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Laundry Wastewater Treatment Using Electrocoagulation/Flotation and Electro-Fenton Processes

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Abstract

Several laundry houses throughout Tehran consume a large amount of water each day and discharge the resulting wastewater into septic tanks or municipal sewage system without any suitable pretreatment. This would result in severe contamination and other serious environmental issues. In the present study, performance of electrocoagulation/flotation process with aluminum and iron electrodes is compared with electro-fenton process for the simultaneous removal of chemical oxygen demand (COD), phosphate and turbidity from laundry wastewaters. The effects of operative chemical and electrochemical variables such as initial pH and hydrogen peroxide concentration, electrode arrangement, current density and electrolysis time on removal efficiency of COD, phosphate and turbidity were also investigated and optimized. During the optimization of effective parameters in these processes, energy consumptions and removal efficiencies were considered simultaneously.

Introduction

Electrocoagulation/flotation process is an electrochemical method for treatment of polluted water or wastewater. Through the applied electric current to aluminum sacrificial anodes, aluminum corrodes produce coagulation agents in solution (such as aluminum hydroxide). The produced coagulation agent sticks to pollutants in the water or wastewater and form large size flocs that can be sedimentated. Besides, released hydrogen gas at the cathode which appears as fine bubbles binds suspended particles and float them to the top of the electrochemical reactor. In electro-fenton method hydrogen peroxide was added into electrocoagulation system, so fenton reaction was formed in the process.

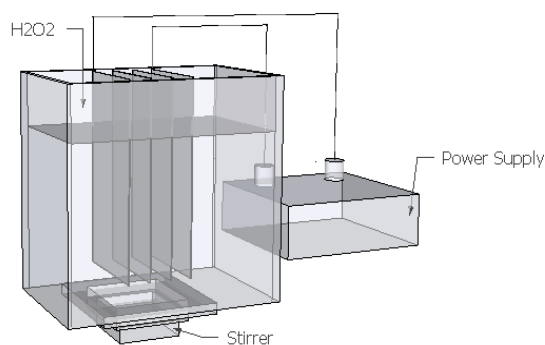


Fig. 1. The schematic experimental setup in the study

Materials and Methods

Experiments were carried out in a 3.6dm³ electrochemical reactor mobilized with a magnetic stirrer for better solution mixture. Aluminum and iron plates were used as anodes and cathodes. The dimensions of plates were 180×90×1mm and the effective area of each electrode submerged in wastewater was 117cm². Inter electrode spacing was 2cm. The electrodes were connected to a D.C. power supply (0-5A and 0-60V). The batch experimental setup is schematically shown in figure 1.

The pH of wastewater was adjusted by adding either sodium hydroxide or sulfuric acid and measured by a 691 Metrohm pH meter. In the electro-fenton method, hydrogen peroxide was applied externally into the electrochemical system. The electrochemical cell was fed by wastewater daily collected from Taleghani laundry house in Tehran.

Results and Discussion

At first, the effect of pH (in the range of 2-10) on the electrocoagulation/flotation processes with aluminum and iron electrodes were investigated. After adjusting pH, the experiments were carried out using five different types of arrangements with optimized pH to determine the best arrangement. In the next step the optimum values of current density (from 0 to 21.36mA/cm²) for both processes were determined. In the electro-fenton process, the effect of pH and the optimal initial amount of H₂O₂ was chosen by adding 0, 150, 300, 450 and 600 mg/lit H₂O₂ to the feed. In the final step, to find the optimal value of electrolysis time, its effect on removal efficiency of COD was assessed. Other parameters such as pH, current density, electrode arrangements and H₂O₂ concentration were remained constant. The results, as illustrated in figure 2, demonstrate the COD concentration as a function of electrolysis time in electrocoagulation/flotation and electro-fenton processes.

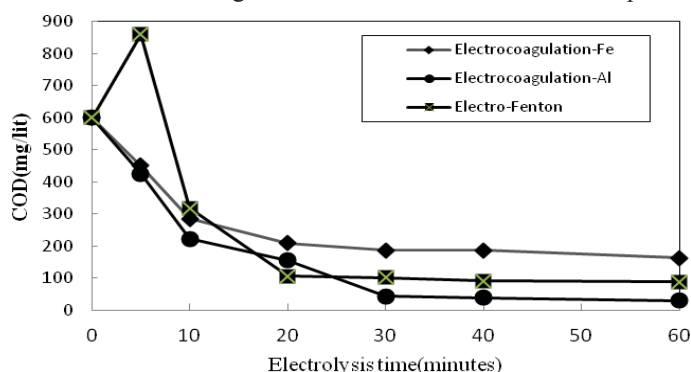


Fig. 2. Effect of Electrolysis Time on COD Concentration in electrocoagulation/flotation and electro-fenton processes

As it can be seen in figure 2, both electrocoagulation/flotation and electro-fenton processes are efficient to remove pollutants from laundry wastewater. Under the optimal parameters such as four aluminum electrodes in parallel connection, pH of 5, electrolysis time of 30 minutes and current density of 12.82 mA/cm² (1.5A), the proportions of COD, phosphate and turbidity removal efficiencies were obtained about 92.8%, 98.6% and 89.2%, respectively, and energy consumption was calculated as 3.1 kWh/kgCOD. During the experiments in the electrocoagulation/flotation process with iron electrodes, the neutral pH with the optimized arrangement of electrodes (four monopolar plates in series), electrolysis time of 30 minutes and current density of 4.27mA/cm² (0.5A) were chosen as optimal values, whereas in the peroxi-electrocoagulation process the optimum pH, current density and electrolysis time were 3, 4.27mA/cm² and 20 minutes, respectively. The best arrangement was similar to that of iron electrodes. The optimal amount of H₂O₂ for the efficient COD removal was obtained 150 mg/lit H₂O₂.

Under these optimal conditions, the COD removal efficiency and energy consumption of electrocoagulation/flotation and electro-fenton processes were calculated as 69%, 3.4 kWh/kgCOD and 82.3%, 1.64 kWh/kgCOD, respectively. Therefore, adding hydrogen peroxide with 150 mg/lit concentration results in greater values for COD removal efficiency and lower values for electrolysis time.

Conclusion

This study indicates that in these processes, i.e. Electrocoagulation/flotation and electro-fenton, there is a possibility of laundry wastewater treatment with acceptable efficiency. These methods can be used in large scale industrial facilities as well as in-situ laundry houses, as a wastewater pretreatment process.

Keywords: COD removal, electrocoagulation/flotation, electro-Fenton, laundry wastewater, phosphate.

Removal of dissolved Chromium (VI) by adsorption onto Elaeagnus angustifolia fruit charcoal, Jujube fruit charcoal and comparison with Granular Activated Carbon (GAC)

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Abstract

Chromium (Cr) is one of the elements presents in crust of the earth. Due to its toxicity, chromium is considered as water contaminant that may disturb metabolic activity. In the present study, adsorption of dissolved Chromium (VI) onto *Elaeagnus angustifolia* fruit charcoal, Jujube fruit charcoal and the standard granular activated carbon (GAC) has been investigated and compared. The effect of contact time, pH value, initial concentration of dissolved Chromium and amount of adsorbent on the adsorption of Cr were investigated by the mentioned adsorbents. Results showed that the adsorption process was highly dependent on pH. Maximum Cr removal was achieved when the pH of the mixture fell within 2. Adsorption test results revealed that Cr adsorption on the studied adsorbents could be better described by Langmuir isotherm. Maximum Cr removal efficiencies were obtained by *Elaeagnus angustifolia* fruit charcoal, Jujube fruit charcoal and GAC 1.66 mg/g, 35 mg/g, 66 mg/g. Based on Cr (VI) removal efficiency, it is concluded that jujube powder could be considered as one of the natural and inexpensive adsorbent to remove Cr (VI) from aqueous solution.

Introduction

The use of metals and chemicals in process industries has resulted in the generation of large quantities of effluent that contain high levels of toxic heavy metals. It is well known that the presence of heavy metals such as cadmium, chromium, copper, nickel and manganese has harmful effects on human physiology and other biological systems, even at low concentrations. This is because of their bioaccumulation, non-biodegradable properties and toxicities. Thus, the removal of heavy metals, such as hexavalent chromium from water has recently attracted considerable attention. The conventional technologies for the removal of heavy metal ions from aqueous solutions include chemical precipitation, ion exchange, reverse osmosis, electrochemical treatment and adsorption. A number of common adsorbents are primarily including activated carbon, carbon nanotubes, chitosan, lignocelluloses, synthetic porous inorganic materials, natural inorganic materials and so on. Conventional treatment technologies utilized in electroplating and metal finishing plants suffer from disadvantages such as high disposal and chemical costs and incomplete reduction of Cr (VI). Therefore, cost effective treatment technologies are needed to meet these requirements. Recently, a variety of low cost materials have been studied for their ability to remove Cr (VI) from aqueous solution and promising results are shown. Some of these low cost adsorbents are dead microorganisms, clay minerals, agricultural wastes, industrial wastes and etc. Many studies have been conducted on the agricultural wastes as cheap and environmentally friendly natural materials as well as on certain wastes from agricultural operations that are very abundant. Considerable attention has been devoted to the study about removal of heavy metal ions from solution by adsorption using agricultural materials such as waste wool, nut wastes, tree bark, modified cotton, sawdust, sunflower, Almond and apricot shells, groundnut shell, corn cob powder, almond green hull, coir pith and peanut husks carbon. In

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the present work, we describe the use of *Elaeagnus angustifolia* fruit charcoal, Jujube fruit charcoal and granular activated carbon (GAC).

Materials and methods

Bio adsorbent without activation has been used to remove hexavalent chromium from aqueous solution. The effects of adsorbent dose, pH, contact time and initial metal ion concentration on the adsorption capacity were investigated. The equilibrium of adsorption was modeled by using the Langmuir and Freundlich isotherms. Core samples were collected and rinsed with distilled water. Then, the samples were put in the oven at 700 °C for 1 hour after the crushing of carbon burned beneath the porcelain mortar with 18 mesh sieve, and sift the remaining carbon in the grain diameter ranging from 0.5-to 1.8 millimeter. A granular activated carbon with quality laboratory (GAC) was purchased from Merck, Germany Company. All solutions were prepared from analytical grade chemicals. One mill molar of Cr (VI) stock solution was prepared by dissolving 0.1471 g of $K_2Cr_2O_7$ (from Merck) with 99% purity, by dissolving in distilled water. The pH of the solution was adjusted by using 0.1N NaOH or 0.1N HNO_3 . After mixing, Cr (VI) concentrations in the solutions were determined by the standard colorimetric method using a spectrophotometer at 540 nm.

Results and discussion

Fig. 1 shows the adsorption of Cr (VI) by *Elaeagnus angustifolia* fruit charcoal, Jujube fruit charcoal, and granular activated carbon as a function of time. Effect of contact time on the removal efficiency in systems was studied by changing exposure time from 10 minutes to 240 minutes. In pH = 3, amount of adsorbent 1.5gr/l and the initial concentration of hexavalent chromium 0.5 mg/l were evaluated. Contact the optimum time to measure the *Elaeagnus angustifolia* fruit charcoal, Jujube fruit charcoal, and granular activated carbon in 240, 210 and 150 minutes, respectively. The experimental data indicate that Cr (VI) ion adsorption increases by increasing time.

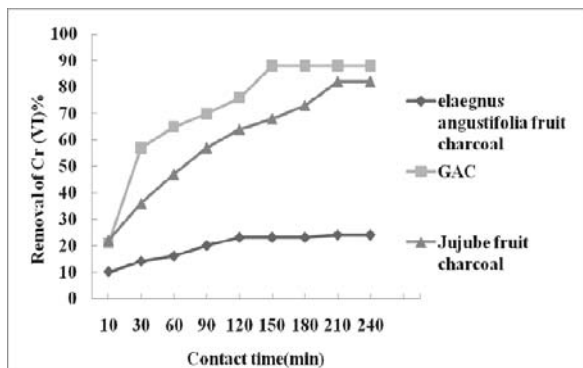


Fig 1. The effect of contact time on Cr (VI) removal

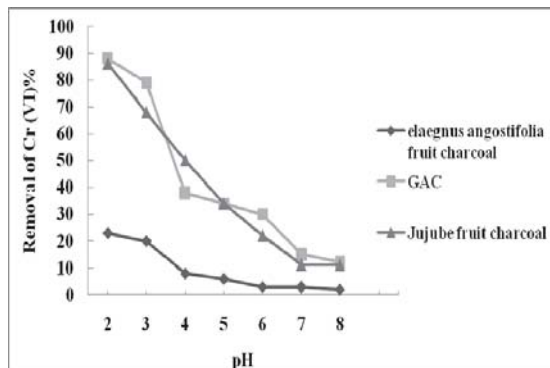


Fig 2: The effect of solution pH on Cr (VI)

Earlier studies have demonstrated that solution pH is an important parameter influencing the biosorption of metal ions. Fig. 2 illustrates the removal of Cr (VI) versus the pH at a constant Cr (VI) concentration of 0.5 mg/L, adsorbent concentration of 1.5 g/L and contact time of 240 min for *Elaeagnus angustifolia* fruit charcoal, 210 min for Jujube fruit charcoal and 150 min for GAC. It was observed that the adsorption capacity of the prepared adsorbent was highly dependent on the pH of the solution. As results show, the optimum initial pH was observed at pH 2.0.

The effect of sorbent variation on the removal of Cr (VI) ion by *Elaeagnus angustifolia* fruit charcoal, Jujube fruit charcoal and granular activated carbon (GAC) is represented in Fig. 3. The effect of adsorbent dose on Cr (VI) uptake was investigated by varying the adsorbent dose (0.3, 0.5, 1, 1.5, 2, 2.5 and 3 g/l) for an optimum time for any adsorbent. Experimental results showed that the percentage removal of Cr (VI) increases with the increasing amount of adsorbent up to 1.5 g/l for granular activated carbon (GAC), 2.5 g/l for Jujube fruit charcoal and 3g/l for *Elaeagnus angustifolia* fruit charcoal.

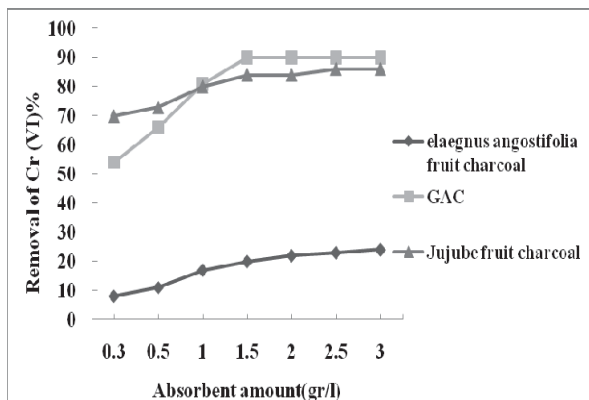


Fig3. The effect of sorbent amount on Cr (VI) removal

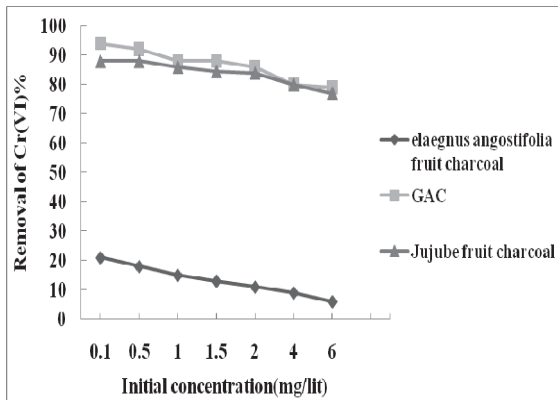


Fig4. The effect of initial concentration on Cr (VI) removal

The effect of Cr (VI) concentration on the sorbent with variation of the initial Cr (VI) concentration (0.1, 0.5, 1, 1.5, 2, 4 and 6 mg/L) in optimum value of time for any adsorbent interval is illustrated in Fig. 4. The percentage removal was decreased with increase in Cr (VI) concentration. In changing the initial concentration from 0.1 to 6 mg/l, the percentage removal decreased from 94 to 79 percent for granular activated carbon, 88 to 77 percent for Jujube fruit charcoal and 21 to 6 percent for *Elaeagnus angustifolia* fruit charcoal.

Conclusion:

The adsorbents and adsorbents will be increased by reducing the concentration of chromium adsorption. In fact, it can be said that the difference in percentage removal of heavy metal chromium in ion concentration of the initial amount of adsorbent and contact time may be similar to the difference in chemical affinity and ion-exchange capacity, in relation to their chemical functional groups. The capacity to exchange ion on the adsorbent surface in chemical functional groups depends on time metal ion hydrolysis rates of hydrolysis and solubility.

Keywords: adsorption, *Elaeagnus angustifolia* fruit charcoal, granular activated carbon, Hexavalent chromium, Jujube fruit charcoal.

Emission Rate Assessment in Landfill and Energy Generation Technologies (Case Study: Aradkooh Landfill)

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Abstract

A landfill is a location designed for systematic long-term storage of waste under the conditions that it will prevent contamination of air and water. Landfill gas is produced by bacterial decomposition, which occurs when organic waste is broken down by the bacteria naturally present in the waste and in the soil used to cover the landfill. Landfill gas is composed of a mixture of hundreds of different gases. By volume, in general the landfill gas typically contains 45% to 60% methane and 40% to 60% carbon dioxide. This study has estimated total produced gas, carbon dioxide and methane, by the basic first-order decay model for Aradkooh Landfill till the next 30 years after the landfill is closed. Gas production has decreasing trend in time, as the maximum gas production for methane and carbon dioxide is in order of 6 and it will be 16 million kg in the year 2015. The minimum contribution will also be in order of 0.3 and 0.8 million kg in 2044. The total produced gas in the 30 years is 213 million m³ which 27% of its mass belongs to methane and 73% is carbon dioxide gas. In addition, the amount of methane, carbon dioxide and sulfur dioxide contributed from energy generation technology is calculated for 30 years and compared. The results show that the emission rate of controlled carbon dioxide gas is 1.85 times in uncontrolled state and the emission of controlled methane gas is 0.15 in uncontrolled state. In addition, using energy generation technology leads to sulfur dioxide contribution. The estimation for total amount of this gas in 30 years is predicted about 361 kg. Finally, the gases emissions predicted from this model are validated using the mass balance method according to other studies. Comparison of results shows good agreement with other studies.

Introduction

Industrialization, along with economic growth, results in an increase in production of municipal solid waste (MSW). Landfills are managed by a simple landfill method, and it creates secondary pollution such as water pollution by leachate, leakage of gases, and bad odors. LFG consists of 50–60 vol% CH₄ and 30–40 vol% CO₂ with numerous chemical compounds such as aromatics, chlorinated organic compounds, and sulfur compounds.

CH₄ and CO₂, both greenhouse gases (GHGs), contribute to global warming. CH₄, in particular, is a very potent greenhouse gas which is almost 21–25 times more powerful than CO₂. However, it is a green fuel which can be used for electricity generation. The most common disposal method for municipal solid wastes (MSW) is burial in landfills since the usage of intermediate treatments such as incineration, pyrolysis, and recycles are not actively practiced to effectively remove the wastes (in Korea). According to various studies, a total of 40–60 Mtonnes of CH₄ is emitted from landfills and old waste deposits worldwide, accounting for approximately 11–12% of the global anthropogenic CH₄ emissions. This ranks landfills third after rice paddies (60 Mtonnes/year) and ruminant livestock (85 Mtonnes/year). Shin and his colleagues (2005) assess different gas-to-energy technology with landfill gas and analyze and compare emission rates of each technology using LEAP model. Jaramillo and Mathews (2005) presented formulas for calculating emission rates of CH₄, CO₂, SO₂ based on landfill gas emission rates and compared emission of controlling landfill gas technologies such as flares, IC engines, gas turbine and steam turbine. In this study, emission rates of different gases such as CO₂ and CH₄ in MSW landfill located in south of Tehran will be calculated in different elapsed time from burial of waste using equations and formulas. The influence of using LFG controlling technologies on emission reduction will also be discussed.

Material and Methods

When a landfill-gas-to-energy project is designed, one of the most important factors to be considered is the amount of gas available to generate the electricity. Landfill gas starts being generated shortly after the landfill begins accepting waste and it can last for up to 30 years after the landfill closure. The production of landfill gas generated in year T given previous disposal of waste at time x (in millions of cubic meter per year) can be estimated from a basic first-order decay model:

$$LFG_{T,x} = 2KR_x L_0 e^{-k(T-x)}$$

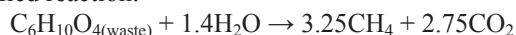
Where, 2 is the ratio of landfill gas to methane; K is the rate of methane generation (1/yr); R_x is the amount of waste disposed in year x (kg); L_0 is the total methane generation potential of the waste and x is the year of waste input (m^3/kg). The total landfill gas generated (LFG_T) in a year by all the waste in the landfill is the sum of $LFG_{T,x}$ across all values of R_x . k depends on the climate of the area where the landfill is located. EPA recommended value for wet climate is 0.225/yr. For medium moisture and dry climates, EPA recommends values of K are 0.1/yr and 0.06/yr. Municipal landfills have the potential to emit large quantities of methane and carbon dioxide, as well as some non-methane organic compounds. Under the 1996 New Performance Standards for Municipal Landfills, large landfills have to control these emissions. Flaring has been traditionally used as the control method. Methane emission control can also be achieved by using electricity-generating equipment. It is important to note that both flaring and electricity-generating equipment create emissions of criteria pollutants such as NO_x , CO, SO_2 , and particulate matter (PM). To perform a more socially relevant analysis, valuation of emissions (greenhouse gases and criteria pollutants) was included for this project. Equations were used to calculate these emissions and were developed by use of the AP-42 emission factors for municipal solid waste landfills. For any given landfill, the costs of net emissions from a landfill gas-to-energy project were compared with the current net emission costs at the landfill. For a landfill where a collection/flaring system is not present, current emissions are uncontrolled (U) methane and CO_2 emissions, as calculated by:

$$U_{CO_2} = (0.5)(1.794)(LFG_T)$$

Where, 0.5 is the assumed percentage of landfill gas that is CO_2 . 1.794 is the amount of CO_2 (kg/m^3_{LFG}), and LFG_T is the total amount of landfill gas generated in year T (m^3)

$$U_{CH_4} = (0.5)(0.6567)(LFG_T)$$

Where, 0.5 is the assumed percentage of landfill gas that is CH_4 , and 0.6567 is the amount of CH_4 (kilogram per cubic meter of landfill gas). The results obtained from this model are validated using the mass balance approach. Due to this method, the maximum amount of LFG generated in the anaerobic decomposition can be estimated by the following simplified reaction:



In landfills where a collection and flaring system is in place, emissions are those from a flaring system. In this case, the uncontrolled methane is converted into emissions of CO_2 (combustion efficiency was assumed to be 100%) and criteria pollutants. Equations are used to calculate controlled (C) emissions of CO_2 , CH_4 . Collection efficiency (η_{col}) is assumed to be 85%.

$$C_{CH_4} = (1 - \eta_{col})(U_{CH_4})$$

$$C_{CO_2} = U_{CO_2} + (\eta_{col})(U_{CH_4})(2.75)$$

Where, 2.75 is the ratio of the molecular weight of CO_2 to the molecular weight of CH_4 . The equations are also valid for CH_4 , CO_2 , and SO_2 emissions from internal combustion engines, gas turbines, and steam turbines, where methane combustion is also assumed to be 100% efficient.

Results and Discussion

It is predicted that according to capacity of the landfill and daily volume of burial waste, Aradkooh landfill will be closed in 2015 to emit gas. The emission of uncontrolled CH_4 and CO_2 were calculated in 30 years. According to the calculation, the maximum volume of landfill gas emission will be $18 Mm^3$ in 2015. And minimum volume of LFG emission will be approximately $0.9 Mm^3$ after 30 years. The maximum and minimum mass of uncontrolled CH_4 will be approximately 6 Mkg in 2015 and 0.3 Mkg in 2044, respectively. Decreasing rate of CH_4 emission is slower in comparison with landfill gas emission. Emission rate of contaminant gases like CH_4 and CO_2 in presence of landfill gas-to-energy technologies such as IC engine, gas turbine and steam turbine in next 30 years were calculated. It is predicted that maximum volume of controlled CH_4 will be 0.85 Mkg in 2015. After 30 years this mass will be decreased approximately up to 0.3 Mkg. Incomplete combustion in each of CH_4 molecules after combusting in gas-to-energy facilities will be altered to 1 CO_2 molecule and 2 H_2O molecules. So the emission of CO_2 in state of using gas controlling technology will become more than emission of uncontrolled CO_2 . Emission rate of uncontrolled CH_4 is approximately 6 times more than emission rate of CH_4 in presence of landfill gas-to-energy facilities. The emission rate of CO_2 in state of using landfill gas-to-

energy facilities are 1.85 times more than emission rate of uncontrolled CO₂. This increase is the result of altering CH₄ into CO₂ in state of using landfill gas-to-energy facilities. Controlled CH₄ emission rate is 0.15 of uncontrolled CH₄ emission rate. Considering that CH₄ global warming effects is approximately 25% more than CO₂, it can be concluded that using landfill gas-to-energy has a significant impact on reducing global warming.

Conclusion

It is predicted and estimated that maximum methane and carbon dioxide emitted from Aradkooh landfill will be approximately 6 and 16 Mkg in 2015 and minimum mass of methane and carbon dioxide emission will be 0.3 and 0.8Mkg after 30 years in 2044. Total gas emission in 30 years will be 213 Mm³. %27 of total mass of landfill gas is methane and %73 of total emitted gas from landfill is carbon dioxide. Using landfill gas-to-energy technologies causes SO₂ emission. The amount of SO₂ emitted from Aradkooh landfill will be approximately 361 kg in 30 years.

Keywords: biogas, energy, greenhouse gas, waste.

Reduction of Greenhouse Gases Emission and Production of Potable Water and Valuable Salts through Power Plants' Stacks

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Abstract

The goal of this research is simulating an optimum reactor to eliminate greenhouse gases, mainly CO₂, through combined cycle in stacks of power plant, using a strong base (sodium hydroxide) thinned by water. During this process sodium bicarbonate salt is generated together with water and the produced salty water is desalinated and its useful salts are also extracted. Four scenarios have been considered which are simulated by ASPEN PLUS and HYSYS softwares. By using scenario A as an optimum scenario simulated by ASPEN PLUS, the amount of existing water and existing CO₂ in the exhaust of the Rudeshour power plant's stack have decreased from 102.780 to 36.642 tons/hr and from 116.430 to 5.3×10^{-10} tons/hr in the reactor's output to be released into the atmosphere, respectively. The amount of water in exiting salty water flow from the bottom of the reactor equals to 1115.280 tons/hr. The amount of produced salt which is a mixture of carbonate, bicarbonate and sodium hydroxide salts also equals to 406.365 tons/hr.

Introduction

Combustion of fossil fuels in power plants is one of the most important sources of air pollution and greenhouse gases such as carbon dioxide. The goal of this research is simulating an optimum reactor to eliminate greenhouse gases, mainly CO₂, through Rudeshour combined cycle power plant's stacks, using a strong base (sodium hydroxide) thinned by water. During this process sodium bicarbonate salt is generated together with water and the produced salty water is desalinated and its useful salts are also extracted.

Material and Methods

Four scenarios have been considered which are simulated by ASPEN PLUS and HYSYS software in order to eliminate and minimize the greenhouse gases in Rudeshour power plant. Using ASPEN PLUS software, on the whole, three scenarios were considered to compare and choose an optimum reactor in all purifying dimensions for the exhaust from the stack and recycling salt and water. One more simulation of the absorption tower was also created by HYSYS software in order to reduce greenhouse gases. Scenarios A, B and C were simulated by ASPEN PLUS software. Choosing a proper thermodynamic equation is the main step in simulation. The amount of the electrolytes can be controlled by equilibrium constants and estimating the amount of produced salts. Furthermore, kinetic data of reactants should be added, too.

In scenario A, reactants start the reaction in flash drum containers. The reactor exhausts contain clean gas that is ready to be released to the atmosphere and thick salty water as a result of a reaction between the acid gases and injected bases. Then, the produced water flow enters the cycle and the existing salty water is desalinated via membranous or thermal method. A make-up water flow is considered to compensate the probable base flow in the cycle. A schematic plan of simulated reactor with recycling salt and water from the cycle in Rudeshour power plant is shown in fig. 1.

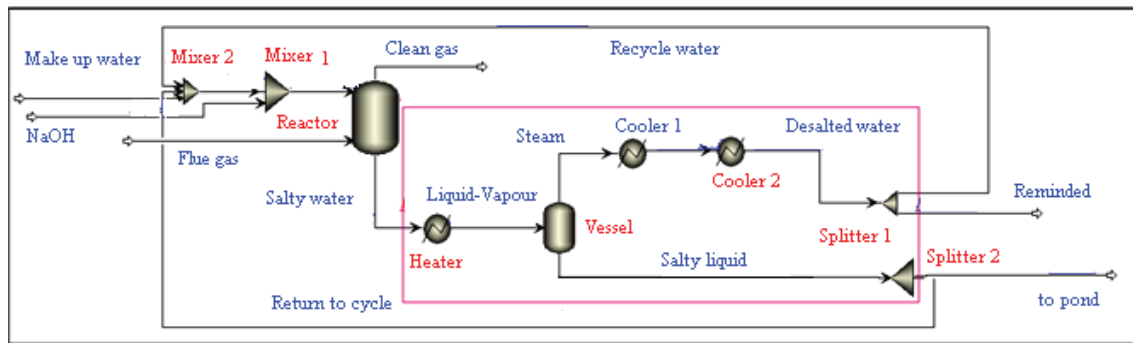


Fig. 1. A schematic plan of simulated reactor with recycling salt and water from the cycle in Rudeshour power plant (scenario A)

In scenario B (Fig. 2), instead of continual circulation of water in the cycle, water is segmented in the reactor and then it enters the evaporating pond and drinking water enters the system instead. All features of gas flow, considered base flow and also the used equipment in the cycle, are the same as those of scenario A, except for the mass of extra water flow.

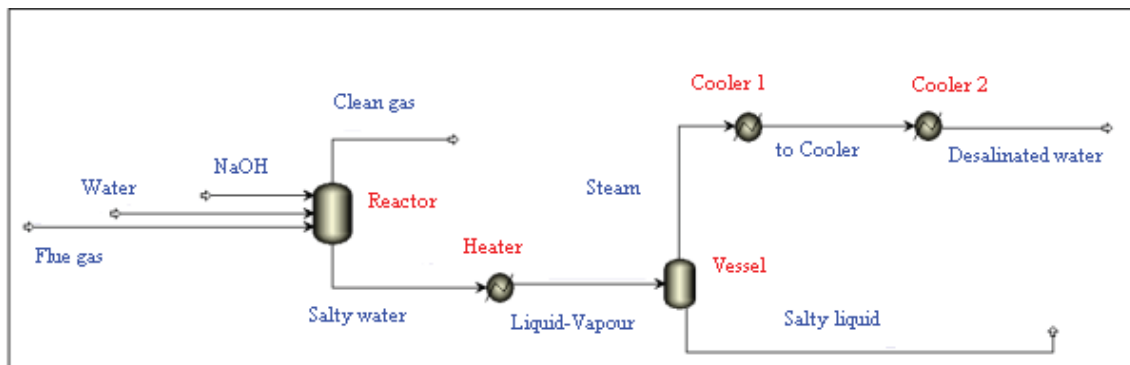


Fig. 2. A schematic plan of simulated reactor with injecting the water to the cycle and recycling salt and water in Rudeshour power plant (scenario B)

In scenario C, the flow of flue gas exiting from the power plant stack enters a thermal converter. Then, the exhaust flow of liquid – gas enters the first reactor. The steam flow and the base flow enter the second reactor. After an acid – base reaction, two flows exit the reactor; one is the clean gas flow exiting from the upper part and the other is the salty water from the bottom. A schematic plan of using two reactors with recycling salt and water in the simulated cycle of Rudeshour power plant is shown in figure 3.

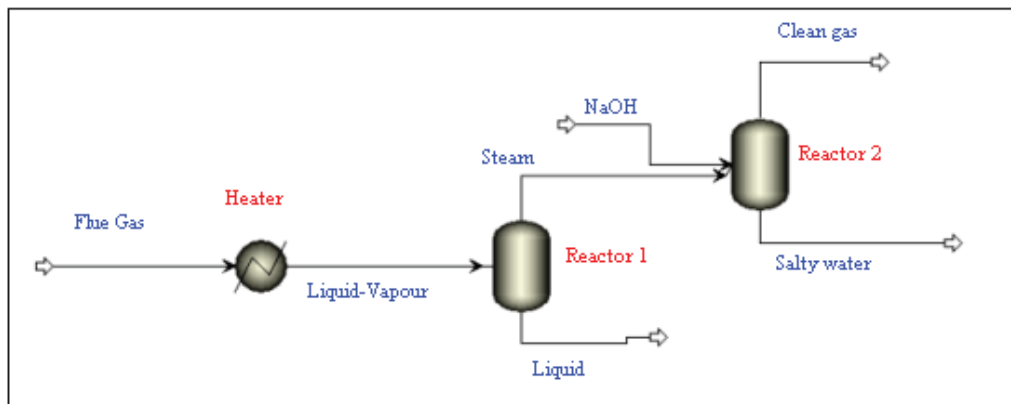


Fig. 3. A schematic plan of using two reactors with recycling salt and water in the simulated cycle of Rudeshour power plant (scenario C)

Scenario D simulated by HYSYS software, is the simulation of the absorption tower in order to reduce the greenhouse gases. Almost all input data in HYSYS is similar to that of ASPEN PLUS, except for some little

differences in equipment and equations. However, the output is designed in completely different flow sheets. The flue gas flow and the absorbent substance of Diglycolamine enter the absorption tower and start reacting on the stages. The produced two exhausts can be referred to as a clean gas flow in the upper part and Rich flow in the bottom of the tower.

Result and Discussion

In scenario A the amount of existing water in the exhaust of the Rudeshour power plant's stack has decreased from 102.780 to 36.642 tons/hr in the reactor's output to be released to the atmosphere. The amount of water in exiting salty water flow from the bottom of the reactor equals to 1115.280 tons/hr. The amount of produced salt which is a mixture of carbonate, bicarbonates and sodium hydroxide salts also equals to 406.365 tons/hr. The amount of existing CO₂ in the exhaust of the Rudeshour power plant stack has decreased from 116.430 to 5.3×10^{-10} tons/hr in the reactor's output to be released into the atmosphere.

In scenario B, the amount of existing water in the exhaust of Rudeshour power plant stack has increased from 102.780 to 136.970 tons/hr in the reactor's output to be released to the atmosphere. The amount of water in the exiting salty water flow from the bottom of the reactor equals to 2033.467 tons/hr. The amount of produced salts also equals to 408.8 tons/hr. The amount of existing CO₂ in the exhaust of Rudeshour power plant stack has decreased from 116.430 to 2.840×10^{-8} tons/hr in the reactor's output to be released into the atmosphere.

In scenario C the results shows that the amount of the existing water in the exhaust of Rudeshour power plant stack has decreased from 102.780 to 65.049 tons/hr in the reactor's output to be released to the atmosphere. The amount of water in the exiting salty water flow from the bottom of the reactor equals to 1085.829 tons/hr. The amount of produced salts also equals to 398.345 tons/hr. The amount of existing CO₂ in the exhaust of Rudeshour power plant stack has decreased from 116.430 to 1.655×10^{-9} tons/h in the reactor's output to be released into the atmosphere.

Results in scenario D shows that the amount of existing water in the exhaust of Rudeshour power plant stack has decreased from 102.780 to 91.544 tons/h in the reactor's output to be released to the atmosphere. The amount of the existing CO₂ in the exhaust of Rudeshour power plant stack has decreased from 116.430 to 9.821 tons/hr in the reactor's output to be released into the atmosphere. No salt has been produced in this scenario and the Amine flow should be refined at the end of the route and returned to the cycle.

Conclusion

In scenario A, as an optimum scenario, the amount of water in the exhaust gas of the reactor to be released in the atmosphere would be reduced to 10^{-8} tons/hr. The reactor also is capable of minimizing the amount of CO₂ to 10^{-13} times in comparison to the existing carbon dioxide in the exhaust of Rudeshour power plant's stack. The amount of produced salt, which is a mixture of carbonate, bicarbonates and sodium hydroxide salts, is equal to 406.365 tons/hr. The desalinated water in this process can be used in agricultural or potable cases or it can be reused in the cycle. The sodium bicarbonate salt can also be offered to various industries after being refined and purified.

Keywords: CO₂, greenhouse gases, reactor, thermal power plant, water and salt.

An Investigation on Soil Lead Pollution due to Vehicle Traffic in Ghamishlu Refuge

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Abstract

Lead as non-essential metal, is known the source of toxicity and impacts on the environment and humans. The goal of recent paper is to determine the Pb concentration of road and road margin dust of Ghamishlu wildlife refuge in Isfahan province with an area about 120,000 hectares surrounded by four main roads. Traffic load in the southern freeway have been reported as about 3600-19000 cars/day. 12 road dust and 72 soil samples (0-5 cm in depth) were collected from transects of the road in distances of 3, 20 and 50m. The sample Lead was extracted according to ISO11466 international standard procedure and analyzed with flame AAS. Pb concentrations of road dust were measured in range of 800.17 ± 109.28 and 582.28 ± 71.28 mg/kg for area with heavy and low traffic load, respectively. In addition, The result of ANOVA shows there is significant difference between Pb concentration of area with high and low traffic loads ($P=0.005$). The rate of mean Pb concentrations of the high to low traffic loads was calculated about 1.37, 1.97, 1.42 and 1.40 for distance of 3, 20 and 50m from the road, respectively. The results shows vehicle transit is the main source of road Pb pollution in the road and its margins. The results indicate Pb concentration decreases significantly with increasing distance from road center. The results show significant difference between road dust and 20m distance from road margin and lead concentration doesn't change significantly far away 20m from road center. Two indices entitled Index of Geo-accumulation and Pollution Index were applied for classifying pollution in recent study. The result of lead road dust indices detects high intensity pollution, and the soil in three meter distance of road margin has non to moderate pollution. I_{poll} detects significant difference compared with I_{geo} in margins ($P=0.00$). More than 22.4% of studied points have high anthropogenic pollution values (at about 75 to 100% of total concentration).

Introduction

Fuel combustion is the major source of environmental pollution. Motor vehicles release trace elements and heavy metals in urban areas. Lead as solid particles exits from exhaust and other parts of the vehicles and settles on the road and margins. Lead is an unessential metal which has the most damaging effects such as renal and liver disorders, anemia, men and women infertility, diminished learning abilities, hyperactivity and aggressive behavior of children. Goal of the present paper is to determine the Pb concentration of road and road margin of Ghamishlu refuge in Isfahan province.

Materials and methods

Study area

Ghamishlu wildlife refuge is located in 45km far from eastern north of Isfahan. Ghamishlu with an area of about 120,000 ha surrounded with four main roads including Isfahan-Tehran highway in the east, Najafabad-Tiran in the south, Dehagh - Alavijeh in the west and Alavijeh industrial park in the north of Ghamishlu refuge.



Fig. 1. Location of Ghamishlu wildlife refuge

Research Method

Soil samples were taken from 12 linear cross sections with three point samples perpendicular to the road. 12 road dust and 72 soil samples (0-5 cm in depth) were collected from cross sections, perpendicular to the road in distance of 3, 20 and 50m. The samples were prepared to be analyzed by International Standard ISO 11466. At first, approximately 3 g of sieved and oven-dried soil sample was weighted and was added to the nearest 0.001 g of the subsample into the 250 ml reaction vessel moistened with about 0.5 ml to 1.0 ml of water and 21 ml of hydrochloric acid followed by 7 ml of nitric acid drop by drop while mixing, if necessary, to reduce foaming. The absorption vessel and condenser were connected to the reaction vessel allowed to stand for 16 h at room temperature to allow for slow oxidation of the organic matter in the soil. Lead concentration was measured with Atomic Absorption Spectrophotometry, model *Analytic jena-350*. Data was analyzed with SPSS 16. Lead concentration of road and margin with low and heavy traffic were compared with ANOVA method. Geo-accumulation index (I_{geo}) and pollution Index (I_{poll}) were calculated (equation 1 and 2) to show the pollution intensity (Muller, 1979).

$$I_{poll} = \log_2 \left(\frac{C_n}{B_n} \right) \quad (1)$$

$$I_{geo} = \log_2 \left(\frac{C_n}{1.5B_n} \right) \quad (2)$$

Where, I_{geo} is geoaccumulation index, C_n is measured lead concentration (mg/kg), B_n is Background lead concentration due to geogenesis.

Results

-Comparison of Pb concentration between heavy and low traffic flow

Pb concentration was measured in range of 800.17 ± 109.28 and 582.28 ± 71.28 mg/kg for heavy and low traffic flow, respectively. The result of ANOVA shows the significant difference between Pb concentration of the road with heavy and low traffic flow ($P=0.005$). Mean Pb concentration is high in point samples no 1, 2, 7, 8, 9, 10, 11 and 12 in heavy traffic flow of Isfahan-Tehran highway and Tiran-Najafabad and low in point samples of 3, 4, 5 and 6 which were sampled in low density traffic roads (Fig. 1). Generally, pb concentration in dust and margin of heavy traffic roads is higher than that of lower density ones.

-Comparison between road dust and marginal soil

Comparing Pb concentration of dust and marginal soil detects significant difference by applying Kruskal-Wallis analysis method ($P=0.029$). Table 1 shows descriptive statistics of Pb concentration of the road dust and soil of road margin. There isn't significant difference between on-site and off-site of marginal soil (3, 29, and 50 m) of Ghamishlu wildlife refuge. The result shows that Pb concentration decreases significantly with increase of distance from road center to margin sampling points.

Table 1. comparison of the Pb concentration range of samples

Sample	No of sample	Pb concentration (mg/kg)		
Dust (total)	12	$720.21 \pm 139.59^{\dagger}$	908.58	519.28
3m road margin	23	109.28 ± 68.14^b	326.00	59.26
20m road margin	24	84.37 ± 49.67^c	284.57	47.53
50m road margin	24	82.75 ± 53.54^c	314.87	47.60

† The same letter means no significant difference.

Index of Geo-accumulation

The least measured pb concentration (47.53 mg/kg) was considered as the background lead concentration due to geogenesis. Analyzing the index indicates that road dust is classified as highly polluted and 3-meter marginal soil is classified as not polluted to semi polluted (Figure 2). Of course, with increase distance from the road, I_{geo} decreases significantly.

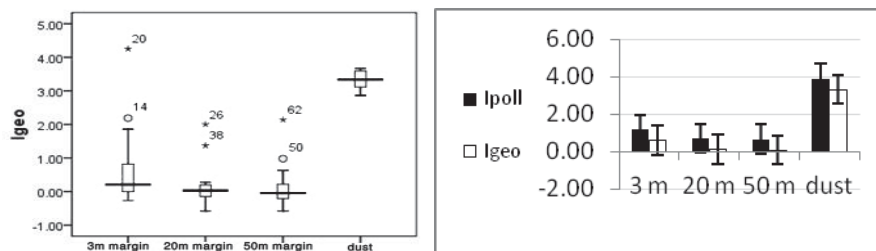


Fig 2. I_{geo} and I_{poll} range in road dust and margin

According to Fig.2, anthropogenic pollution is classified at least one class higher than geogenesis pollution. 3-meter, 20-m and 50-m marginal soils are classified as moderat, not to moderate polluted and not polluted, respectively.

Ipoll

The results showed that manmade pollution of lead contamination in 22.4% of the points allocated to 75-100% of the pollution (Fig.3).

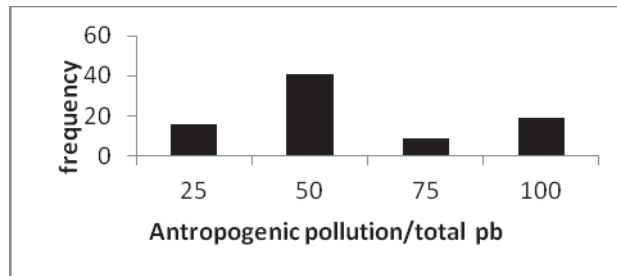


Fig 3. Manmade pollution relative abundance of total lead contamination

Discussion and conclusion

The lead resulted from fuel consumption is the main source of environmental pollution. Lead as solid particles exits from exhaust and other parts of the vehicles and settles on the road and margins. The study area is surrounded by four main roads. Isfahan-Tehran and Najafabad-Tiran roads have heavy traffic and it is lower in Dehagh-Alavijeh and the north road traffic density. Measuring lead in the present study indicates the role of traffic in increasing the amount of lead in Ghamishlu area. The mean ratio of pb concentration of the road dust in heavy and low traffic roads in 3, 20, and 50 meters are 1.37, 1.97, 1.42, and 1.40 respectively. That's why traffic is considered as the major source of lead in the area. Road is considered as the basic source of emission to the surrounding environment and its pollution is up to 7 times as much as the margins. The results are in line with the results from Ordons, Rahmani, and Kheiri comparing pb concentration in road dust and also in margins and significant reduction of concentration show the same result.

The results indicate the significant effect of the road to 20 meter distance on the margins while the results for 20 and 50 -meter distances are not significant that approve the results from Taebi and Rahmani. Two indices entitled Igeo and PI were applied for classifying pollution in recent study. Because of the similarity of mathematical basic formulas of the two indices, their classifications aren't different. The Igeo is very efficient as the criteria for classifying the lead pollution in soil and dust of the margins. In this case, road dust is classified as high class and after that, 3-meter margin is classified as medium and 20-meter and 50- meter margins are not polluted to semi polluted. This results are in line with the results from Feiz. We hope that the amount of lead will be reduced in the margins of the roads regarding that using lead -free fuel has been preferred in Iran Environmental Protection Organization as well as changes in political.

Keyword: dust, geo-accumulation index, Ghamishlu refuge, lead, pollution index.

Effect of Zero-Valent Iron Nanoparticles on VOCs Removal from Air with a Modified Zeolite Bed

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Abstract

Volatile organic compounds (VOCs) are in categories of mankind and environmentally harmful materials. Some of VOCs are also carcinogenic and mutagen. Because of expanded application of these compounds as various domestic and industrial usages, prevention of environmental contamination of these compounds is a substantial issue. In this study, the effect of zero-valent iron nanoparticles application on a natural zeolite media, for VOCs removal efficiency was surveyed.

The Clinoptilolite zeolite after acidic amendment was used as a bed and coated with zero-valent iron nanoparticles. The particles were in size of 30-60 nm. The BTX compounds including Benzene, Toluene and Xylenes were applied as indices for VOCs pollutants. The obtained results showed a significant difference in removal of the pollutants whether by use of iron nanoparticles or not ($P=0.008$). The average removal efficiency without iron nanoparticles application was $43.31\pm 24.84\%$, and by application of the nanoparticles it was $83.83\pm 1.3\%$. Application of iron nanoparticles caused more complete decomposition of the pollutants up to 57.82%. According to the results, iron nanoparticles increased the VOCs removal efficiency of the zeolite and led to decomposing more amounts of pollutants in a unit volume of the zeolite. The amount of pollutants which completely decomposed to CO_2 is also increased.

Introduction

Volatile organic compounds (VOCs) are widely used in petrochemical products. The BTX are VOCs, including Benzene, Toluene and Xylene, which have harmful health effects such as anemia and carcinogenesis. The absorption properties of natural zeolites such as Clinoptilolite for VOCs are mentioned in various studies. The pervious researches declared also the increasing of transition metals oxidation- reduction property in nanoscales and decomposition of various compounds catalyzed by the transition metal, with this scales of size. Complete decomposition of VOCs will led to production of CO_2 and H_2O which is said mineralization. If the mineralization is not done properly, some organic intermediate compounds will be produced. In this study, we surveyed the effect of coating the natural zeolite, Clinoptilolite, with zero-valent iron nanoparticles in BTX removal from polluted air and its mineralization.

Material & Methods

1-2 mm diametric size zeolite grains were washed two times by 0.1N hydrochloric acid. Each washing operation took up to 6 hours to complete. It, then, rinsed several times with distilled water and dried at 180 °C. The zero-valent iron nanoparticles were dispersed in distilled water by an ultrasonic set during 5 minutes and added to zeolite grains in a flask and was shaken for 24 hours and then gently dried at 80 °C. The nanoparticles coated zeolites were placed in a furnace for 2 hours in 300°C for activation. The porosity and blank volume in zeolite were determined by water saturation test. A steel cylinder ($D=4.5$, $L=30$ cm) was used as reactor. The prepared zeolite was placed in the cylinder with the amount of as much as 200 g in each experiment. Polluted air with BTX was crossed through the reactor, and the pollutants concentration was measured in inflow and outflow. The air flow was 1.5 l/min, the sampling flow was 100 ml/min and sample volume was 2 l. Temperature of the reactor was set at 200 °C during the experiment. The BTX sampling was carried out by using the charcoal tube that was extracted by CS_2 as a solvent. The samples were analyzed by a GC-FID. CO_2 concentrations were measured with CO_2 detectors and 100 ml sample as the detectors' instruction. All of the reagents used in this work were in lab grade.

Discussion of Results and Conclusions

The results declared that 93.94% of the applied nanoparticles were coated on zeolite grains, and it was 4.69 wt% of zeolite. Fig. 1 shows the zeolite grains with nanoparticles coating and without it.

The blank volume in nanoparticles coated zeolites (CZ) was 50.66% vs 51.34% for the not coated (Z). For 200 grams of each zeolite they were 231.84 and 235.86 ml, respectively. So, the retention times were 4.67s and 4.84s and the difference was negligible. The mean pollutants' elimination efficiency for the CZ was 83.83% vs 43.31% in Z. In table 1, the results of the removal process experiment are given in more details. The ANOVA test on these data showed a significant difference in pollutants' removal by the CZ and Z (p-value= 0.008). The CO₂ concentrations in inflow were the same, 500 ppm, but the outflow of CZ has higher concentration of CO₂. It was 625 ppm for CZ vs 525 ppm for Z. According to CO₂

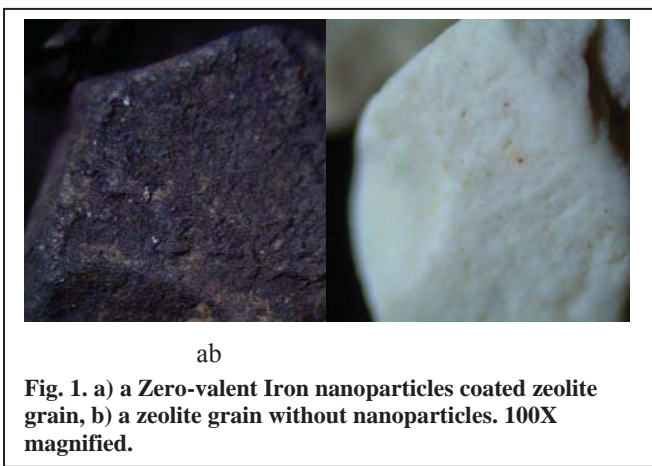


Fig. 1. a) a Zero-valent Iron nanoparticles coated zeolite grain, b) a zeolite grain without nanoparticles. 100X magnified.

concentrations and concentration of pollutants in inflow and outflow with regard to an air flow of 1.5 l/min during the experiments, the percent of pollutants mass which completely decomposed to CO₂ are calculated and are presented in Fig. 2. The standard deviation of pollutants' elimination in CZ is 1.31 whereas in Z it is 24.84. This reveals that, the elimination of pollutants in CZ is much against that for Z. These high and close pollutants' removal efficiencies in CZ cause it to be more reliable for elimination of different VOCs. Increased concentration of CO₂ in exhaust of CZ shows that the complete decomposition of the BTX in this one was higher than Z. Incomplete decomposition of the BTX may lead to some other organic compounds like Oxyphenyls or Formic, Oxalic and acetic acid or other organic compounds.

In Cz, with presence of zero-valent iron nanoparticles as reductants, the redox process can act more effectively in decomposition of the pollutants. The Fe⁰ atoms can donate electrons to reduction of the pollutants. This electron donation with presence of water vapor and heat can also result in production of OH[•] and H[•] radicals. Zhang in removal of VOCs by iron nanoparticles showed that, the iron nanoparticles by giving to electrons were converted into Fe²⁺. More oxidation of the Iron nanoparticles will produce Fe³⁺ that in presence of oxygen it makes Fe₂O₃ or Hematite. Combined application of zero-valent iron and copper oxide nanoparticles on a zeolite bed for BTX removal showed a complete decomposition up to 82.78% and average BTX removal of 56.98%. This is higher than that for the iron nanoparticles. However, the average BTX removal efficiency for the iron nanoparticles is higher. In another study, coating the zeolite with copper oxide nanoparticles decreased the BTX removal efficiency but it led to a little increasing of complete decomposition. According to these results, coating with nanoparticles decreased the pollution adsorption. The results of this study showed that the zero-valent iron nanoparticles have more ability for BTX removal and complete decomposition rather than copper oxide. In a study, TiO₂ nanoparticles on a bed of SiO₂ were applied for elimination of VOCs. The results of the study showed that the Toluene as an index of VOCs was eliminated by adsorption and catalytic decomposition processes. In the outflow, there were toluene, CO₂ and water vapor which are results of organic compounds' decomposition. Therefore, we can say that, in our work, the pollutants can be removed by those processes and the nanoparticles acted as the catalyst in pollutants' decomposition process and as excess CO₂ concentration of its outflow can prove the matter, in the CZ. So, according to the above discussions adsorption was the main mechanism of pollutants' removal in Z. But, in the CZ the main removal process was catalytic oxidation that could eliminate the pollutants with a similar rate where the adsorption did not show the same results.

Table 1. removal efficiency of Benzene, Toluene and Xylenes in a Zero-Valent Iron nanoparticles coated zeolite filter and a zeolite filter without nanoparticles coating.

	Benzene	Toluene	p-Xylene	m-Xylene	o-Xylene
Zeolite without nanoparticles coating	87.3±5.37	62.1±3.25	30.2±1.84	32.15±3.39	18.8±3.39
Zeolite with zero-valent Iron nanoparticles coating	82.54±4.3	83.89±1.99	83.14±0.91	83.61±0.58	85.99±1.68

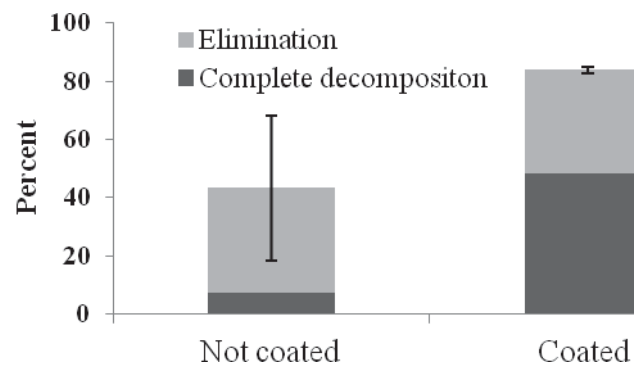


Fig. 2. Elimination and complete decomposition percent of BTX in Zero-valent Iron nanoparticles coated zeolite and the zeolite without coating.

Keywords: air pollution, Benzene, Toluene, VOCs, Xylene.

An Evaluation about the Role of Microorganisms Isolated from the Soil in the Biological Removal of Toxic Petroleum Pollutants

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Abstract

Polycyclic aromatic hydrocarbons (PAHs) such as anthracene, naphthalene, and phenanthren are the most toxic and carcinogenic pollutants which cause severe damages on soil and water resources. In order to remove these materials, biological methods and using potential of local microorganisms of oil contaminated soils are preferred because of cheapness and availability. Existing soil microorganisms use these hydrocarbons as carbon and energy and finally produce water, CO₂, biomass, and harmless material sources. In the present study, the sampling was conducted from different points in soil of Tabriz and oil-polluted soils from oil materials of Tabriz refinery. The samples were cultured microbial in YGM and starch case in agar. About 100 microbial colonies and isolations were obtained. 1000 mg/l of anthracene hydrocarbons were obtained in Muller Hilton broth, and then fixed amounts of these bacteria were added separately. They were treated and incubated by shaker in 130 RPM, at 28°C for one week. The rate of mentioned hydrocarbons' destruction was evaluated by the spectrophotometer that determined reliability of primary aromatic compounds by TLC method. Up to 90 anthracene reducing bacteria were isolated that their destroying rates were 3.4-82.6%. Some samples from secondary metabolites of each hydrocarbon which had the most destroying percentage were under GC-Mass analysis in order to be identified. Then, some toxic-free mediatory substances were obtained because of anthracene biological reduction. By improving the growth and proliferation of effective bacteria and identifying obtained metabolites, it can be possible to clear polluted spoils from PAHSs and to produce useful metabolites and other harmless materials in semi-industrial and practical pilots.

Introduction

Polycyclic aromatic hydrocarbons (PAHs) are composed of two or more rings of six members. These rings bind to each other by sharing a pair of carbon atoms among rings. Aromatic hydrocarbons are among oil-pollutants which enter water and soil ecosystems by different sources like petrochemical, industrial and household sewages, oil exploitation, pharmaceuticals, colour, plastic, insecticide. They can transmit to human being directly so cause some problems such as cancer. Anthracene (C₁₄H₁₀) is toxic and carcinogenic material. Its polluting rate in the air is 0.02 mg/l. The main ways of absorption of Aromatic hydrocarbons in human body are inhalation and skin. The rate of its toxicity depends on its physicochemical compounds, natural toxicity, metabolites, and clinical medicines. The target organs for aromatic compounds are nervous system, liver, kidneys, skin, lungs, mucous membrane of the respiratory tract, and eyes. Crude oil, with 340 products, is one the most important energy source and worldwide economical power. Some bacteria and microorganisms can cause oil material reduction in soil. Bioremediation is one of the main ways for environmental clearance. In this method living creature specially bacteria, fungi and plants are used in order to reduce environmental contaminants as well as to change them into nontoxic compounds.

Various microorganisms have a role in this process, the most important of which are *bacillus- pseudomonas- proteus- cloestridium- staphylococcus- acinetobacter- mycobacterium- rhodococcus- micrococcus*. No

microorganism, essentially, is able to reduce completely the oil- hydrocarbons to carbon dioxide and water as final products. The aim of the present study is at evaluating the ability of soil-isolated organisms from different regions of Tabriz to reduce phenanthrene, anthracene as a polycyclic aromatic hydrocarbon.

Materials and Methods

Soil in different region of Tabriz and outside as well as contaminated soil of Tabriz refinery were sampled in order to isolate effective bacteria. Followings prepare concentrations of 10^{-1} to 10^{-4} from samples in physiologic serum, 100 μ l of concentrations was cultured in a plate containing starch casein agar and incubated at 28°C for a week. Then, grown colonies were fixed according to the incubation condition in yeast glucose malt agar for fortification and purification. 25 mg of pure anthracene was weighted and added to 25 ml Muller Hilton broth in capped Falcon tubes in sterile condition. Then, a suspension equal to 05-Mac Farland standard was obtained from purred bacteria in Tryptic Soy Broth; then, 0.5 ml of the suspension was added to Falcon tubes. Falcon tubes were fixed in a shaker incubator at 28°C and 130rpm in one week to reduce anthracene by bacteria .

After the mentioned period, contains of Falcon tubes was transferred to a 100 ml decantation funnel in a sterile condition. Organic solvent of toluene was used in order to isolate the remaining anthracene. Two phases were formed by adding 10cc toluene to the funnel with mixing it. Lower phase is consisted of culture medium and bacteria, and upper phase consisted of remained toluene and metabolite . The upper phase was collected in a capped bottle and was kept in a refrigerator at 4°C until the rate of OD is read. In order to evaluate OD at first anthracene λ_{max} must be determined. For this purpose, various concentration standards in toluene were obtained and their OD was determined using a double beam spectrophotometer (made by Shimadzu, Japan) compared with blank solution and λ_{max} was determined. Then, the samples of OD were evaluated at this wavelength. Considering the drawn curve, the rate of anthracene reduction in different samples was observed . The percentage of anthracene destruction of bacteria was calculated by the following relationship: Destruction

$$\text{percentage} = \frac{A_1 - A_2}{A_1} \times 100$$

A_1 : anthracene absorption before destruction

A_2 : anthracene absorption after destruction by microorganism

Results

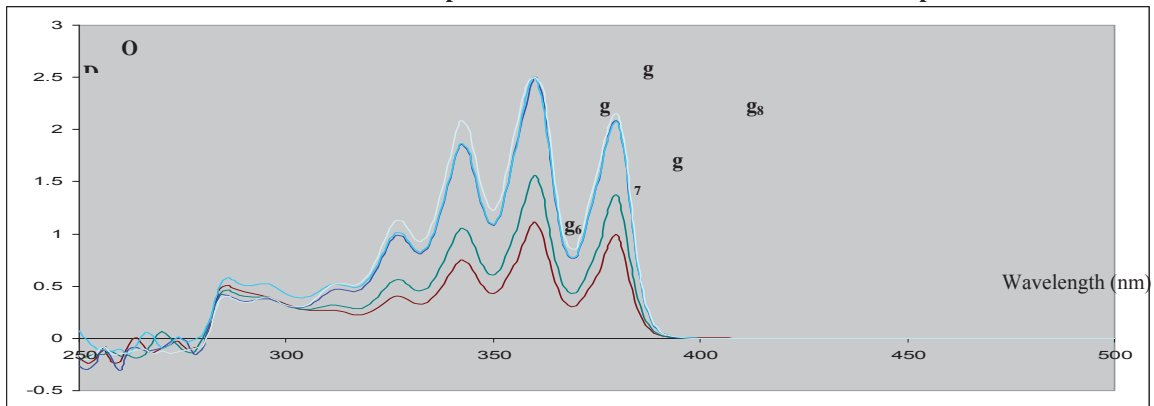
100 stubs of purred bacteria were obtained in order to culture different soils. 14 microbial stubs associated to the Tabriz refinery with the codes of g_1 to g_{14} , and 86 isolated stubs are from different regions of Tabriz. 90 bacterial stubs had the ability to reduce and destruct anthracene in in-vitro condition following treatment of the isolated bacteria. λ_{max} was determined 360nm by measuring anthracene standard OD against blank solution in 250-500nm wavelength. Absorbed spectra by samples in wavelength of 360nm were recorded following the treatment of specific amounts of anthracene with different bacteria and exploitation of remaining anthracene (curve 1). The percentage of anthracene destruction in different microorganisms was obtained by $\frac{A_1 - A_2}{A_1} \times 100$. Findings suggest that different destruction percentages of 3.4 to 82.6 have primary anthracene.

Discussion

Bioremediation is a natural process by which pollutants are recycled rather than burying. Furthermore, from the public point of view, bioremediation is more desirable and in most of the world organizations are disseminated by this method for remediation of damaged regions using environmental contaminants. One of the best bioremediations is biologic method and using microorganisms. Bacteria have the most importance compared with other microorganisms because of their different reductive enzymes. Considering the results of the present study and other conducted studies, soil bacteria, more or less, have the potential of reduction and destruction of polycyclic aromatic hydrocarbons. In the present study, stable hydrocarbons with high toxicity were used and it was observed that from 100 isolated stubs only 90 bacteria had the destruction power between 3.4 – 82.6% and among them, 12 stubs had over 50% destruction power. In the present study, also, polluted soil bacteria of Tabriz refinery were used that 14 stubs of bacteria were isolated. By evaluating their results about the destruction of hydrocarbons this destructive potential of polluted soil bacteria can easily be understood.

Using micro organisms as an inoculation is the main consideration in purifying the polluted soils with oil substances; because 1. They are able to degrade hydrocarbons, 2. They are durable and adaptable to environment; 3. They are able to compete with endogen microorganisms; 4. Most of them are not pathogen. Therefore, several studies are conducted based on isolation and evaluation of capabilities of environmental microorganisms.

Curve 1. absorbed spectra associated with anthracene treated samples.



$$g_{10}=2.5, g_9=2.5, g_8=2.5, g_7=1.566, g_6=1.118$$

Keywords: aromatic toxins, bioremediation, soil contamination, soil microorganisms.

Health, Safety and Environment Management in Urban Parks

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Abstract

Because of the importance of health, safety and environment (HSE) issues in urban parks, this paper is organized in the form of integrated management of health, safety and environmental assessment in urban parks of 6th district of Tehran. Assessment of HSE in urban parks provide quality of their field and positive experiences to the next., Based on the results of the expectations of citizens and municipal services in planning of Quality Function Deployment (QFD) methodology and comparison with the results of analysis on existing parks models are developed to assess the status of HSE, especially in dealing with urban parks. Indicators for classification of citizens voice, output of the AHP methodology and indicators of classification concerns about the municipal parks and green spaces has been outputs of Delphi survey method.

The measurements from the questionnaire that obtain views of citizens about the status of HSE in the 6th district of Tehran parks have been statistically analyzed using software. The results indicate that the desirability of health measures in parks under study was 48.2 %, the safety indicators about 52/9%, and most of the environmental indicators of desirability was 42/4%. The indicators of trash in the park, manuals and warning signs of surface water and sewage disposal in three sectors of health, safety and environment was, respectively, 32/8%, 36/2% and 26/7%, to have the lowest utility.

Introduction

In recent years, health, safety and environmental management systems are discussed as a management tool to control and improve matters in most environmental studies. This system will study simultaneously three factors of health, safety and environment. This attempts to create a healthy, pleasant and happy environment free of accident, damage or injury. This system is not limited to a certain horizon. Parks with various functions, operations and activities in urban areas are considered to be a kind of social work that a high population with different cultural, economic, social, health and traffic conditions will visit these places. Thus, there is possibility of spreading disease in these places. Therefore, it is important to consider safety issues and environmental pollution in the design, development and maintenance of urban parks. The purpose of this study is to provide a unique model for assessing the status of health, safety and environmental management in urban parks and principal components of health, safety and environmental issues in urban parks and the status of management in improving the situation.

Materials and methods

In this study, for as sampling of parks in the 6th district of Tehran, two parks of "Shafagh" and "Ghezel Ghale" in the scale of neighborhood parks, and two parks of "Sae" and "Laleh" in regional scale were selected. To access citizens' expectations and concerns related to the service in the parks and green spaces in District 6 of Tehran Municipality, the QFD method was used. Considering the diverse applications of this method, the QFD method was used in this study for municipal services for citizens in urban planning of urban parks. Thus, the citizens of this study are assumed to be identical. In this way, the desired characteristics of the citizens are asked to provide input for QFD matrix. The health, safety and environmental elements of the citizens in urban parks were to be collected. In the QFD method the priority categories of citizens in classification of surveys are

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performed. Citizens' voice for classification and considerations related to the service provider will be classified. Thereafter, the two units are connected and the QFD method is called in the HOQ. After that, a comparison indicator based on the nature of the extracted components of health, safety and environment was selected based on the fact that the nature of which indicators is closer to the priorities in the park. Matching criteria obtained with the situational analysis of the park offers the HSE assessment of the urban park. In this model, the implementation of existing standards was studied through some of the examples witnessed in the parks. Based on this model, a questionnaire was compiled. Surveys monitoring the quality of the park are in direct contact with the audience. The population was selected so that different age and gender groups of park users are included. The higher the level of credibility, the better the citizen voice classification indicators derived from the output of the AHP. In fact, the Delphi survey method was used among all of the parks in a group of volunteer parents.

The AHP survey method and classification indicators with the considerations related to the 6th district of Tehran Municipality's parks and green spaces were used to help get the output.

Results

The results of the health, safety and environmental assessment indicators based on specific models that measure the general state of health and safety of the parks showed that there were moderate and weak environmental indicators in the parks under study. The desirability of the health measure in the parks was 48.2% and less than the utility of the safety indicators with 52.9%, and most of the environmental indicators of desirability, with 42.4% (Figure 1, 2, 3). Other results indicate that the indicator of trash in parks, state manuals and warning signs, and the disposal of surface water and sewage, respectively, in three sectors of health, safety and environment were 32.8%, 36.2% and 26.7%, in case of having the lowest level of utility.

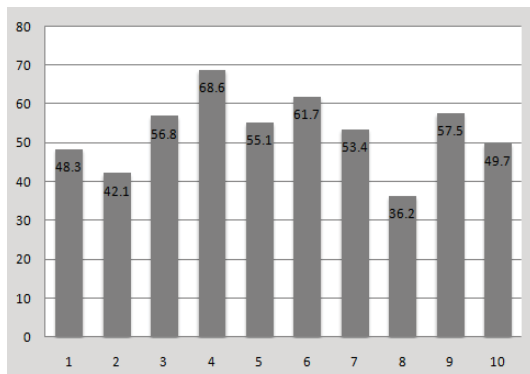


Figure 1. Mean of safety index in parks

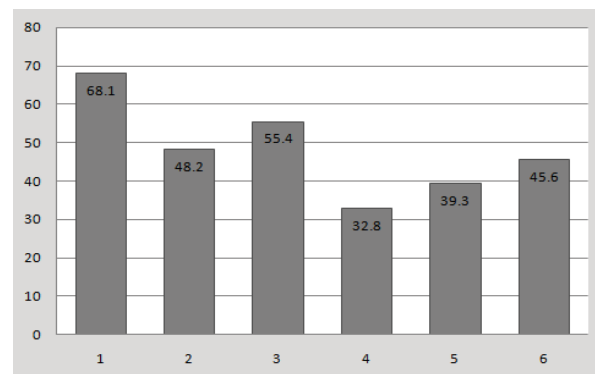


Figure 2. Mean of health index in parks

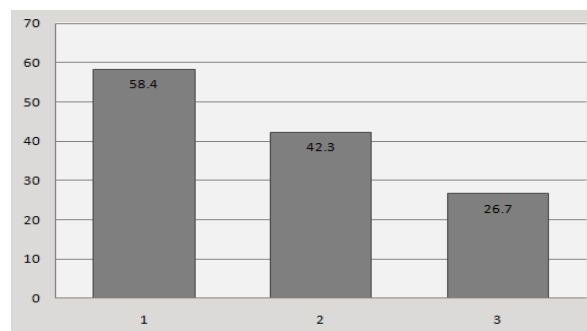


Figure 3. Mean of environmental index in parks

Conclusion

Undoubtedly, health, safety and environmental arrangements for parks are among the important requirements of municipalities. Safety and health of the parks will not be practical unless the three factors mentioned above and the integrated management model for the implementation of HSE-MS can be considered in a successful strategy. It also seems that the results of HSE assessment of the specific model presented in this study, in one hand, and reasonable scientific framework for assessing the current state of urban parks on the other created in the health, safety and environment towards improving the quality of health, safety and environment of urban parks. It is evident in other public spaces of cities in Iran that the HSE assessment process may reveal hidden layers of content in public spaces, and provide looking towards the promotion of safety and health for urban life.

Keyword: HSE, QFD, urban environment, urban parks.

Environmental Impacts of Urban Sprawl (Case Study: Gorgan)

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Abstract

One of the most important subjects in 21 century in relation to sustainable urban development is urban form. Urban form that is pattern of spatial distribution of human activities in a specific period can be divided into two kinds: Compact city and Urban sprawl. Because there is a close relation between urban form and urban sustainability, urban planners have to know about urban pattern and form to achieve more sustainability. For understanding urban form of the study area, the city of Gorgan, we used several methods: Population density, Map of the city in different periods and Holdern model. Attained results show that Gorgan sprawl was very high in 1996, and it increases in next period (2006). This city in addition to high population growth, has had a unplanned physical development that cause some undesirable outcomes in social, economical and environmental dimensions. These effects such as loss of agricultural lands and forests, contamination of waters, and air are considerable.

The most causes of Gorgan sprawl are high rate of immigration, ambiguity in the laws, superfluities of armed and military land use per capita, combination of villages, and etc. So, for attaining to more sustainability, the urban development pattern should be changed and some strategies must be used to decrease urban sprawl and undesirable outcomes.

Introduction

Urban sprawl is an important problem in 21th century. Beginning of the twenty-first century has been started with the development of a new city in the world. Urban form that is the pattern of spatial distribution of human activities over space in given period can be divided into two different types: Compact city and Urban sprawl. Because of the close relationship between urban form and urban sustainability it is required by urban planners to know about urban pattern and form to make well decisions for more sustainability. One of the critical issues associated with sustainability in the 21st century is how to form and shape the development of space. Spatial development of the city can be defined as a model of human activity in a certain period of time.

Materials and Methods

Methods of this study are a descriptive -analytic. We used data from library resources, field observation, statistical, and graphical information using software. To measure the vertical distribution of Gorgan, Holdern model are used as temporal variations in population density and size in different periods.

Discussion of Results and Conclusions

For understanding urban form of study area we used several ways: Population density, Map of the city in different periods and Holdern model. Attained results show that Gorgan sprawl was very high in 1996, and it increased in next period (2006).

The most common indicator used is the density distribution. It is a city that can reflect the low density urban distribution. The population density of the city of Gorgan in 1335 was 2.99 persons per hectare. It was, in 1345, 5.93 persons per hectare in and in 1365 about 6.91 persons per hectare. Apparently, the trend of this year after intense congestion starts in 1375 to 1.67 and in 1385 was 77.08 people per hectare. Changes in population and land area of Gorgan and its density from 1335 to 1385 are given in Table 1.

Table 1. Changes in population growth and city of Gorgan

Density (people per hectare)	Area (hectare)	population	Year
99.2	286	28380	1335
93.5	547	51181	1345
88.2	997	88033	1355
80.9	1722	139430	1365
67.1	2809	188710	1375
77.08	3560	274438	1385

Source: (Population and housing censuses from 1335 to 1385 and of the results of the authors).

In this study, the size of Gorgan in different directions, maps, and tables of physical development in the years from 1230 to 1386 are shown in table 1. The amount of land consumed per period of growth has been very high, and much of the city is 85-acre (85.0 square kilometer) in 1230 AD. It is no more than 3560 hectares (6.35 sq. km) in 1385. The results are given in Table 2.

Table 2. Changes in the land uses of Gorgan

Area (hectare)	Name
5.6	From forest to residential
4759.4	From agricultural to residential

Source: authors.

One of the basic methods for determining the standing of Holdern urban growth is sparse. Using this method, it can be specified that how much of the growth is for urban population and how much is for the shape. If the year of 1335 was beginning of the period of 1385 to the end of the course, we should look at the overall growth and physical size of the period, 74 percent of the city's population growth and 26 percent of the rest of the spread or dispersion is horizontal. Between 1385-1335, 74% of the physical growth of urban population and 26% of the horizontal dispersion are reducing congestion and increasing per capita gross margins of urban land and the spread horizontally immethodical city.

It appears that the horizontal distribution of Gorgan cause negative environmental impacts such as the loss of agricultural lands and forests around the city, or the land use change and urban air pollution, and water. One of the negative effects of horizontal dispersion is loss of agricultural and forest lands. So, the equation Holdern shows on average one-quarter (25%) of physical growth and increasing population growth but rather represent the effect of growth factors. Due to the proximity of the city of Gorgan to high quality agricultural land and forest land in the southern portion, horizontal expansion of agricultural land in each period have been under construction in the city. From 1365 to 1381, more than 4,000 hectares of land that was capable for farming has been eliminated. Overall, 4,765 acres of farm and forest land have been converted into urban uses. The share of agricultural land has changed and decreased more than others.

Results of the 1365 and 1381 satellite images indicate that destruction of the city was mainly in agricultural land and forest. Horizontal expansion increase air pollution through an increase in the number of vehicle trips and fuel consumption as well as increased consumption of other energy carriers. Pollution of water resources due to increased waste and inefficiency by the large number of wells, sewage system, and sewage disposal will be resulted from the increase in sprawl. Given that water wells are less deep in Gorgan, the risk of contamination of water resources is very high. The results of this research indicate that during the study about irregular horizontal distribution of Gorgan, unfortunately this trend is negatively continuing. The main reasons for the sharp horizontal distribution of Gorgan in 1385 are a lot of unnecessary applications, such as military and moorland and etc. some of the causes for the sprawl are including many people migrated to the city, land and housing policies after the revolution, increase in the rate of private car ownership or improvement in transportation, integrated townships, villages and cities, urban uncertainty and frequent changes in laws and regulations and city managers.

Keywords: environmental impacts, Gorgan, Holdern model, population density, urban sprawl.

Environmental Impact Assessment of Industrial Complexes Using AN-AM (Case Study: Sarcheshmeh Copper Complex)

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Abstract

Environmental impact assessment is one of the acceptable methods for achieving sustainable development. It is considered as a planning tool for managers and decision makers. Based on the potential effects that could occur as a result of project construction and development it is reasonable to eliminate or reduce the adverse effects. Today, the activities of the copper industry in providing the country's copper requirements and the growing importance of environmental compliance issues affecting various industries, especially the copper industry, make it necessary by the need for better and more efficient methods to identify and control the effects of the industrial complex activity. In this study, the environmental impacts of Sarcheshmeh Copper Complex were studied. In this regard, by use of experts opinion, and a check list for assessment of the environmental and socio-economic factors that are affected by the project, the assessment data is gathered. Then, using rapid impact assessment matrix (RIAM) which weighted by ANP Method (Method AN-AM), and with the help of experts, the impact assessment were done. Results show that 12 environmental factors, and 3 social factors are moderate and less affected by the project and 5 socio-economic factors are benefited very positively by the project. As a result, given the strategic situation of the copper industry in the country and with the improvement plans and corrective options, continuation of the works of Sarcheshmeh Copper Project is suggested.

Introduction

Environmental impact assessment is a proper tool to ensure project implementation and it can be a way to specify, predict and interpret the social and environmental impacts of a proposed project's. Also considering environmental impact assessment is a systematic identification and evaluation of projects, programs and proposals on physical, biological, cultural and socio-economic elements of environment. its purpose is to ensure that all of the development options consistent with sustainable development and environmental impact at the design stage of any project should be identified and considered. Background of plans and projects in the country shows that in the past planning, like many developing countries, the importance and the value of natural resources and social environment are hidden from view of decision makers. Many of them without considering environmental and socio-economic considerations, design and exploitation have led to the consequences of such actions including incidence of pollution and resource degradation and social problems in a wide area of the country. However, in many areas of expertise, commitment to studies of impact assessment is not legitimacy in the national or international scale, but implementation and dedication to these issues in the deployment stage or implementation of systems have become integral part of these studies. Since the method of operation and management of multi-criteria model analysis of the environmental impacts assessment for industrial complexes projects have not been studied in a codified method, this research aims to propose a multi-criteria analysis to environmental impact assessment of industrial complexes in the country.

Material & Methods

Sarcheshmeh Copper Complex: Copper Mining coordinates is "20'52° 55' east longitude and "40'56° 29 north latitude. The mine is connected by asphalt road to Rafsanjan and Sirjan. The average height from sea level is 2620 meter, and its highest point above sea level is 3280 meters high. The mine is located 160 kilometers southwest of Kerman and 50 km south of Rafsanjan and in the central region of the Zagros Mountain Range.



Figure 1: Location of Copper Complex

Methods: In this study, in order to assess environmental impacts of Sarcheshme cooper complex, rapid impact assessment Matrix Method (RIAM) is used, except that the changes and parameters of the matrix have been weighted using the ANP, and so called "Weighted rapid matrix (AN-AM)" method.

Analytic Network Process (ANP): The method offered by Tomas Saaty for determining multi rate, named Analytic Network process method. After many years ANP method is used for solving the problems. Analytic Network process method makes a large frame that it is connected to their elements. The results with real world and people decision is more complicated, in the Analytic Network process method there is complicated relations between the original elements that is from substituting respective building with network construction.

This model is developed to improve the lack of connection between the elements and criteria in the hierarchy models. ANP is categorized into two sections: 1) the criteria and sub-criteria of the hierarchy models or the controlling network which control the transactions and, 2) a network including the effectiveness of clusters and elements.

Table1. the Saati's pair-wise comparison model

Linguistic variables	Numbers
Equal	1
Interval	2
Moderate	3
Interval	4
Strong	5
Interval	6
Very strong	7
Interval	8
Extreme	9

Rapid impact assessment matrix: Sharafi *et al.* express that the concept of rapid matrix has been developed by Pastakya in 1998. The method has been evaluated on a standard definition of important criteria. Rapid Impact Assessment Matrix tool is applied to organize, analyze and display the results of a comprehensive assessment of the environmental effects.

Results

In order to analyze the results of rating, the rapid matrix weighted method (AN-AM), the "Final Score" in Table Pastakya domains, are compared. Then, in Table 2 the number of environmental and human factors is identified in various domains.

Table 2. Number of parameters in various Domains

E	D	C	B	A	N	-A	-B	-C	-D	-E	Domains
-	-	-	-	-	-	7	4	1	-	-	Environment
-	-	-	-	-	-	7	4	1	-	-	Environmental
-	2	-	1	2	-	1	-	-	2	-	Socio-economical
-	2	-	1	2	-	8	4	1	2	-	Total

With regard to the fact that copper mining project is strategic for economy of the country, therefore, the project should be implemented and expanded, but it is better to reduce damages to the environment. For each of the environmental and socio-economic factors that are affected by the project, options for reform and improvement projects have been done.

Discussion & Conclusion

Use of ANP model to environmental impacts assessment and provide "weighted rapid matrix" to assess the effects of various projects can be investigated in two dimension. On one side these methods to eliminate many of the problems and costs of other methods of assessment can be useful; on the other hand, ANP method in Multi Criteria Decision Making model can be a better model.

Keywords: environmental factors, rapid matrix weighted, Sarcheshmeh copper complex, socio-economic factors.

Environmental Effects of Brick Kilns Factories, Ghohab Area of Esfahan, Iran

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Abstract

The development activities would impose some risks to environment. These probable risks are different with respect to the nature of the project and vulnerabilities of the environment. The brick kilns factories have considerable potential effects on the environment. So, by assessing the environment and presenting a suitable management these negative potential effects can be decreased to a minimum to improve the affected area. The main goal of the present research is to check the environmental effects of the brick kilns factories of Isfahan (Mohammad Abad Ghohab zone). According to assumptions, the most important environmental effect of brick kilns is the suspending particles, and using the soil for brick factories would cause the erosion of soil in the areas. First, extensive data from 10 brick kilns located on Mohammed Abad Ghohab, in Isfahan, are collected and a sample of the air chimney for testing the (sound) Audio of the area was performed. Then, they are compared with environmental standards by using SPSS software and also using the techniques of testing checklist and counter balance to recognize the index of environmental effects. Analytical Hierarchy Method (AHP) has been used for giving value to the effects used in checklist, TOPSIS technique for grading the choices which had been used in the test. By noticing the consequences of the research, it was specified that the most negative disadvantages of these factories were suspending particles, destroying the soil and erosion of soil. The only advantage of these factories was employment. By paying attention to the obtained results, the most negative effects of brick factories are the suspending particles with the weight of 0.667 with regard to air pollution criterion. Degradation of soil gets the weight of 0.140 and the drift or thrust of the soil the weight of 0.123 and the hygiene is with weight of 0.133. The positive advantage of the burning kilns factories is employment with a weight of 0.101. The burning brick kilns factories are to be observed in terms of environmental regulations. The choice of execution with protection and modification allocates more weight to itself compared with an ideal solution. For the purpose of assessing the suggestive productivity of the modified actions and evaluating the unforeseen effects of the project, we need to establish environmental management system.

Introduction

This present research attempts to observe the specifications of factories and sensitivities of environment. It also contains the center of population in Ghohab zone and residential complex on the district of burning brick kilns factory as study area. The prevailing wind which is blowing from west to east would affect the residents of Ghohab area. This is one of the air pollution parameter. With this regard that Ghohab zone is a salt desert and dried area, any kind of air pollution would leave a double effect on the ecosystem of the region. Therefore, in study about the effects of these factories it is important to observe the topography and climate situation of the area. A research with the subject of regulate evaluation of the effects of diffusion from burning brick kilns on air in Thailand was done in 2009. In this research this was mentioned that a variety of air pollutants diffused during the period of burning bricks among the brick kilns. Spreading the amount of suspending particles diffusion inside the chimney was specified by using the cascade impactor. So₂ was the highest critical pollutant in this case. Ghohab area is located on 20 kilometer east of Isfahan. The total measurement of Ghohab area is 400 kilometer and total population of northern and southern of Ghohab is 9939. Number of brick kilns factories located in this area are 74 which they had been built gradually from 1356.

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Material and Methods:

In this phase, first we gathered extensive information about the project under research which is 10 factories of brick kilns on Ghohab area in Isfahan. The research investigate the geographical situation of brick kilns, recognition of their activities, the method of production, the kind of primary material, and regulations and principles which they observe about these factories that are on contrary with the rules and regulation of environment. This is conducted in two phases; in place activities and librarian studies, and also the test of air quality of the factories' s chimney and audio test have been performed to compare them with the environmental standards. Then, by using the software (SPSS), we did the comparison of each sample with the standards. We also used the counterbalance – checklist testing for recognition of the environmental index effects and using the AHP method for giving weight or value to the used effects. According to this technique, in the present research, first we specify the effective criterion in any environments (physical, chemical, biological, economical, social and aesthetical) by observing the importance and severity of effects and by using the cochran formula, which is one of the most popular method for measuring the capacity of statistic samples. To specify the capacity of samples by cochran formula, we need to know the capacity or the measurement of society. Here, a number of environment experts and some stationed experts in the site are known as statistical population (30 persons). Then, by employing the Delphi questionnaire, we specify the most important environmental effects of brick kilns. We submit the questionnaire to the respondents who was obtained by cochran formula. Subsequently, we specify the index of the environmental effects, with respect to the achieved responds from questionnaires. For giving value or weight to criteria or samples in this research, we first draw a hierarchy construction with the purpose to check the environmental effects of burning brick kilns. The criteria that are the environmental effects of the kilns are arranged and then the choices, each criterion is related to its corresponding choice and we connect them together on the graph to compare each level to its upper level. That would be the establishment of pairwise comparison matrix for each level. The weights are giving (proportional weight) to criteria by employing the AHP method on EC (expert choice) software by special graph. Therefore, by obtaining the weight of criteria and choices, the priority of each one is specified. For computing the scale of criteria in each choice (scaling), we divide the raw data of the choice to the most amount of the raw data in choices. In the next, we write the weight of each criterion in column weight in the chart of counterbalance checklist testing and the weight of each choice proportion to each criterion in the column of raw data. At the end, the total index is obtained by the total product of the criteria weight to criterion scale for each choice. Here, the indices or important criteria that have the highest weight are specified. After employing the two methods counterbalance checklist testing and AHP, we used the TOPSIS technique for certainty of the obtained results from the checklist method in comparison with the multiplication product of cleared scaling matrix by square matrix. The main diagonal elements are the indices weights obtained according to entropy and its other elements are zero. The symmetrical cleared scaling matrix was achieved. The subject of ideal positive and negative values of each index was determined and the distance of each choice from positive and negative ideal values was obtained by the TOPSIS method. The proportional closeness to ideal solution (CL) computed and consequently the grading of choices was done. The value of CL is between zero and one. The closer the sum to one is the closer is it to ideal answer or solution at the end. The conclusions are achieved from TOPSIS method in combination with checklist testing technique for grading the choices and determining the most important bio environmental outcomes of brick kiln factories.

Results

In the results section, first we present the area restriction that we had specified and done the research, and there is Mohammad Abad Ghohab in Isfahan. We obtained the air pollution results in winter. Those factories which use the petrol consumption, the amount of suspending particles and (CO₂) monoxide carbon in their chimney are higher. With respect to achieved results from the analysis by SPSS software it can be said that the degree of suspending particles is more than the standard and the amount of CO₂ is less than the standard and that by observing the results of (SPSS) software, the average of sound in all three stations in every factory is less than the standard value. With respect to the method phases mentioned in chapter three for specifying the effective criteria in environmental area by using the counterbalance checklist testing and cochran formula we determined the number of statistical population, the capacity of the statistic sample is around 27 persons. All of them are assigned to experienced experts for analyzing the effects. With respect to severity and importance, 15 effects were chosen as the most important. For specifying the environmental quality (EQ) and index effectiveness in counterbalance checklist testing method, we should give weights to them. This will be done by AHP technique. By concentration to chart and the weight of every sub criterion and proportional to considered criterion, about the norm of air pollution the sub criterion has the most amount of suspending particles for air pollution, and for the norm of soil pollution the sub criterion of residue has the highest weight. By checking each choice proportional to each norm the suspending particles and soil demolition has the highest weight in connection to executive choice plus protection and modification; and criterion of employment has the most weight for

executive choice without protection and amendment and also the production of materials in executive choice without protection and modification has more weight. In executive choice plus protection and modification the criterion of employment and materials production have less weight that shows little importance for executive choice with protection and amendment related to criteria and by concerning to obtained results from EC software. The first choice which is protection and modification has the highest weight. Among the criteria, air pollution, soil demolition, thrust of soil, employment and hygiene have the most weight or value related to aim or goal. Consequently, these norms have more environmental effects proportional to the rest of criteria, and they are more important environmental parameters. After employing two methods; the counterbalance checklist testing and AHP, they used the TOPSIS technique to become certain about the results obtained from above methods. First, the quantification of the criteria was performed. The entropy method is used for assigning weights. With respect to the norm of weights or values in entropy method for indices with negative aspect the suspending particles of the soil demolition and hygiene have the most weight. For the indices with positive aspect the production and employment have the most weight or value. Consequently, the choice 1 which is execution with protection modification is closer to ideal answer and is a better modification relative to the choice 2. Choice 2 is without protection and modification. According to above research or study, we must observe the choices of protection and modification particularly with respect to the norm of pollutants and soil demolition.

Discussion and Conclusion

The most important negative environmental effect from these factories is the soil demolition. In that, soil is the main primary material which is used in burning brick kilns. After demolition the soil the result would be erosion and drift of soil and by depleting the layer of the soil and the erosion begins. A negative outstanding effect of the burning brick kilns is air pollution. Suspending particles have also more negative effects than other air pollution factories because the burning consumption of these factories under checking in winter time is black petrol that causes more pollution in the region. Another problem of brick kilns is hygiene and breathing. If we do not observe the security and hygiene features in the area of these factories, we will face serious sickness and breathing problems. From the positive advantages of the burning brick kilns we can mention the employment which is the most positive one and also centralization of population and material production in the area. By establishing or setting up the burning brick kilns in an area, and the needs of workers, they cause employment, of course, providing that they employ the local workers.

Keywords: brick kiln, symmetrical examinational checklist method, AHP Technique, TOPSIS Technique

Environmental Risk Management of Oil Products Transfer in Pipeline of Bandar Abbas-Sirjan by Using Bow_Tie Method

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Abstract

The current study was carried out with the aim of environmental risk assessment and management of 26 inch petroleum product pipeline from Bandar Abbas to Sirjan (273 km). For this purpose, the environmental risk assessment was performed using the method of Indexing System. Accordingly, identification of hazards and assessment of risks were performed by analyzing two indices; Sum index and Leak Impact index. Afterwards, the risk score was determined based on relative risk model of indexing system. Subsequently, a zonation was made of the pipeline route at three levels of high (0.08-0.26), medium (0.26–0.44) and low (0.44–0.62) risks using Arc GIS 9.3 software. For environmental risk management Bow-tie Method was applied. The method has the ability to display the relationship between all components applied in the analysis of potential harmful factors with control measures, activities and critical duties. This offers the clearest graphic illustration of the risk management. The obtained results indicated that 7% out of the entire route has a high-risk potential with a risk score range of 0.08 to 0.26. Designing features (potential for soil movement) and third party damage were identified as the most effective factors causing risk in the study area. To mitigate and control the identified risks some managerial strategies were presented in the form of Bow-tie Model. Some of the preventative and control measures are including installing warning systems, appropriate response to calls, applying maintenance equipment, quick disconnect of flow inside the pipe, quick informing and restoration and reconstruction of affected areas.

INTRODUCTION

The study ahead focuses on environmental risk assessment of Bandar Abbas-Sirjan petroleum product pipeline using Bow-tie Method. The risk management of the project aims at planning, organizing, directing and controlling the project activities and processes so that maximize the opportunities and minimize the impacts of the threats. Bandar Abbas-Sirjan pipeline located in Hormozgan Province has an approximate length of 273 km. Based on the designs, the pipeline originates from Bandar Abbas pump-station and after changing direction moves towards the east to the point where intersects the main road of Hajiabad-Bandar Abbas and goes along this road to the north of the province. The establishment purpose of the pipeline is transportation of 300,000 barrels of production per day from the refineries in Bandar Abbas, Hormuz to the center of the country. The useful life of the project is considered to be 25 years. The pipe is made of API-51-X52 and its diameter equals to 26 inches. The pipeline will use two pump-houses; Ghotbabad and Meharan to provide appropriate aerodynamic to transfer the fluid in the pipeline.

MATERIALS AND METHODS

In the study, the technical characteristics of the project and the affected environment were initially identified regarding the existing situation of the study area. The affected scope of the pipeline was determined in a radius of 1 km regarding the international references. Likewise, the impact scope of the project on physical, environmental, biological and social areas was considered 1 km by the research team. Afterwards, indexing system was applied for environmental risk assessment. Arc GIS (9.3) software was used for zonation of the pipeline route. At the end, by means of Active bowtie software, control measures and monitoring were suggested based on Bow-tie Method in order to manage the environmental risks. Risk

assessment of oil and gas transmission lines is conducted using indexing system based on determining two indices; total hazards and impacts. In total hazard index, all factors that increase the risk of accident or danger are classified into four sub-indices including third party damage, corrosion, designing and incorrect operation. Achieving high scores in each of these sub-indices indicates that the pipeline status is desirable. The leakage impact index is calculated through factors such as product potential risk analysis, leakage rate, fluid release and the recipient environment factors. The index score is obtained by multiplication of the scores of the mentioned factors. Acquiring lower scores in each of the sub-indices resulting in lower score of leakage impact indicate the desirable status of the pipeline. In this method, scoring is performed by a subjective scoring system. The relative risk score is calculated based on Muhlbauer relative risk model by dividing the score of total hazard index on the score of the impact index. The bow-tie chart which is considered an attractive tool for risk identification and qualitative analysis, not only illustrates the possible paths between hazards and disasters (major and main events), but also reveals the distinction between preventive and reducing barriers of the impact. In Bow-tie model, the main risk is displayed in the center of the diagram, inside a circle-shaped symbol. Threats and obstacles are shown to the left-side of the diagram while the right-side demonstrates possible consequences and their control measures in the form of rectangles with vertical and horizontal color bands. In order to better reveal the distinction between the different components of the model, a specific color for each component can be defined.

RESULTS

In current study, the environmental risk of 26" products transmission pipeline of Bandar Abbas – Sirjan was assessed through analyzing the two indices; Table1 gives the scores of each sub-index in two sections of Index Sum and Leak Impact Index.

Table 1. The scores of the sub-indices in both indices of sum index and leak impact index

Index	Sub index	Sub index Score	Project Score
Index Sum	Third Party Damage	100	50
	Corrosion	100	79
	Design	100	30-40
	Incorrect Operation	100	88
Leak Impact Index	Product Hazard	22	13
	Dispersion Factor	12	4, 16
	Ecological Sensitivity	16	8-15

The Final risk score obtained from combining the scores of Index Sum and Leak Impact Index varies along the pipeline route. It is within the range of 0.62-0.08. Based on the scoring criterion in this method, higher scores indicate a lower risk. Fig.1 illustrates the score and risk level.

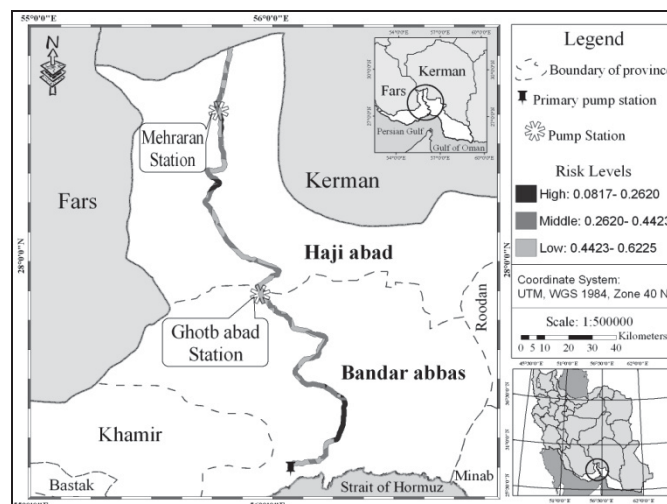


Fig.1. zoning the scores and risk classes

Subsequently, using the results of the risk assessment, the environmental risks of the project were managed.

The product leakage was considered as the identified operational risk of the pipeline and the main event whereas; the most severe environmental risk is resulted from potential leakage of the material from inside the pipes to the surroundings. Parameters that are presented in in Bow-tie Model are include: Threatening factors identified in this study, the major consequences caused by leakage of petroleum, effective factors proposed to prevent and reduce probability of risk occurrence resulting from each of the threatening factors, and recommended strategies for controlling and reducing the consequences of the leakage.. Fig.2 shows the Bow-tie Model plotted for environmental risk assessment of the pipeline.

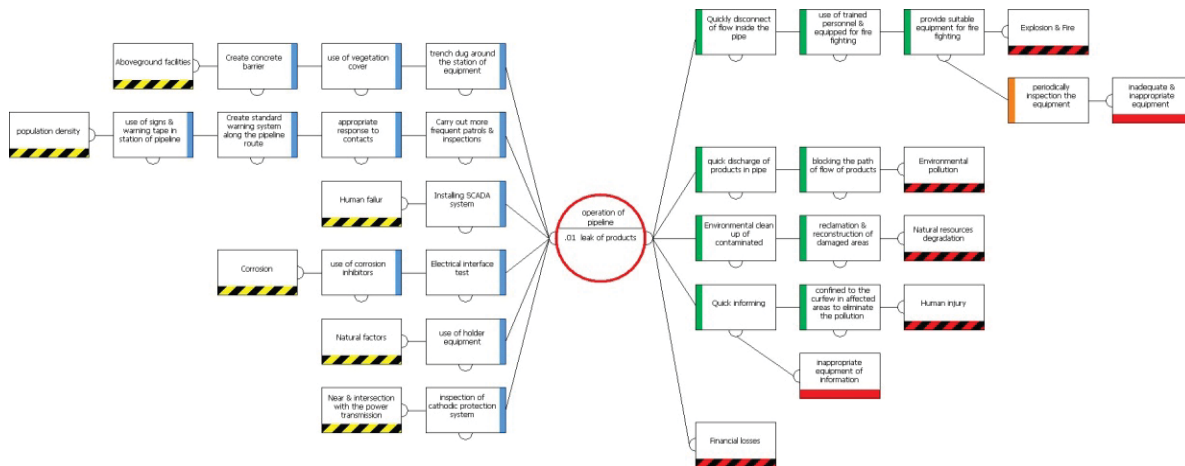


Fig.2. Bow-tie Model of environmental risk management of Bandar Abbas – Sirjan pipeline

In this model, Threats have been specified as a rectangle with striped yellow and black. Moreover, the recommended measures to prevent the occurrence of any of the threats are presented among the relevant factors and the main event. It is worth noting that they are specified in the form of a rectangular with blue stripes. The right-side of the diagram includes potential consequences resulting from product leakage which are illustrated with a red and black hachure. There are some rectangles with green strips which include retrieval and corrective measures following the occurrence of the main event. In this diagram, the factors which cause the incompetence of the retrieval actions are illustrated through rectangles with red strips. They are connected to the retrieval measures with a diagonal line. The effective measure that can be considered to prevent failure of retrieval measures are represented in front of failure factor which is specified by an orange strip.

CONCLUSION

The research findings in relation to the identification and assessment of environmental risks indicated that the final risk score of the project is within the range of 0.08 to 0.62. Based on the zonation of the risk score classes, 7% out of the entire pipeline route has the high risk potential. In this study, the risk level at different parts of the pipeline was compared by mapping and allocating a numerical value to the raster cells using Arc GIS 9.3 software. The result of this study suggests that damages may be caused by third-party have a significant fraction of the pipeline incidents. In the current study, the result of the risk management was offered by Bow-tie Model. Some of the useful features of the method are including: clarifying the distinction between preventive and reactive barriers for removal or reduction of risk occurrence of a specific incident, capabilities of the Bow-tie Method in simplifying, determining and recognizing “cause and effect” factors, and summarizing and converting large amounts of quantitative data to relatively few common scenarios. Consequently, Bow-tie approach can be considered as an effective way to present and communicate the risk project and management which is understandable for all levels of project managers and staff.

Keywords: Bandar Abbas-Sirjan Pipeline, Bow_Tie model, environmental risk management, indexing system, risk.

Application of Multi Criteria Decision Making Method and the Integrated ANP- DEMATEL Model for Agricultural Land Suitability Analysis (Case study: Qazvin Plain)

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Abstract

Peri-urban area development process decreases agricultural land use because of significant trend of city sprawl. In the agricultural sector, goals for sustainability generally include maintenance or enhancement of the natural environment, meeting of human needs for food, economic viability, and social welfare. As agriculture has enormous environmental impacts on peri-urban regions, it is necessary to evaluate agriculture land use. Therefore, agricultural land suitability analysis is a prerequisite to achieve optimum utilisation of the available land resources for sustainable agricultural production. This paper presents an integrated technique of Decision Making Trial and Evaluation Laboratory (DEMATEL) and Analytic Network Process (ANP) to evaluate the land for peri-urban agriculture. Ecological word model, slope, climatic soil properties, water resources and vegetation density were chosen as the major factors affecting the peri-urban agriculture. Then, in a model, it was evaluated by Multi Criteria Decision Making (MCDM) with the Analytic Network Process (ANP) and DEMATEL after overlaying the layers by Simple Additive Weighting (SAW). Assessment of results confirmed presence of six classes of agricultural land use. according to the results, northern parts are not suitable for the agriculture development. However, the layers determined that 98598.20 ha of the polygons are extremely high suitable to medium suitable for agriculture. In fact, the specific model represented a effective solution to help group decision making of evaluators.

Introduction

Agricultural land suitability classification based on indigenous knowledge is vital to land-use planning (ecological capacity evaluation). Execution of development and creation of appropriate areas 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 include the maintenance or enhancement of the natural environment, meeting human food requirements, economic viability, and social welfare. As agriculture has enormous environmental impacts on peri-urban areas, it is essential to investigate agriculture land use suitability. Therefore, agricultural land suitability analysis is a prerequisite to 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 simple additive weighting (SAW). In this paper, we determine agricultural land suitability classifications using case spatial data sets from Qazvin Plain.

Material and Methods

This research was done in framework of the ecological model and multicriteria decision making methods such as DEMATEL, ANP, SAW by using ArcGIS 9.3, Excel 2007, Super Decision 2.0.8, MATLAB 7.11.0 software, with the aim of choosing the suitable locations for agriculture land use in Qazvin plain. Suitable ecological model for evaluation of capability of study area for agriculture land use in Iranian special ecological models was prepared in six-degree value and based on special conditions of concerned region and existing data. DEMATEL

is a comprehensive method for building and analyzing structural model involving causal relationships between complex factors. ANP is based on the creation of a control network which describes dependency among decision elements. The method involves numbers of pairwise comparisons for deriving the priorities of different alternative evaluation. The consistency ratio (C.R.) in the method should be less than 0.1. Simple Additive Weighting (SAW) is a multi attribute decision technique. The method is based on the weighted average. In the method, an evaluation score is calculated for each alternative by multiplying the scaled value given to the alternative of that attribute with the weights of relative importance. Therefore, ecological criteria of slope, climate, soil properties, water resources and vegetation density were chosen as major factors affecting the peri-urban agriculture. The study area is located in Qazvin plain. This area is limited in 31°, 36' to 36°, 30' north of latitude and 49°, 30' to 50°, 30' east longitude.

Discussion of Results

Analyzing the criteria objectively involved using 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 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 dependencies, since 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 weights in each cluster (Table 2). In final, all the digital layers were integrated using the simple additive weighting method to evaluate each alternative. Fig.1 shows the final layer of evaluation.

Table 1. Sum of criteria effects

Ecological criteria	r	c	r - c	r + c
Soil Fertility	2.297	3.176	-0.880	5.473
Soil Texture	3.152	2.388	0.764	5.540
Soil Deep	2.378	2.232	0.146	4.609
Soil Erosion	3.108	3.389	-0.281	6.498
Soil Granulation	2.870	2.639	0.231	5.508
Soil Drainage	2.442	3.574	-1.133	6.016
Slope	3.454	2.459	0.995	5.914
Vegetation Density	2.815	3.753	-0.937	6.568
Water	3.407	2.895	0.512	6.302
Temperature	2.619	2.037	0.583	4.656

Table 2. Final Weights of criteria

Temperature	Water	Vegetation Density	Slope	Soil Erosion	Soil Granulation	Soil Drainage	Soil Deep	Soil Texture	Soil Fertility	criteria
0.033	0.169	0.131	0.200	0.133	0.096	0.018	0.035	0.035	0.150	Final Weight

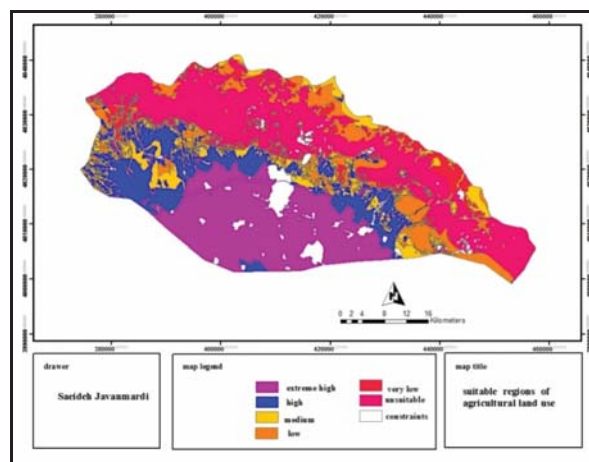


Fig. 1. The final layer of agriculture land use evaluation

Conclusions

Ecological capability of the region was distinguished by agriculture ecological model and implemented based on land suitability. The results indicate the presence of total classes of agriculture land use in the region. There are limiting factors for agriculture land use in the region such as unsuitable soil in north, gardens and forest land uses in south.

Keywords: agriculturalland use, analytic network process, decision making trial and evaluation laboratory, simple additive weighting.

Using fuzzy Analysis Network Process (Fuzzy ANP) in Recognizing Optimum Place of Transfer Stations for Solid Waste in Esfahan

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Abstract

Collecting, transferring, and excretion of urban garbage have sanitary and socio-economic importance. The plethora of waste generation cause many acute problems, which are considered as environmental crisis in many countries. Based on necessity and facilities, garbage collecting and transferring is carried out by many ways. The most common way is to use the garbage transferring stations. Transfer station efficiently increases collecting waste matters and decreases transportation costs, pollution, energy, trucks transportation, and road exhaustion. The sites for these stations should be selected considering financial and technical facilities. Considering the goals of this research, at first, effective factors and criteria in site selections were recognized by a review of previous studies and former researches. For recognizing internal relations between criteria, DEMATEL technique was employed. Weight of each criterion was determined after completion of pairwise comparison questionnaire using fuzzy analysis network process model. It was combined with a sum function in ArcGIS software. This process runs for recognizing optimum places in Esfahan. This research helps urban managers and programmers to recognize and choose establishment places for garbage transferring stations by recognizing effective factors in determining the garbage transferring stations site selection.

Introduction

Collecting, transferring, and excretion of urban garbage have sanitary and socio-economic importance. The plethora of waste generation leads to many acute problems, which are considered as environmental crisis in many countries. Based on necessity and facilities, garbage collecting and transferring is carried out in many ways. The most common way is to use the garbage transferring stations. The main purpose of building transfer stations is to collect the waste by great quantity of small vehicles and carry them to the transfer stations. In the transfer station if the station sites are selected properly, the waste would be transferred from the small vehicles to big vehicles until they are carried to the burial site. Because of the population growth and village-to-city migration, the burial sites are designed for a long period. They must be away from the city and the future development path. Henceforth, their distance to the city area would be far. In such cases, transfer stations are helpful. In addition, wastes produced by sub-urban factories and uncovered areas would be carried to the transfer station. Therefore, study of transfer stations is very important from sanitary and economic aspect. Nowadays, collection and transference of wastes in many cities of Iran are being done non-sanitarily and in many cases some obsolete methods are used. In fact, transfer stations are the optimized form of temporary waste stations in city of Isfahan. Their difference is that the sanitary protocols are of the primary rules of transfer stations- unlike the temporary waste stations. Transfer station efficiently increases collecting waste matters and decreases transportation costs, pollution, energy, trucks transportation, and road exhaustion. The sites for these stations should be selected considering financial and technical facilities.

Materials & Methods

Considering the goals of this research, at first, effective factors and criteria in site selections were recognized according to previous studies and former researches. For recognizing internal relations between criteria, DEMATEL technique was employed. Weight of each criterion were determined after completion of pairwise comparison questionnaire using fuzzy analysis network process model and combined with a sum function in

ArcGIS software. In this research, MATLAB software was used to implement DEMATEL and Fuzzy ANP techniques. ArcGIS was used for spatial modeling and zoning. This process runs for recognizing optimum places in Esfahan. This county is one of the counties of Isfahan Province located in center of Iran which its center, the city of Isfahan, is in the third rank of population and produces 900 tons of wastes per day. The mentioned county has 9 cities with 6 districts. The new location for waste dumping of the city and the adjacent towns is located in the east of Isfahan in Segzi region, Km 2 of Isfahan- Naeen road, at 32° 37'36" Northern Latitude and 52° 1'36" Eastern Longitude.

Discussion of Results

In the first step, the criteria effective in selecting the waste transfer stations were distinguished. These are distance from waterway, soil, geology, distance from main passages, slope, and distance from faults. Then, the interactions and inter-relations between the criteria were investigated using the DEMATEL technique. DEMATEL is a technique of decision making methods based on pairwise comparative, and expert judgments. The table 1 shows the final weights of the effective criteria in selecting the suitable sites for installation of transfer stations using Fuzzy Analytical Network Process (Fuzzy ANP).

Table 1. Final weights for each criteria and sub-criteria using Fuzzy ANP

Criteria	Physiographic		Technical, Environmental			Economic, Social	
Sub-criteria	Distance from Fault	Slope	Geology	Soil	Distance From River	Distance from Residential Area	Distance from Highway
Weight	0.1148	0.1583	0.1168	0.1055	0.1529	0.1812	0.1705

In order to make a zonation of the region, the amount of fuzzy membership for each criterion was determined and the fuzzy map for each one was designed in ArcGIS. In the final step, the obtained weights in analytical hierarchy process were multiplied to their fuzzy- derived maps and all weighted maps were combined together using the SUM function (related to the raster layers models) in ArcGIS. In order to identify and evaluate the potentials of the region for the installation of waste transfer station, the final map were classified into 7 classes based on standard deviation.

Class 1 was recognized as the most proper due to the highest potential of installation of transfer stations and other classes are respectively of a lower importance. The results indicate that only 0.727 percent of the region, equal to 114.172 square kilometers, is determined as class 1. Class 2 has a percent of 6.686. The proportions of classes 3, 4, 5, 6 and 7 are, respectively, 20.982, 41.376, 23.627, 6.157, and 0.262 percent. In addition, with respect to the location of cities of this county and the location of current waste dump, some points were suggested for installing new transfer stations. To reach out to this point, the least distance to the location of sites with class 1 priority were considered as a site for installing new transfer stations. Furthermore, by adding the land use layer of the county, the new sites were suggested to be located in deserted land use or in the land uses with no vegetation cover so that the cultivated lands are prevented from any harm. The table 2 describes some additional information about the suggested points.

Table 2. The situation of suggested points for waste transfer station

Suggested transfer stations	The city under cover	Distance to the city (Km)	Current land use	Class condition	Field assessment
Station 1	Koohpayeh	6.5	Deserted area	1	Very Proper
Station 2	Harand	7	Deserted area	1	Very Proper
	Azhieh	13.5			
Station 3	Varzaneh	6.5	Deserted area	1	Very Proper
Station 4	Hasan Abad	7.6	Deserted area	1	Very Proper
Station 5	Nik Abad	11.1	Rangeland	1	Very Proper
	Mohammad Abad	6.4			
Station 6	Rahna	12.5	Cultivation lands	2	Proper (the only obstacle is being located in cultivated areas)
	Isfahan	7.6			
	Khoorasgan	7.2			

Conclusions

The rapid development of urban and population growth accompanied with whole amount of urban wastes requires attention for management of these wastes. The process of selecting proper sites for transferring of the waste as an alternative requires various parameters. Attention to each of these parameters and selecting a proper site increases the efficiency of waste collection and decreases the transportation costs, air pollution, energy consumption, truck traffic and road exhaustion.

This research helps urban managers and programmers recognize and choose establishment places for garbage transferring stations by recognizing effective factors in determining the garbage transferring stations site selection. An important issue is precision in determination of the weight for each criterion, which plays a great role in the results. The more these weights are calculated, the more reliable the results will be.

Fuzzy Analytical Network Process technique plays a great role in making the results closer to reality by considering relationships among criteria and by being close in comparing criteria to human thinking. This reliability can only be achieved when the experts correctly determine the relations among the criteria. Furthermore, combination of effective criteria is another point to be considered in order to have more accurate results. The technique used in this article is one of the simplest techniques in combining criteria that has shown a significant accuracy due to the evaluations. In order to achieve better results, it is necessary to evaluate this research with other combination methods and compare the results, so that a better decision making for this important economic issue could be obtained.

Keywords: DEMATEL technique, Esfahan, fuzzy analysis network process (fuzzy ANP), garbage transit station.

Urban Flood Hazard Zonation Using GIS and Fuzzy-AHP Analysis (Case study: Tehran city)

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Abstract

Accelerated process of urbanization and global warming make urban flood one of the most important issues in urban planning. Tehran recently has been affected by the flooding and its damages. High intensity rainfall and uncontrolled urban development and main inefficient networks of drainage system are the main reasons. This research uses an efficient approach for flood hazard assessment in Tehran city. This study is to develop an urban flood hazard zonation based on multi-criteria decision analysis and GIS. This model was developed using the following five criteria: distance to the drainage network, flow accumulation, slope, height, and built or not built land areas. Fuzzy Analytical Hierarchy Process (Fuzzy AHP) method as one of the most efficient multi-criteria decision-making systems was used for this study. The final hazard map obtained using the weights of criteria and each of their classes in GIS. Urban flood hazard maps indicate that the waterways and their privacy and central to the southern city area have the highest potential of overflowing and flood rise.

Introduction

Flood is one of the most destructive natural hazards that offset its effects; especially in areas where there are aspects of human development, such as cities, it can impose high financial damages. Urban development, especially along the rivers has increased the flood damage in recent decades. Thus, knowledge about the risk of different areas and attention to urban flood management as one of the major themes in addressing urban issues, with an emphasis on the urban environment, is important consideration for urban planning and policy makings.

Flood hazard maps can be used as an effective tool in planning for future development of the city and also identification of the areas where infrastructure development is required for flood drainage. In this study, Tehran, as the capital of Iran that is in danger of flooding, has been studied.

Materials and Methods

Procedures of this study are presented in Figure 1, which includes provision of primary data, preparing them in GIS, multi-criteria decision analysis and mapping of flood hazard.

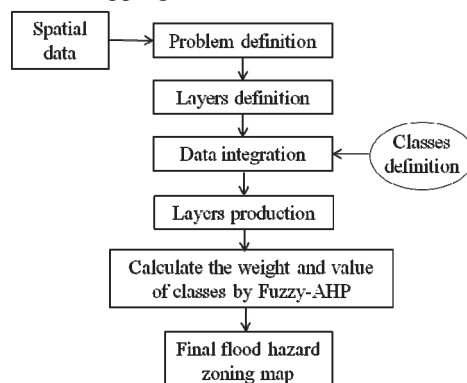


Fig.1. Flowchart of research procedure

Three major sources of data to provide layers were used as follows:

1. Digital elevation model to provide the run off aggregation layer, slope and elevation of the study area,
2. Landsat TM images (summer of 2011) to derive permeable and non-permeable land and
3. Digital files of surface water drainage in the city.

The layers used in this study are shown in Figure 2.

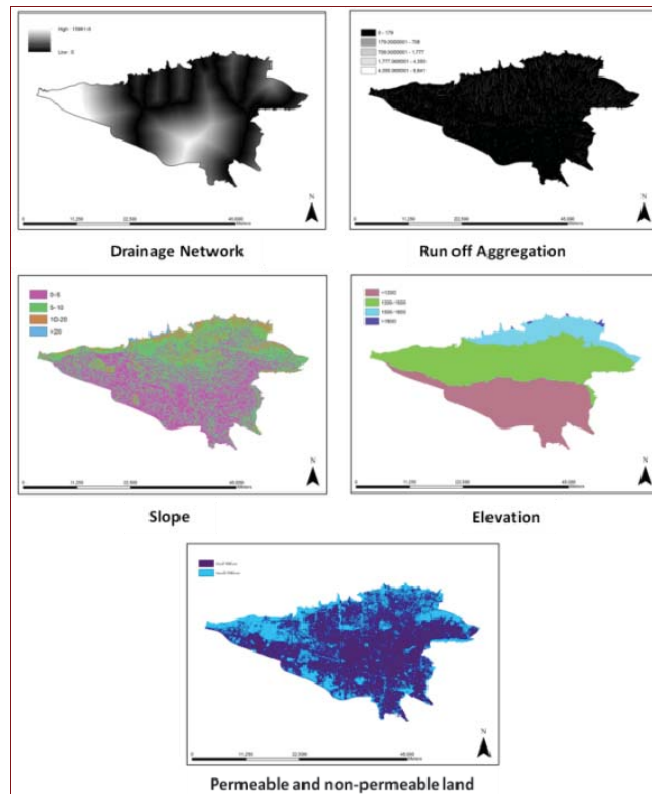


Fig.2. Layers used in the study

Then, the weight and value ratings were assigned to layers and classes of layers. The process of assigning weights and values ranking was performed by AHP-Fuzzy method. Weights calculation was performed using Matlab software programming environment.

Fuzzy Analytic Hierarchy Process

Fuzzy AHP method, proposed by Buckley, as a generalized form is classic AHP method. In this method, a couple of options for gaining weight and priority of fuzzy numbers and the geometric averaging method are used. Because this method can easily be generalized in fuzzy and also unique solution for pairwise comparisons matrix can readily be determined. In this method, the decision maker can compare pairwise each of the options in the form of trapezoidal fuzzy numbers to express.

Results

The methodology used in this paper is the analysis of flow variables at the time of peak rainfall and the drainage network capacity control. Here, we focus on the establishment of appropriate correlation between model and GIS, enabling the desired changes, modifying and updating them easily and with minimal cost and time. Such a system has considerable potential for management of floodplains or flood crisis management and rescue during flood sand rebuilding after the flood management and relevant to subscribers. Applying weighted layers in GIS, flood hazard zonation map of Tehran was prepared. The map at the end was classified in five categories: very high risk areas, areas of high risk, moderate risk areas, risk areas and low risk areas was very low (Figure3).

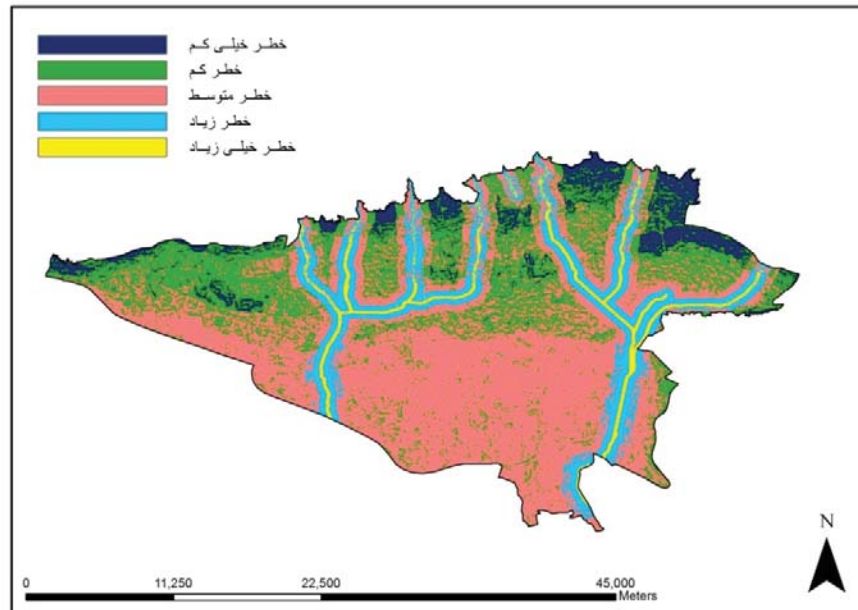


Fig.3. Final classified flood hazard map of Tehran

Discussion

Urban flooding risk map is a new tool that can help urban planners and decision makers, for example, in evaluating the effectiveness of drainage infrastructure and development efforts. These are needed to reduce the risk of flood damage for the urban population.

Keywords: AHP- Fuzzy, flood, hazard zoning, GIS, Tehran city.

Change Detection of Bakhtegan Lake, Fars Province, During 1956-2007

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Abstract

Change detection is process of identifying differences in the state of an object or phenomenon by observing it at different times when it can play an important role in regional planning. This study is an integration of remote sensing data and Geographic Information System in order to detect changes of land use/land cover around the Bakhtegan Lake in Fars province from 1956 to 2007. After geometric and atmospheric corrections, we have classified satellite images in five categories of water zone, land farming, shrubbery, bare and salt lands using maximum likelihood algorithm. Then, we have compared the output images using post- classification method. This method leads to calculating rates of changes. We have also maintained the effect of rainfall oscillation on water lake area because it has huge effect on ecologic condition of the lakes in semi-arid regions. Results showed whenever lake water decreases in a period of time, bare and saline lands increase, which correspond the dryness of the lake. Comparing water lake areas during a period of 51 years indicates a total decrease of 296 square kilometers from the water body of the lake. Calculated overall accuracy and kappa coefficients for output results showed maximum accuracy in classification of TM data and minimum accuracy for MSS images.

Introduction

The Bakhtegan Lake is the second largest lake of Iran with a length of 77 km, average width of 10 km and an area of about 750 km². It is located in eastern area of Fars province.

In this study the aerial images of 1/50000 zones where have been taken from the zone on 3/06/1956 as well as satellite images of ETM 13/05/2005, MSS 28/06/1976, TM 9/05/1990, and ASTER 15/06/2007 have been used as the material. The changes related to water width of lake as well as covering changes around the lake of Bakhtegan have been studied during time period from 1956 to 2007 and their relation was determined with the study of precipitation rate of the period.

Methods

In this research the aerial images of 1/50000 related to the year 1956 (oldest accessible source) as well as the images of MSS in 1976, the TM of 1990, ETM of 2005 and the ASTER of 2007 related to Bakhtegan lake changes and the range around it have been studied during time period of 1956-2007. First, the aerial images have been used to prepare land use and land cover maps and to determine Lake Boundary in 1956. As two or more images are used in change detection methods and as these images should completely be coinciding with each other geometrically, they have been used by two hybrid methods that are the combination of image repairing methods to map and stabilize the images. First, the ETM image have been corrected geometrically based on 1/25000 topography maps then all images have been stabilized on this image. Re-sampling has been done to create the new image by using the prevalent closest neighborhood method. The internal average relative reflectance has been used in order to achieve an atmospheric correction and the images have been classified after correcting. Generally, the classification methods are divided into parametric, non parametric and non metric groups. The parametric classification method has considered the statistical distribution of educational data in image classes and uses a statistical model to distribute pixels in these classes. One of the most prevalent methods of parametric classification, the maximum likelihood method, has been used in this research and its accuracy have been evaluated and studied. The maximum likelihood algorithm allocates each unknown pixel to the most likely class. This method supposes that the distribution of educating data is in normal form in each class. In this

article the images from different dates have been grouped into five classes of water width, agricultural covering, shrubbery, bare and saline lands. The water width class due to differences in water reflection in different depths has been divided into three parts, low depth, medium and deep and their total was considered as water width. After changing the outputs format to suitable format in geographic information system, the land covering area has been calculated separately in each time phase. The post processing method, considered as the most prevalent qualitative methods has been used to statistically evaluate the changes. In this method, at first the images of different dates are classified by one of the prevalent methods and following that, the corresponding pixels of images are compared to each other. Then digital results are presented and analyzed in confusion matrix. The images are also compared two by two to detect the changes in the study area. To compare the land covering in two time phases of 1956 and 2007, a ready GIS map, obtained from 1/50000 aerial images is compared with ASTER image to calculate rates of changes in a 51 years time distance. Then the accuracy of classification is calculated for different images using the parameters of general accuracy and Kappa coefficient calculated for output data. In the following to determine effect of precipitation on the lake water rate, the annual average rainfall in the period is calculated and its relation with water width of the lake is studied.

Discussion

The interpretation of aerial images from 1956 and MSS satellite images processing in 1976, TM of 1990, ETM of 2005, ASTER of 2007, achieved the land use and land cover maps related to around Bakhtegan Lake in five classes of water width, agricultural cover, shrubbery, bare and saline lands in related years. The land use and land cover maps have indicated that the water width class has the maximum area of change compared with other classes and the change tone is not a linear process; the major known reason is the oscillation in precipitation. As the oscillation has the maximum effect on the water width changes and ecological conditions of the lake, it is strived to be dealt with in more details. The data from four rain gauging stations of Arsanjan, Neiriz, Abadeh tashk and Sahl Abad has been used to determine the effect of rainfall oscillation on water width area of Bakhtegan Lake. Due to the lack of data related to rainfall before 1976; the average annual precipitation was calculated for time period of 1976-2007 and it has been compared with water width change in lake. The surveys has indicated that in the time periods with low precipitation rate, the water width area of the lake has been decreased and during the time period of 1990-2005 when the annual precipitation rate was maximum, the Bakhtegan Lake also has the maximum water width area. To evaluate the accuracy, the educational samples of the zone using the topographical maps of 1/50000 and 1/25000 and the satellite images is determined. After data classification, the detection accuracy of each image is calculated using the parameters of general accuracy and Kappa coefficient of confusion matrix. The overall accuracy and Kappa coefficients for image are determined as 59/6 % and 0/54 % for MSS, 92/3 and 0/90 for TM image, 93/9% and 0/92 for ETM and 92.7% and 90% for ASTER images. The producer's accuracy related to each of the specified zones in image is obtained from the division of the number of the pixels that are placed in that class by the detection changing method, (Diagonal elements of confusion matrix) by the whole existing pixels in that classe which are existed in reference data. The user accuracy is obtained from the division of the number of the pixels (that are placed in that class using the detection changing method) by the number of the pixels allocated to that class using detection changing method. The results indicated that most of the data groups have been classified with high accuracy.

Conclusion

To determine the land use and land covering changes in the limited area of Bakhtegan Lake, the maximum likelihood algorithm has been implemented on MSS satellite images in 1976, TM in 1990, ETM in 2005 and ASTER in 2007 and the images have been compared two by two. In addition, to determine the land use and land cover changes in the time period of 1956-2007, the GIS ready map resulted from the interpretation of 1/50000 aerial images have been compared with the similar map resulted from the classification of ASTER image. The studies have indicated that during a time period whenever there is a low precipitation rate, the water width area of the lake has also been reduced and during time period of 1990-2005 when the water width area has been increased, the under cultivation area indicated a decrease due to water salinity of the lake. In addition, the change of saline land area is in relation to water width area of the lake as during the time period of 1976-1990 when the lake has minimum quantity of water the width of saline land area was maximum and during the time period of 1390-2005 when the lake water is maximum, the width of saline land area decreases. The change detection during time period of 1956-2007 has indicated that the area of water width and shrubby covering around the lake has a decrease of 296 and 5/5 square km², respectively. However, the bare lands, the agricultural covering and the width of saline lands had an increase of 130, 12 and 71 square km², respectively.

Keywords: ASTER, Bakhtegan Lake, change detection, land use/land cover, landsat.

Estimating Global Warming External Costs Due to Road Transportation in Iran (Case study: Expressways)

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Abstract

After power stations, transportation section, especially road traffic, is known as the most important cause of climate change. In the transportation literature these costs, known as the external costs, are not paid by people who cause them. Conversely, based on the economic welfare theory, any cost that takes place in society must be paid by people who cause it. So these costs must be recognized to be converted into the monetary value. The values, then, must be taken by charges or other ways taxes.

In Iran, there is no research that relates to the issue of external cost of climate change. Therefore, there is no monetary value of climate change costs due to road transportation in Iran yet. In this paper, this research gap is considered and a mathematical model is used to estimate the mentioned costs. The results are obtained for different vehicles in road transportation including car, mini bus, bus, truck and other vehicles. The model is run for freeways in Iran. The results of the model indicate that external costs of global warming are 10.3, 31.3, 94, 94 and 135.8 Rials for 1 Km mileage of each passenger car & pickup, mini bus & light truck, two and three axle trucks, bus and heavy trucks, respectively. Annual external cost of CO₂ emission in freeways is also approximately 360 billion Rials, 30% of which is the contribution of heavy trucks, passenger cars & pickup take the second place with the share of 25%. The results of this paper can certainly help the policymakers to make good, precise and fair decisions related to the charges of road transportation.

Introduction

Road transportation, primarily, due to its unique characteristics have a special position among various transportation modes. Road transportation is the most available and easy to use mode of transport in Iran. But the transportation has negative impacts too. Road transportation activity imposes external costs such as air pollution costs, noise costs, climate change costs and etc. What should be considered in external costs is that the contribution of the road transport, as international studies show, is around 92% of total external costs of the transport sector. Climate change or global warming is one of the major threats to humanity in the 21th century. After energy section, transportation section especially road transportation, is known as the most important cause of climate change. In the transportation literature these costs, known as the external costs, are not paid by people who cause them. Conversely, based on the economic welfare theory, any cost that takes place in society must be paid by people who cause it. These costs cause loss of a considerable amount of public resources. For example, the external costs for 17 European countries for year 1995 have been around 975 billion dollars. This costs has been estimated around 600 billion dollars for US in 1989. So, these costs must be recognized to be converted into monetary value and then these costs must be taken by charges or other ways of road pricing. This paper is based on a theoretical-practical research which deals with one of the major challenges of the present transportation by employing quantitative techniques and statistical and econometrics models.

Methods

In Iran, there is no research that relates to an issue of external cost of climate change. Therefore, there is no monetary value of climate change costs in Iran yet. Unfortunately, the government is not attentive to external costs; although the topic has been highlighted in recent years and some studies have been conducted regarding the subject. Yet, these costs are not considered in economical transactions. In this paper, this research gap is considered and a mathematical model is used to estimate the costs of climate change. The results are obtained for

different vehicles in road transportation including passenger car and pickup, mini bus, bus, two and three axles truck and heavy truck. The model is run for Expressways in Iran and results are demonstrated. Estimation of some of the parameters existing in the model would take a long time and require a much budget. So, these parameters were extracted from the literature. To estimate the global warming costs, a simple model from GRACE project has been adopted. Table 1 shows more details of the mentioned model.

Table 1. The model for Estimating costs of global warming

Model Name	Estimating costs of global warming		
Model	$C_{GW} = \sum (EF_{dir}(m, v, g, l) \times DF_{dir}(m, g) + FC(m, v, f, l) \times DF_{FP}(m, f))$		
	Variable	Description	Unit/Comment
Variables	C_{GW}	Cost of global warming due to greenhouse gases	Monetary unit per vehicle
	EF_{dir}	factor-Direct emission	Gram per 1 KM-Vehicle
	DF_{dir}	Damage factor-Direct emission	Monetary unit/gram
	FC	Fuel consumption factor	gram per 1 KM-Vehicle
	DF_{FP}	Damage factor-fuel production	monetary unit/gram
	m	Transportation mode	Road, Rail, ...
	v	Technology of Vehicles	Fuel type, environmental standards
	g	Greenhouse gas	CO ₂
	l	Place	Urban/Rural
	f	Fuel type	Gasoline, Gasoil, ...

The required data for this model has been prepared. These data items include price of 1 tone of CO₂, amount of CO₂ released by each vehicle type and amount of CO₂ released from fuel production.

External costs of global warming are estimated for expressway network of Iran based on the model presented in previous paragraph and in Table 1. The first step of this phase is to select a representative sample of Iran's expressways. Totally 13 expressways were selected. It was tried to select a sample representative of Iran's expressway network to facilitate generalization of the results. In the next step, a lot of information regarding the selected roads (including length of road, daily traffic volume, statistics of vehicle types, and etc.) from different data sources has been collected, aiming at using this information in appropriately in the model. In addition, vehicles have been classified in five main classes. After gathering the required information, the model was employed and the external costs of global warming have been estimated corresponding to different types of vehicles.

Discussion and Conclusions

Table 2 shows the average global warming external cost of 1 KM mileage of each vehicle type.

Table 2. Average global warming external costs of 1 KM mileage of each vehicle type(RIAL)

	Vehicle types				
	Passenger car and Pickups	Minibus and light trucks	Two and three axle trucks	Bus	Heavy trucks (>3 axle)
Expressway	10.3	31.3	94	94	135.8

The values in above table have a straightforward interpretation. As an example, a user of passenger car or a pickup must pay 10.3 Rials passing 1 KM of expressway as a compensation of global warming external costs. This value is 135.8 and 94 for heavy trucks and buses, respectively.

The results indicate that annual external cost of CO₂ emission in Expressways is approximately 360 billion Rials, 30% of which is the contribution of heavy trucks with more than 3 axles followed by passenger cars and pickups with the share of 25%.

The considerable amount of these external costs is a good index to realize the importance of external costs of Iran's road transport. It should be noted that these costs are different from many non-monetary effects which external costs impose to society. This involves careful attention of governors and macro-level decision makers to external costs and their issues to provide appropriate solutions to reduce or internalize these costs.

It should be noted that the main and most important solution to reduce and manage external costs is road

pricing and charging road users. The experience of this solution in the world has shown that besides reducing external costs, a considerable financial resources is gathered from user charging, which can be used in more transportation infrastructure developments.

The results of this paper can certainly help the policymakers to make good, precise and fair decisions related to the charges of road transportation.

Keywords: climate change, CO₂, external cost, greenhouse gas, road transportation.