of clay–salt, due to high salinity and sodium they are highly sensitive to erosion. The soil of this land is sensitive and highly susceptible to erosion. The Neogene hills are the highly resistant against wind erosion because they cover pebbles and rubble. The research in case of wind erosion in Yazd – Ardakan plain showed the area involving Sebkha and Kalut. Although the area is small, it has the highest contribution in wind erosion and production of dust.

Keywords: dust, fingerprinting, tracer element.

Assessment of R.sun Model in Estimating the Solar Energy Received in Arid and Semi-Arid Areas (Case Study: Isfahan Province, Iran)

Mahmood Zoghi[1], Mahdis Sadat[2], Amir Houshang Ehsani[3]*

1. MSc in Environmental Planning and Management, Faculty of Environment, University of Tehran, Iran (Zoghi87@ut.ac.ir)
2. MSc in Environmental Planning and Management, Faculty of Environment, University of Tehran, Iran (Mahdissadat74@ut.ac.ir)
3. Associate Professor of Environmental Design Engineering, Faculty of Environment, University of Tehran, Iran

Introduction

The movement towards the modern lifestyles has led to uncontrolled population growth, urbanization, disorderly expansion of cities on the natural habitats and ecosystems, destruction of traditional rural communities and farm lands, indiscriminate utilization and destruction of natural resources, air pollution and many other environmental problems in large cities. On the other hand, the problems of environmental pollutions and exhaustion of energy resources have long been considered as one of the main issues of societies. The utilization of clean and natural solar energy has been introduced as a substantial approach to resolve this issue. Today, one of the important aspects of sustainable development is environmental considerations with the appropriate use of energy sources as a significant component. It is clear that offering energy consumption patterns and higher utilization of renewable resources can be useful in this regard. As defined, sustainable development of energy contains policies, selection and exploitation of technologies which supply the energy needed for all demands while they contain the minimum expenses in terms of price, as well as environmental and social impacts. Today, the role of energy in world economy indicates the significance of the energy issue more than ever before. In this regard, development and expansion of theories and uses of energy leads to the attainment of new methods for adjusting the issues of energy and environment.

The amount of solar energy received at one point on the earth surface depends on various factors including: latitude, longitude, the sundial, humidity, evaporation, air temperature, angle of the sun, and other factors. The amount of solar radiation received by the top of the atmosphere is a function of latitude. After reaching the earth's atmosphere, some of these solar radiations would be dissipated due to the atmospheric diffusion and absorption phenomena and this amount would be increased when the sky is cloudy or when there are more particles in the air. Knowing the amount of solar radiation in each area has a great importance for many practical issues such as evaporation, transpiration, architectural design, agricultural crop growth models, and etc. However, despite the importance of measuring these parameters, due to economical problems, the right tools and equipment for measuring radiation are not available in all regions, as is the case with other meteorological parameters such as temperature and rain and it has to be somehow estimated. Consequently, the need for the researchers' inclination to utilize radiation models has been increased. This study is an endeavor to model and calculate the amount of solar energy intake in Isfahan Province by using the new research approaches based on the r.sun model.

Isfahan Province is located between latitudes 30° 43′ to 34° 27′ North and longitudes 49° 36′ to 55° 31′ East and covers an area of 107017 square kilometers, equivalent to 0.5% of the total Iran territory with 23 cities, 106 towns and 126 villages. Because of the number of major industrial workshop and industries and industrial estates, Esfahan is one of the most important industrial centers in Iran. All factors above have caused high consumption for electricity power in this province. This province is one of the arid and semi-arid regions of the country.

Material and Methods

In this study, the GRASS Geographic Information System (GIS) was applied for modeling of solar radiation, with the diversity of different modeling algorithms. To this end, the R.sun rule as one of the location models of solar energy was used and analyzed. The R.sun computes beam (direct), diffuse and ground reflected solar

---

* Corresponding Author: E-mail: Ehsani@ut.ac.ir

irradiation raster maps for given day, latitude, surface and atmospheric conditions. Solar parameters (e.g. time of sunrise and sunset, declination, extraterrestrial irradiance, daylight length) are stored in the resultant maps history files. Alternatively, the local time can be specified to compute solar incidence angle and/or irradiance raster maps. The shadowing effect of topography is optionally incorporated. This can be done either by calculating the shadowing effect directly obtained from the Digital Elevation Model (DEM) or by using raster maps of the horizon height, which is much faster.

The solar geometry of the model is based on the works of Krcho, later improved by Jenco. The equations describing Sun – Earth position as well as an interaction of the solar radiation with atmosphere were originally based on the formulas suggested by Kitler and Mikler. This component was considerably updated by the results and suggestions of the working group co-ordinated by Scharmer and Greif (this algorithm might be replaced by SOLPOS algorithm-library included in GRASS within r.sun mask command). The model computes all three components of global radiation (beam, diffuse and reflect) for the clear sky conditions, i.e. not taking into consideration the spatial and temporal variation of clouds. The extent and spatial resolution of the modelled area, as well as its integration over time, are limited only by the memory and data storage resources. The model is built to fulfil user needs in various fields of science (hydrology, climatology, ecology and environmental sciences, photovoltaic, engineering, and etc.) for continental, regional and the landscape scales.

As an option, the model considers a shadowing effect of the local topography. The R.sun program works in two modes. In the first mode, it calculates the set local time of a solar incidence angle [degrees] and solar irradiance values [W.m-2]. In the second mode, daily sums of solar radiation [Wh.m-2.day-1] are computed within a set day. By a scripting, the two modes can be used separately or in a combination to provide estimates for any desired time interval. The model accounts for sky obstruction by local relief features. Several solar parameters are saved in the resultant maps' history files, which may be viewed with the R.info command.

Results and Discussion

According to the outcomes, northern and north-eastern parts of the province and the southern parts contain the most sundials; the north-eastern parts also have the least sundials. Maximum hour of receiving sunshine in the province is 3392 hours and the least is 2918 hours (Fig. 1). The analyses obtained from the modeling also confirm the high potential of the region in receiving solar energy. Isfahan province naturally possesses a great potential and good share in receiving solar energy since it is mainly situated in the angle between 46 and 67 degrees (Fig. 2). The highest reflection irradiance of Isfahan province is assessed as 1194 and the lowest is 40 watts per square meter (Fig 3). Most of the zones in Isfahan have the average level and receive solar energy between 600 and 1000 watts per square meter. The important point in this research is that highlands, i.e. mountain peaks, have the most irradiance. Namely, in right angle radiation the areas receive the irradiance higher than 1000 watts per square meter. Generally speaking, the region's condition in terms of receiving solar energy can adequately be assessed.

Fig1. Total hours of sunshine   Fig 2. Angle irradiance   Fig 3. Reflection irradiance
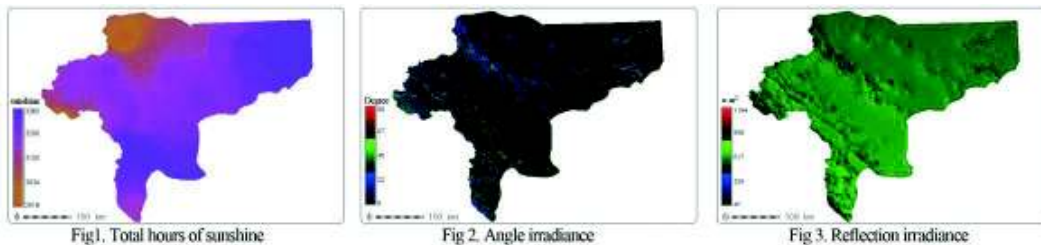
Based on the results, the number of sunshine hours is with a gentle slope that represents the damping of the area sundial. The area is in a balanced state in terms of mean radiation. Irradiance reflection map from the surface shows that the observed fluctuations are variable due to topographic lines and area altitude; and the higher the altitude the more the slope angle. Moreover, radiance angle has constant changes that are directly associated with total solar irradiance changes. Generally, the situation of the area can be assessed as suitable for investments and the utilization of energy in terms of most solar energy parameters and its received energy.

Conclusion

Solar energy is an essential parameter in various models related to energy in industries, landscaping, vegetation, evaporation and transpiration, snowmelt, and or remote sensing. The maps of solar radiation angles can be useful in correcting radiometric and topography of mountainous and hilly regions. Moreover, the outcomes of this study

can be cited as one of the most significant criteria of the region's potential to organize and plan the utilization of solar energy. All in all, the innate potential of the region has made Isfahan province capable of developing solar power plants and establishing solar panels in order to exploit solar energy. In addition, to improve the researches in this field, we propose further study on energy zonation and site selection of potential zones to establish solar power plants in the province. Therefore, by this we can see the sustainable development of energy in the region and utilization of clean and renewable solar energies.

Keywords: renewable energy, R.sun model, solar energy, solar power.

Land Suitability Evaluation to Determine Agricultural Land Use by Multi Criteria Decision Making Models ANP- DEMATEL and FAHP Chang (Case Study: Behbahan Fringe)

Hamid Reza Pourkhabbaz[1*], Hossein Aghdar[2], Fatemeh Mohammadyari[3], Saeideh Javanmardi[4]

1. Assistant Professor of Environment, Faculty of Natural Resources, Behbahan Khatam Alanbia University of Technology, Iran
2. MSc Student in Remote Sensing and GIS, Faculty of Science, Shahid Chamran University of Ahvaz, Iran (aghdarhossain@yahoo.com)
3. MSc. Student of Evaluation and Land Use Planning, Faculty of Natural Resources, Behbahan Khatam Alanbia University of Technology, Iran (m.fatima.1364@gmail.com)
4. Instructor of environment, Faculty of Natural Resources, Behbahan Khatam Alanbia University of Technology, Iran (Sajavanmardi@yahoo.com)

Expanded Abstract

Introduction
Suitability evaluation can be considered as a basic strategy for land use because the development is synchronous with the nature and can be achieved by identification and assessment of the ecological characteristics of the area. Agricultural land suitability classification based on indigenous knowledge is vital to land-use planning (ecological capacity evaluation). Execution of development and creation of appropriate points for agriculture land use without considering ecological capability will result in the appearance of several environmental, economic and social problems. In the agricultural sector, goals for sustainability generally contain the maintenance or enhancement of the natural environment, provision of human food needs, economic viability, and social welfare. Since the agriculture has enormous environmental impacts on peri-urban regions, it is necessary to evaluate agriculture land uses. Therefore, agricultural land suitability analysis is a prerequisite to achieve optimum utilisation of the available land resources for sustainable agricultural production. The objective of the present study is to evaluate the arable land suitability using the decision making models such as analytic network process (ANP) and Fuzzy Analytical Hierarchy Analysis (FAHP CHANG). In this study, we determined agricultural land suitability classifications using case spatial data sets from Behbahan north Plain.

Materials and Methods
This research was conducted in the framework of the ecological model and multi-criteria decision making methods such as DEMATEL, ANP, and FAHPCHANG by using ArcGIS 10, Excel 2013, Super Decision 2.0.8, MATLAB 7.11.0, and Surfer11 in order to select suitable locations for agricultural land uses in Behbahan north plain. The present study is based on the ecological parameters (physical and biological) to assess the ecological capability of agriculture landuse including physiographic (percent slope) (So), precipitation (Cp), temperature (Ct), distance from water sources (Wc), soil depth (Pd), soil erosion (Es), soil structure (Ps), soil texture (Pte), soil drainage (Pdr) and vegetation types (Vgo). DEMATEL is a comprehensive method to build and analyze structural model involving causal relationships between complex factors. ANP is based on creation of a control network to describe dependency among decision elements. In Fuzzy Analytical Hierarchy Analysis method, triangular fuzzy numbers and geometric averaging method were used for pairwise comparison of the criteria and for gaining weight and preferences, respectively. Simple Additive Weighting or Weighted linear combination method (SAW) was used to integrate layers. The study area is located in Behbahan north plain. This area is limited in 30°, 36' to 30°, 37' north latitude and 50°, 19' to 50°, 29' east longitude.

Results and Discussion
Analysis of the criteria objectively involves application of specific GIS techniques to break the analysis down into quantifiable measurements. From the available 10 m interval contour map of the study area in ArcGIS, a

---

∗ Corresponding Author: E-mail: Pourkhabbaz@yahoo.com

contour Digital Elevation Model (DEM) was generated from which a grid DEM was derived and the slope data was obtained. The reclassify tool was then used to reclassify all the variable data sets by Iranian ecological model. It is favourable to use the DEMATEL to handle the problem of inner dependences, because it can provide more valuable information for decision-making. For example, from the causal table (r + c and r – c matrix), it can be directly and visibly seen that the most important criterion is slope (Table 1). This study also shows that using DEMATEL to normalize the unweighted super matrix in the ANP procedure is more reasonable than using the assumption of equal weight in each cluster (Table 2). The FAHP and pairwise comparisons were conducted by the experts, the weight of each of the evaluation criteria and sub-criteria affecting agriculture can be calculated using MATLAB application in fuzzy evaluation criteria of ecological agriculture (Table 3).

In final, total digital layers was integrated using the simple additive weighting method and evaluation of each alternative. Based on the zonation map by ANP method, from the total area, 4% have the appropriate power and 3% have the inappropriate power for use as agriculture and by FAHP method, 4% have the appropriate power and 11% have the inappropriate power for the use as agriculture. Figure 1 shows the final layer of ANP evaluation method. Figure 2 shows the final layer of evaluation of FAHP method.

Table 1. Sum of criteria effects

Ecological criteria	r	c	r - c	r + c
Soil structure	2.188	10.353	7.751−	12.956
Soil Texture	2.843	2.227	0.616	5.071
Soil Deep	1.976	2.154	0.178−	4.131
Soil Erosion	2.835	3.141	0.306−	5.977
Soil Drainage	2.168	3.275	1.106−	5.444
Slope	3.132	1.442	1.690	4.574
Vegetation Density	2.575	3.454	0.879−	6.029
Water	2.995	2.676	0.318	5.672
rain	2.188	2.830	0.641−	5.018
Temperature	2.238	1.870	0.368	4.109

Table 2. Final weights of criteria

criteria	Water	rain	Temperature	Slope	Vegetation Density	Soil Erosion	Soil Drainage	Soil structure	Soil Deep	Soil Texture
Final Weight	0.083	0.250	0	0.153	0.180	0.080	0.113	0.027	0.096	0.018

Table 3. Fuzzy evaluation criteria of ecological agriculture

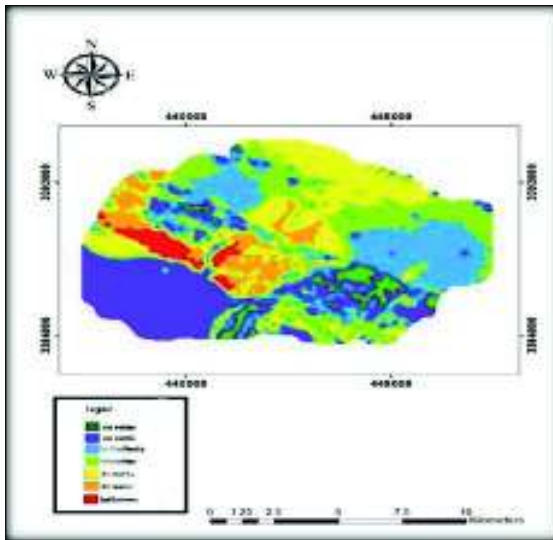| Criteria	Soil	Climate	Physiographic	Vegetation Density	Water	Final Weight
Soil	1, 1,1	1, 3.2, 2	3.2, 2, 5.2	5.2, 3, 7.2	1, 1,1	0.242
Climate	0.5, 0.66, 1	1, 1,1	3.2, 2, 5.2	3.2, 2, 5.2	1, 3.2, 2	0.305
Physiographic	0.4, 0.5, 0.66	0.4, 0.5, 0.66	1, 1,1	1, 3.2, 2	0.5, 0.66, 1	0.135
Vegetation Density	0.29, 0.33, 0.4	0.4, 0.5, 0.66	0.5, 0.66, 1	1, 1,1	0.4, 0.5, 0.66	0.073
Water	1, 1,1	0.5, 0.66, 1	1, 3.2, 2	3.2, 2, 5.2	1, 1,1	0.073

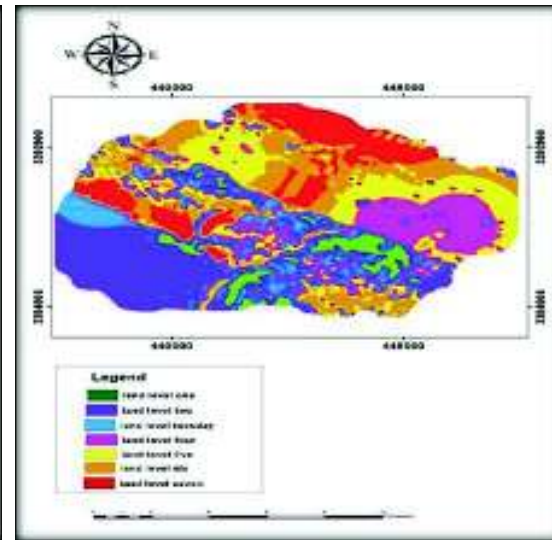**Fig. 1. final layer of evaluation ANP method**   **Fig 2: final layer of evaluation FAHP method**

Conclusion

In agriculture ecological model, seven classes were considered from class one to class seven. The quality of land becomes inappropriate for this user that there are seven classes in the study area. In general, it can be said that the study area in terms of ecological potential is unsuitable for agricultural land use because of proximity to the mountains, the hills and the dissolution formations of gypsum and limestone. This result is clearly seen in the Fuzzy AHP method. The results of such studies can help those in charge of the area designated for agriculture. In any case, we can conclude that models of Multi Criteria Decision on assessment of land suitability are very useful for various applications.

Keywords: agriculture land use, Analytic Network Process (ANP), DEMATEL, ecological capability evaluation, Fuzzy Analytical Hierarchy Analysis CHANG..

Evaluation of the Environmental Instability Indicators in Ahvaz Metropolis

Mostafa Mohammadi Deh Cheshmeh[1], MohammadAli Firoozi[2], Jafar Saeedi[3*]

1. Assistant Professor of Geography and Urban Planning, Shahid Chamran University of Ahvaz, Iran
   (m.mohammadi@scu.ac.ir)

2. Associate Professor of Geography and Urban Planning, Shahid Chamran University of Ahvaz, Iran
   (m.alifiroozi@scu.ac.ir)

3. MA Student in Geography and Urban Planning, Shahid Chamran University of Ahvaz, Iran

Expanded Abstract

Introduction

Discussion of sustainability and sustainable development, regardless of towns and cities, would be meaningless Cities as the main factor causing instability in the world are, in fact, the concept of urban sustainability and global are stability. Environmental crises and urban issues such as air pollution, water, soil and water resources and agricultural land use renewable, Global warming and climate change and other issues that are fundamental problems are not just for scientists, But citizens and society has also faced daily and directly understand the environmental constraints. Urbanization is the second revolution in human culture, the optimism human interaction with each other, with an increase in urban population, exploitation of the environment is worsening. In recent decades, rapid growth of urbanization and the expansion of industrial activities, infrastructure and reduce environmental waste has increased and cities have significant growth. And increasingly exposed to a traumatic crisis, especially in developing countries. Poverty, environmental degradation, lack of urban services, the decline of existing infrastructure, lack of access to land and adequate shelter, such crises are related to this topic. Now the man with the environmental challenges faced unprecedented. Wide agreement among experts on the subject there are environmental The Earth's ecosystems can no longer current level of consumption and the development of economic activities and are unable to tolerate it and not stabl Because the pressure and the load on the environment is twofold. In this regard, in relation to sustainable urban development and environmental sustainability, in the summer of 1992 Earth Summit held in Rio de Janeiro. Participants at the meeting agreed that the topics include the Agenda 21, has been noted that in forty chapters. To achieve sustainable development of human settlements may return. It should be noted that Agenda 21 expresses the fact that Agenda 21 expresses the fact that the population, consumption and technology, changes in the environment are major forces. This agenda is trying to policies and programs to achieve a sustainable balance between consumption, population and capacity to introduce land degradation. in fact, the main issue of Agenda 21 for the healthy development of the city and at the same time, the need to reduce poverty by increasing poor people's access to resources for the sustainable life. The agenda and other wealthy nations have committed to developing nations to help minimize damage to the environment. On the other hand, in Iran, in the sixth chapter of the fifth development plan is to draw attention to environmental sustainability indicators including substances 184 and 185 in order to assess the environmental strategy at the national, regional and thematic. In this field, the urban geography and spatial analysis and ecological assessment of the stability characteristics of the areas, in urban areas, trying to help the urban environment for residents and provide .the communication with the issue, now with the increasing population of the metropolitan area has appeared in Ahvaz The many problems that threaten the ecological day so that this city with many problems, including widespread marginalization and Adverse effects on the urban environment, noise, pollution, urban waste, domestic sewage and industrial production increased, Soil pollution caused by the Karun river, air pollution Due to the high rate of fossil fuel consumption and vehicle industries And other sources such as dust in the dry season due to the proximity to the desert West and burning fields, pollutants Industrial pollution, etc. are facing. In recent years, air pollution in the city of Ahvaz has been partially the city is one of the most polluted cities in the world. this situation is due to the fragility and vulnerability of the environment in this area. Environmental pollution conditions in the city of Ahvaz on environmental sustainability negatively affected and lower the living conditions of people in the city. Air pollution and industrial pollution, noise pollution, soil pollution, water pollution and solid waste pollution in urban areas of the

---

∗ Corresponding Author: E-mail: j_saedi69@yahoo.com

most important parameters in Thus, according to these indicators, in order to achieve sustainable urban planning and macro t seems necessary. The identification and assessment of indicators and factors affecting the stability and instability metropolitan Ahvaz and provide appropriate models of sustainability and environmental instability patterns, the study reveals the importance and necessity. The subject of this angle is important to be able to apply sound management and environmental principles and balance the relationship between man and the urban environment and the causes of pollution in the area, the necessary programs to prevent and reduce environmental pollution in the city, did And steps taken for the purposes of environmental sustainability. The pathological study approach, assessment of environmental instability bedder it is challenging. The overall objective of this research is to develop indicators to assess and prioritize environmental instability in Ahwaz. Finally, this study seeks to answer the question that the best indicators for assessing urban environmental are instability. How the indicators of environmental sustainability in order of priority and importance of affect in Ahwaz?

Research Methodology
The present study is a descriptive analysis of the functional nature. The purpose of this study was to evaluate and prioritize environmental instability indices six of the eight metropolitan areas in Iran with emphasis on noise pollution, soil pollution, air pollution, water pollution, pollution from industrial and urban waste pollution. Methods of survey data collection library in an extensive literature survey and analysis process using Marnamh, the experts have also been used. n addition to the weight of the criteria according to the situation of each of the available reports and projects and field studies, A questionnaire survey of experts in the urban environment was used The AHP. Due to the hierarchical structure of the questionnaire (AHP) in the form of tables and the formation of paired comparisons between specialists and 40 copies Urban environmental experts were distributed. The paired comparison matrix, the matrix group (unit), software (Expert Choice), were And relative weights of criteria and sub-criteria are considered, relative to each other was determined. The calculated weight options and prioritization criteria were evaluated. In the second stage of the analysis of the results in AHP and GIS Spatial and temporal analysis of eight areas with comparative approach that has been done.

Results and Conclusions
The achievement of stability and instability leads to environmental factors in the cities major issue, especially in developing countries are considered. To compensate for the backwardness of the country and to achieve balanced and sustainable development which contributes to improving the lives of all human beings, Correct understanding and proper planning and optimization of the national and regional level. In this context, to understand the role of the urban environment, and measures to reduce the harmful effects of these effects can be applied, primarily in the city as part of the environmental assessment. Ecological approach to urban renewal and urban areas in terms of the dimensions of sustainability, Positive steps towards sustainable development. The approach to the sustainability of natural resources in cities, and this is a special emphasis on the different aspects of sustainability in the urban system. Thus reducing risks to the environment and achieving environmental sustainability, increase knowledge and awareness of the environment in developing countrie As well as developing countries such as Iran, requires careful planning and constant monitoring of the program and its implementation. Many environmental instabilities in city includes a variety of urban environmental pollution, soil erosion, deforestation and desertification, loss of fresh water resources, soil salinization, etc. resulting from the turmoil In use of land. And the ecological, economic, social, reduce the use of resources. Many of the problems of environmental problems, just as a local or national issue not counting, but every environmental problem In every size and small scale within a country is a problem for the whole earth. Accordingly, several methods have been calculated in order to evaluate the environmental impacts and sustainability of urban areas have been designated. Often one-dimensional or applied in specific topics. In the unstable environmental indicators as a tool for assessing the ecological effects of the urban environment is a method that can shed light on the growing consumerism, urban growth will lead to ecological instability and disability. In this context, the analysis and evaluation of sustainability and environmental instability in Ahwaz After examination of the theoretical and research literature and survey studies and documents, and the views of experts in the study area, The six criteria for the study were identified in the eight districts in Ahwaz These criteria included: water pollution, soil pollution, noise pollution, industrial pollution, pollution, waste and air pollution. Since each of these dimensions and measures in weight, with varying degrees of importance in achieving In environmental instability determine the contribution of each of these criteria are the city of Ahwaz AHP multiple criteria decision making method was used to determine the importance of each criterion based on the impact and role in the instability of the city, Properly analyzed. In conclusion, the findings of this study indicate that Ahwaz based on the assessment criteria considered the most important factor In environmental instability in Ahwaz air pollution index weight (280), were identified. Finally, the need for a holistic approach to environmental

sustainability and macro dimensions such that the stability of the metropolis, Iran should be comprehensive and holistic view In all local, national and international simultaneously be followed. By identifying optimal strategies for use in the process of spatial development and stability of the city, the impact of urban development on environmental instability indexs Understanding the environmental pollution caused by the uncontrolled expansion of urban and environmental projects and studies can be applied to the sustainable management of the environment in Ahwaz.

Comparative Study about the Impacts of Micro-Climate Features on Urban Behavior Patterns (Case Study: Urban Spaces of Yazd and Fuman)

Hossein Bahrainy[1], Hossein Khosravi[2*]

1. Professor of Urban planning, Urban Planning Department, College of Fine Arts, University of Tehran, Iran (hbahrain@ut.ac.ir)
2. PhD Candidate in Urban Planning, Urban Planning Department, College of Fine Arts, University of Tehran, Iran

Expanded Abstract

Introduction

Recently, the presence of residents and their behavior in the urban spaces have become so important that many contemporary urban theorists view the present era as the "turn of urban space and what is happening in it". The importance of urban behaviors and activities could be discussed from different points of view. In the contemporary literature of urban design, it is concentrated on the mutual interaction between urban behavior and different urban aspects including cultural, political, social, economic, natural environment and public health. For example, the recent researches demonstrate that residents' walking in the urban spaces significantly result in reduction of blood pressure, decrease in anxiety, prevention of osteoporosis and type II diabetes, moderation of body mass index, and the enhancement of overall physical and mental health.

Hence, it could be easily claimed that all of the contemporary urban design movements have put an emphasis on the increase, intensification, qualification, and diversification of urban spaces to the extent to which different behaviors could be done in the spaces. Hence, the harsh attributes of climate is seen as a barrier to residents' urban behaviors.

Materials and Methods

One of the main functions of environment (natural and man-built) is the ordering of the life-world of live creatures. For millions of years, natural environment has imposed its requirements to the life style of living organisms. In order to survive, creatures had the options of adapting to the environment or modifying and moderating the environment. The main difference between human kind and other organisms is that other creatures communicate to their surrounding environment only through the adaptation process; whereas humans, through a dialectic process, change the environment in a way to reduce its imposed order and consequently benefit from more freedom and autonomy. Indeed, one of the main purposes of changing the natural environment into a man-built environment is for the autonomy psychological need. This dialectic approach which believes that human kind simultaneously affects and is affected by his sounding environment is known as the organismic approach in anthropology. One of the aspects humans have sought to moderate is the harsh climatic features. It could be claimed easily that in a great deal of human intervention in nature and, in other words, in most of the global historic architecture and planning phenomena, the importance and effect of climatic comfort could be recognized.

Environment and space could either have a deterrent or limiting role in urban behaviors, or they could be supporting and encouraging. Today, there is no doubt that the environment could determine the possibility or probability of specific behaviors. The first approach is known as possibilitic and the second one as probabilistic. In any approaches, the environment imposes the order in three dimensions of the behaviors:

1. Times, cycles or period of behavior
2. Type of behavior
3. Relationship in the behavior

In regard to time, the environment determines the period, frequency and time interval of behaviors. It is observed by Gehl and Gemzoe that the number of Copenhagen citizens in the urban spaces in summer days is two times more in comparison with winter days. In warm seasons their continuity of presence in urban spaces are four times more and their density in spaces are eight times more than in cold seasons.

∗ Corresponding Author: E-mail: h.khosravi@ut.ac.ir

In regard to the typology of the behaviors, the environment has a significant impact on which the behaviors (necessary, optional or social) are permitted to be more prevalent. The environment strongly influences the proportion of recreational-purposive behaviors and staying-passing behaviors. Above all, the environment strongly determines the avoidance behavior or approaching activities. The importance of the last differentiation is due to the effect they could have on residents' mental health. The avoidance behaviors are done to decrease the insufficiency, deficits, stress, tension and anxiety. Hence, it could not lead to happiness but only relief, sedation, and palliation. In opposition to this, the approaching activities which would not be done according to the environmental impositions but based on personal will and tendency, would meet the person's autonomy and psychological needs. Consequently, this kind of activity leads to high performance of the residents, their happiness, good mood, and mental health. To clarify, Gehl and Gemzoe, in their study about the urban behaviors in Copenhagen, observed that in the winter the residents walk is faster and with longer steps whereas in the summer times they move calmer during their roaming and rambling. In other words, in the winter people were avoiding the harsh, cold temperature whereas they have more autonomy about what they like to do in the summer.

As mentioned before, the aim of this research is to investigate the impacts of climatic features on the urban spatial forms and behavioral patterns. The research method is comparative study between urban behavioral patterns of warm and arid climate in one hand and moderate and humid climate on the other hand. The data of the behavioral patterns have been gathered thorough observation (timed photography). This type of photography is a random method to collect the behavior pattern data in the specific period of time. It must be considered as the visual-behavioral research.

Results and Discussions
The analysis of urban behavior in warm and dry climate shows that the density of behaviors is the most in the morning of winter days and the evening of summer days. In this period, proportion of the optional and social behaviors in comparison to the essential behaviors is the most. In addition to these, in the summer evenings, the sitting on the projected edge of pools is also the most. This is because of the increased humidity and a little decrease in the temperature of the air. In opposition to this, in the morning of the hot season and in the evening of the cold season, urban behaviors is the least. In this period, the urban spaces are greatly devoid of optional and social behaviors. The residents' passing ways are strongly determined by the shadows in morning of summer days and the sunlight in the evening of winter days.

The analysis of urban behavior in moderate and humid climate demonstrates that behavior density in the summer is significantly more than the ones of the winter. This shows that in this climate, the effective time cycle is seasonal, not daily. Low difference between temperature of days and nights (due to the high air humidity) lead to the decrease in the daily cycle effect on behavioral patterns. In this climate, the appropriate condition makes a vaster range of behaviors possible (including walking, sitting, watching, being watched, eating, talking). Due to high humidity and cloudy air, the proportion of indirect sunlight is more than direct sunlight. Hence, all sides of urban spaces are used almost equally. Despite this, the center of space benefits more from the air circulation and consequently attracts more people to itself.

Conclusion
This study shows that the climatic conditions have an impacts both on the typology of the urban behaviors and on the time cycles these behaviors cause in urban spaces. This impact in the harsh climates is significantly more and consequently the necessity of considering the climatic design criteria.

It should also be noted that climatic design requirements of different climates are various. In moderate and humid climate, the relationship between the humidity and air circulation are important whereas in the hot climates, temperature, radiation and reflection must be taken into consideration.

Studying the historic spatial-formal patterns in the warm and arid climate shows that atmosphere is welcomed to the extent to which air circulation does not make over sweating. It is better that the entrance of new air be located in a situation that transmits the humidity to all parts of urban space. In the cold season, the strategies must be completely different. The space must be protected from the cold winds. Hence, the main axis of the space must be located along the summer winds and perpendicular to the winter ones.

In designing the places for people to sit, including the edge of space and urban furniture, in addition to the temperature resistance, attention to the temperature capacity is also important. Investigation about the historic formal-spatial patterns of warm and arid climates can also demonstrate that the plan of space in this climate must be to condense and be concentric. The building density should be high in order to make the shadows as long as possible. In this climate, usage of opaque white, caved, rough and textured surfaces were prevalent. In opposition, application of the shiny surfaces and long windows were prevented. In this climate, usage of different kinds of green elements has been widespread. In spite of this, it must be noted that planting of covering

elements such as grass in this climate because of great need for water is contrary to the environmental sustainability. Finally, usage of the deciduous trees for benefiting from the sunlight in the winter days is also common.

In the historic spatial-formal pattern of the moderate and humid climate, according to the fact that the shadows are less important in comparison with the air ventilation, not only the attached buildings is avoided, but also the distance between the surrounding buildings has deliberately been kept high in order to conduct the appropriate winds to the spaces. Reduction of building height besides the usage of slope roof, Gorberos and avoidance of planting bushes in the center of space have enhanced the ventilation in the space.

Keywords: behavioral pattern, climate, Fuman, urban spaces, Yazd.

Environmental Rehabilitation of Urban Distressed Areas to Improving the Quality of Open and Green Spaces by Integrating Brownfields into the Green Infrastructure Systems in the Framework of Sustainable Development, Case Study: District 12, Tehran

Mohammad-Reza Masnavi[1*], Esmail Salehi[2], Minoo Baghbani[3]

1. Associate Professor of Environment, Faculty of Environment, University of Tehran, Iran
2. Associate Professor of Environment, Faculty of Environment, University of Tehran, Iran
   (tehranssaleh@ut.ac.ir)

Expanded Abstract

Introduction

Cities are manmade ecosystems that differ from other ecosystems in several ways. Ecological scholars have described the city as a heterotrophic ecosystem highly dependent on large inputs of energy and materials and a vast capacity to absorb emissions and waste. Compared to a "natural" ecosystem with a typical energy budget ranging from 1,000 to 10,000 Kcal per square meters per year, cities consume a vastly larger amount of energy. The budget of an urban ecosystem in an industrialized country can be ranged from 100,000 and 300,000 Kcal per square meter per year. Other key differences in urban ecosystems are the lack of integration of habitat patches, the invasion of nonnative species, and the external control of succession [2]. By the way, cities like other dynamic ecosystems tend to chaos. According to the Gunderson and Holing theory called "Adaptive Theory", all the ecosystems pass 4 stages:

1. Rapid growth
2. Conservation
3. Collapse
4. Reorganization/regeneration

In this process, old cities are facing modern life and may lose their resilience ability to adapt themselves with new changes. Many cities are extended to the suburb instead of passing from collapse to regeneration step which is contrast to sustainable urban development and will stop being a well-defined spatial entity.

In the urban planning context, revitalization means the planning measures that are necessary to improve the physical, social, and economic activities of the distressed areas which have lost their original functional vitality. The aim of urban revitalization should be an appropriate balance between urbanization and natural conservation. It includes maintenance of its natural resources and extension of the nature into the city. For regeneration stage, we should use strategies such as conservation, rehabilitation, renewal and etc. as necessary.

Materials and Methods

The gravity model calculates the interaction between each pair of nodes of a and b using the following formulas:

$Na = [x(ha) / s(ha)]*10$

$Gab = (Na *Nb) / Dab^2$

The level of interaction represents the efficiency of corridors and the significance of linked nodes: pairs of nodes with higher habitual quality and lower impedance have greater interaction. Where Gab is the interaction between nodes a, and b, N is node weight of node a, Nb is node weight of node b, and Dab is distance between the centroids of the nodes a and b.

The next step is to generate the schemes connected to the nodes based on the information gained from the model. One of the primary concerns in network analysis is efficiency.

Results and Discussion

According to sustainable regeneration, we can design patches and their connected corridors in different levels. Patch hierarchies allow researchers to ask questions related to what factors influence the patterns and processes

---

∗ Corresponding Author: E-mail: masnavim@ut.ac.i

observed at each nested scale and functional relationship within and between the scales. Urban landscape as a complex mosaic of biological and physical patches within a matrix of infrastructure and social organization has heterogeneity in its ecosystem. Keeping in mind these principles, we suggest a table for urban regeneration.
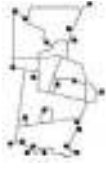
Table 1. Two different levels for urban regeneration in the distressed areas

Regeneration level	Connectivity	Models
regional level	Integrate open, green and redeveloped brownfields to reach an ecological network in patch-corridor framework in regional level	Gravity model
local level (Sectoral part of region or neighborhood)	Design the patch & corridors according to social, recreational, conservational , cultural needs in local level	Green way planning strategies

The connectivity indices in the gravity model can be useful measure for describing the degree of connectivity. It is an appropriate approach to greenway planning, as it provides a method of systematizing the relationship between the elements that can serve as greenway nodes as well as accounting for the conditionsof the potential links.

By this model, we suggest three different ecological structures (model, Band C) of green, open and derelict spaces to reach a new structure of optimum ecological condition (model C).

Table 2. three different ecological networks in district 12 of Tehran

model	typologies	Apply on district12		Ecological map
A	Least Cost to User			
B	Hierarchical			
C	Beckman Topology			

Conclusion

Redevelopment of derelict lands by turning them into the green infrastructure in a network and integrating them to the upper level network is a smart conservation of land. This can reduce the ecological and social impacts of sprawl and the accelerated consumption and fragmentation of open lands. By this kind of sustainable regeneration, cities have the interaction among ecological, social and economic processes, useful to dynamic change of urban structure. Green infrastructure systems help protect and restore naturally functioning ecosystems and provide a framework for future development and redevelopment. In doing so, they provide a diversity of ecological, social, and economic functions and benefits: enriched habitat and biodiversity; maintenance of natural landscape processes and clear air and water; increased recreational opportunities; improved health; and better connection to nature and sense of place. Hence, many researchers argued that changes in the approaches to the derelict lands are necessary to be able to return them into the cities life and livability systems. This presents the results of an ecological systematic approach together with the application of Gravity Model in the district 12 Tehran city. Several scenarios were prepared and compared with each other to make use of decayed urban lands and distressed urban fabric for creating an integrated ecological green infrastructure network. The evidence from this study suggested the efficiency of cyclical Gravity Model for urban fabrics in the Tehran inner city areas.

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

Narges Hajkazemiha [1*], Mahmoud Shariat[2], Masoud Monavari[3], Mohammad Ataei[4]

1. PhD Candidate, School of Environment and Energy, Science and Research Branch, Islamic Azad University, Tehran, Iran
2. Professor, Environment, School of Environment and Energy, Science and Research Branch, Islamic Azad University, Tehran, Iran (mahmoudshariat@yahoo.com)
3. Assistante Professor, Environment, School of Environment and Energy, Science and Research Branch, Islamic Azad University, Tehran, Iran (monavari_m@yahoo.com)
4. Professor, Petroleum and Geophysics, Shahrood University of Technology, School of Mining, Petroleum and Geophysics Engineering, Semnan, Iran (ataei@shahroodut.ac.ir)

Expanded Abstract
Introduction

∗ Corresponding Author: Tel: +98 9123136570   E-mail: nargeshajkazemiha@gmail.com