

Table of Contents

Title	Page
<p>■ Assessing the Changes in Tehran' Ecosystems Using the Landscape Metrics and Carbon Sequestration Rates <i>Mir Saeed Mohaghegh, Naghmeh Mobarghaee Dinan, Alireza Vafaeinejad, Soheil Sobhanardakani, Seyed Masoud Monavari</i></p>	1
<p>■ A Structural Analysis of the Effective Components on Resilient Space (Case Study: Tabriz Historic Bazaar Complex) <i>Raheleh Abdollahi, Islam Karami, Ahad Nejad Ebrahimi, Leila Rahimi</i></p>	4
<p>■ Investigation of Water Footprint and Ecological Footprint of Passive Hybrid Cooling System <i>Mahnoosh Eghtedari, Sbbas Mahravan, Maryam Ansarimanesh</i></p>	7
<p>■ Gender Gap in Environmental Activism: A Sociological Analysis <i>Leila Alavi</i></p>	10
<p>■ Environmental Study of "Village" and its Effects to Judging about the Rural Land Use Change (Case Study: Ranching in Environment of a Village in Unification Judgment No 760 of Supreme Court) <i>Hassan Mohseni</i></p>	13
<p>■ Investigation of Seasonal Variation Effects on Household Hazardous Waste Composition and Generation Rate in Tehran and Proposing Environmental Solutions to Prevent and Reduce <i>Houman Gholampour Arbastan, Saeid Gitipour</i></p>	16
<p>■ Application of Graph and Least-Cost Theory to Urban Green Space Network Development and Enhancing Landscape Ecological Connectivity (Case Study: Tabriz city) <i>Hasan Mahmoudzadeh, Hasan Masoudi</i></p>	19
<p>■ Optimization of the Electrolysis Process Efficiency to Improve the Anaerobic Baffled Reactor Performance by Controlling the pH Value for Wastewater Treatment ithm <i>Gagik Badalians Gholikandi, Behnam Inanloo Beklar, Maryam Amouamouha</i></p>	21
<p>■ Management Model Presenting for the Continuation of Activities and Services After the Crisis (Case Study: The Headquarters of Tehran Water and Wastewater Company District 3) <i>Gholamreza Nabi Bidhendi, Aghil Olya</i></p>	23
<p>■ Evaluation of Risk Potentials and Determination of Zn, Pb and Cd Source in Soil around Angouran Mineral Processing Complex <i>Zahra Sheikhi Alman Abad, Hossein Pirkharrati, Monir Mojarrad</i></p>	25
<p>■ Optimization of Meteorological Variables to Predict Air Pollutant Concentrations for Use in Artificial Neural Network Model to Reduce the Cost and Time of Analysis <i>Afsaneh Ghasemi, Jamil Amanollahi, Mohammad Darand</i></p>	28
<p>■ The Scenario base Calculation of Ecoidrological Water Needs for Sustainable Development of Water Resources (Case Study: Kaji Salt Wetland of Nehbandan) <i>Mohammad Hossein Sayadi, Elham Yousefi, Elham Chamanehpour</i></p>	31

Assessing the Changes in Tehran' Ecosystems Using the Landscape Metrics and Carbon Sequestration Rates

Mir Saeed Mohaghegh¹, Naghmeh Mobarghaee Dinan^{2*}, Alireza Vafaeinejad³, Soheil Sobhanardakani⁴, Seyed Masoud Monavari⁵

1. Ph.D. Student, Department of the Environment, College of Natural Resources and Environment, Science and Research Branch, Islamic Azad University, Tehran, Iran (Email: eli.net62@gmail.com)
2. Associate Professor, Environmental Sciences Research Institute, Shahid Beheshti University, Tehran, Iran
3. Assistant Professor, Department of the Civil, Water and Environmental Engineering, Shahid Beheshti University, Tehran, Iran (Email: a_vafaei@sbu.ac.ir)
4. Associate Professor, Department of the Environment, College of Basic Sciences, Hamedan Branch, Islamic Azad University, Hamedan, Iran (Email: s_sobhan@iauh.ac.ir)
5. Associate Professor, Department of the Environment, College of Natural Resources and Environment, Science and Research Branch, Islamic Azad University, Tehran, Iran (Email: monavarism@yahoo.com)

Received: December 2, 2019

Accepted: March 5, 2020

Expanded Abstract

Introduction

The over half of world population are living in cities and counties. It is expected 66% of them will live in and around the cities in 2050 (World Population Prospects, the 2012 Revision). Increasing in population growth and development, especially in cities, has changed the ecology of entire earth planet (Alberti et al., 2008; Rockstrom et al., 2009). Based on the report of millennium ecosystem assessment, ecosystems have wider and faster changed by human during recent 50-year compared to any other temporal period in human history (Millennium Ecosystem Assessment, 2005). These extensive changes in ecosystem structure and function lead to disturbance in providing ecosystem services potential (Vitousek et al., 1997). Considering evidences, extended disturbances in ecosystem structure and function are regarded as a factor for reducing ecosystem services during several recent decades, which cannot be perceived perfectly as yet (Raudsepp-Hearne et al., 2010) and result in arising some problems such as the global phenomenon of climate change, contamination of air, occurrence of erosion, flow offlood, reduction of water quality, extinction of species and loss of natural landscape. Nowadays, metropolitans are facing to various problems such as over population and its negative outcomes including the air, soil and water pollution, destruction of natural resources and traffic. Considering large changes in city of Tehran, as the largest metropolis of Iran, due to irregular population growth and urbanization growth, this city has faced to the different problems in the field of environmental, physical, economic and social infrastructures during recent decades and these problems lead to reducing the environment quality. The present study sought to assess urban changes by using landscape metrics and their relationship with carbon sequestration rates and storage in city of Tehran. The evaluation of the trend of ecosystem changes by using landscape metrics can represent the reduction of services along with changes.

Material and Method

City of Tehran as the most populous metropolitan and capital of Iran with an area of 720 km² is located in the northern half of the country. The altitude of this city is varies between 1100 m to 1700 m. In this study, in the first step, base maps were extracted from Landsat 5 satellite images related to 18.6.1986, 13.6.1996 and 1.7.2008 and Landsat 8 images related to 20.6.2016, then, land-use map was prepared with intended classes (spatial

* Corresponding author:

E-mail: n_mobarghei@yahoo.com

resolution= 30 m). Based on the nature of the present study, uses were classified into six classes involving man-made (residential, commercial, administrative and urban services), green space, agricultural, industrial-workshop, barren and non-built, road and transit routes classes. These maps were used as base map to calculate landscape metrics. Before anything, vector format was converted to raster format since landscape analyses are conducted in raster-based GIS software. The optimum pixel size of the vector land-use map related to city of Tehran with raster model was set at 30 m. Gradient analysis which was first developed by Whittaker (1975) to analyze vegetation is regarded more efficient and can be performed by using FRAGSTATS 3.3. software. Urban expansion was also studied through this analysis based on landscape metrics (Zhang et al., 2004). Regarding gradient analysis, the area under study was divided into 113 km buffers starting from city center and analyses were conducted in these buffers. Metrics were calculated by using FRAGSTATS 3.3 software on the class level. Four metrics of the percentage of lands cover, number of patch, mean patch size and area-weighted mean patch fractal dimension were selected among all metrics to compare changes.

INVEST is considered as one of the models of carbon storage and sequestration, in which the information related to the amount of wood harvest, harvested production, destruction, storages existing in the four carbon pools of above and underground biomasses, soil organic matter and dead organic matter, current carbon storage in landscape. Carbon sequestration in any time are estimated based on land cover or land-use map (Tallis et al., 2011).

The annual mean of the air quality parameters including PM₁₀, CO, NO₂, SO₂ and O₃ was determined in the air pollution monitoring stations located in city of Tehran during two temporal ranges of 2006 and 2016 and interpolated through inverse-distance weighting. Further, the correlation between air quality parameters and amount of carbon sequestration rates during two ranges of 2008 and 2016 were evaluated by using Pearson's correlation coefficient.

Results

After classifying satellite images, the accuracy of classified images is assessed. Overall accuracy and Kappa coefficient are regarded as more common components for assessment (Foody, 1992), which were used to evaluate classification accuracy in the present study. Kappa coefficient calculates classification accuracy with respect to a completely-random classification in which each image was randomly classified (Mitsova et al., 2011). It is considered as one of criteria for assessing map accuracy, represents agreement between the results of classification and reality of land. Kappa coefficient varies between zero and one, where one indicates 100% agreement between classified layer and reality of land (Congalton & Green, 2009).

The land-use maps of area were prepared in six classes of man-made, barren, agricultural, green space, industrial-workshop and road network during four temporal ranges by using satellite images. The spatial resolution of all images was 30 m, which was regarded appropriate for the study. These maps were used to as base map analyze landscape. Class-level analyses were used in six classes in the class level.

Discussion and Conclusion

Land-use changes during a 30-year range represent the replacement of natural (barren lands) and semi-natural resources (agricultural lands) by man-made areas, which result in increasing residential areas and developing and expanding road network and urban green space. The addition of population rate and urbanization growth are regarded as main factors for changing landscape structure and function and affecting the climate of area (Orville et al., 2000). An increase in artificial or man-made patches indicates the destruction of lands, while an addition of the number and diversity of natural patches results in enhancing ecosystem relationships and land sustainability (Botequilha % Ahern, 2002). Further, increasing the number of man-made patches leads to the reduction of continuity and transmission between natural covers (McGarigal & Marks, 1995).

Based on the metrics analysis, extensive changes occur in landscape. The number of patches in man-made class increases over the time and this addition is significant, especially in zone 4. An addition of the number of patches is regarded as an important index for the decomposition of land and results in enhancing the destruction of land. In fact, it represents decomposition and reduction of continuity (McGarigal & Marks, 1995).

Regarding the metric of mean patch size, its amount reduces especially in 2016. An increase in the number of patches and reduction of mean patch increasing demonstrate that the tissue of residential are became fine and landscape of area is fragmented. The maximum of disturbance is corresponded to zones 5-11 where maximum changes, conversions and road network expansion occurs over the time and their lands (mainly barren) are replaced by man-made areas and road network. Human accessibility to land is positively related to its change and destruction rate and an addition of roads results in increasing the rate of change trend (Arumalani et al., 2004). Mean patch size and area-weighted mean patch fractal dimension increase in road network over the time, while the number of patches and area-weighted mean patch fractal dimension decrease in agricultural lands.

Regarding the industrial lands which were centralized in zones 6-10, they increased in 2008, while a decrease was observed in zones 8-10 in 2016. The number of patch represents a decreasing-increasing trend from center to zone 6. Based on the metric of area-weighted mean patch fractal dimension, its value reduces over the time. Barren lands increase by moving from center toward edges. Over the time, a decreasing trend occurs in are as near the center, leading to great reduction over the time. The number of patches decreased in 1996, and increased during 2008 significantly, especially in zones 3-6, and finally minimized in 2016 with a significant decreasing trend. Mean patch size increases at the first, while it represents a decreasing trend in 2008 and 2016. Regarding the metric of area-weighted mean patch fractal dimension, a decreasing trend is observed from center toward edge, while here is an increasing trend in zone 8 and over. The shape of the borders related to the diverse natural covers of land is more complex compared to that in the covers derived from human activities. An increase in human disturbance results in decreasing the mean fractal dimension of patches (Turner & Ruscher, 1988). During 1996-2008, the amount of sequestration decreased in most areas instead of zone 6 where an increasing trend was observed due to an addition of green space area in this zone. Further, carbon sequestration rates significantly reduced in zone 3 due to the decrease of agricultural lands and increase in man-made uses.

Keywords: carbon sequestration, city of Tehran, gradient analysis, landscape metrics.

A Structural Analysis of the Effective Components on Resilient Space (Case Study: Tabriz Historic Bazaar Complex)

Raheleh Abdollahi¹, Islam Karami^{2*}, Ahad Nejad Ebrahimi³, Leila Rahimi⁴

1. Ph.D. Student, Department of Architecture, Ardabil Branch, Islamic Azad University, Ardabil, Iran (Email: Abdollahi2013@yahoo.com)
2. Assistant Professor, Department of Architecture, Ardabil Branch, Islamic Azad University, Ardabil, Iran
3. Associate Professor, Tabriz Islamic Art University, Tabriz, Iran (Email: Ahadebrahimi@tabriziau.ac.ir)
4. Assistant Professor, Faculty of Civil Engineering, University of Tabriz, Tabriz, Iran (Email: L.rahimi@tabrizu.ac.ir)

Received: May 31, 2019

Accepted: March 5, 2020

Expanded Abstract

Introduction

The term resilience has been investigated for decades in a wide range of studies in order to describe how different types of systems and environments respond to unexpected shocks, mostly addressing the subject of sudden disturbances such as natural disasters and their effects on the systems. However, limited studies have been examined the effect of slow disturbances. It is worth noting that in today's societies, the resilience of built environments has an active role in a city's resilience, and the life of each city depends on the life of different spaces and environments located in it. In fact, the spatial dimension of resilience is a new subject in the field of architecture which indicates the continued vitality of spaces over time against gradual and slow disturbances. Today, the spaces that are constructed without reading the context and suitable response to it are vulnerable to shocks and changes, and lose their efficiency quickly. In this regard, attention to spatial features and capabilities, although contributing to resilience to change, is not sufficient by itself to examine the subject; hence, the harmony of space with the context and utilizing the components of context are of utmost importance and contextualist approach can lead to valuable results in this field. Therefore, the purpose of the research is to identify effective components with an emphasis on contextualist approach. For this purpose, the historic bazaars of Iran have been determined as the identifiable spaces for exploration, and the historic bazaar of Tabriz was chosen specifically as the case study. It is important to evaluate this bazaar due to its special cultural, social, and economic role as well as its high cultural-religious value in people's mental structure and the need to protect the country's cultural and architectural heritage as the largest covered bazaar. Thus, this research seeks to answer the following questions:

1. What is the level of resilience of Tabriz historic bazaar from the perspective of contextualist approach?
2. Which components and indicators play an effective role in achieving this resilience, relying on this approach?

Materials and Methods

This is a case study that contains the basic theory to guide the research process. In this research, contextualist approach was used as the basic theory to formulate the research method. This research employed a combination of quantitative and qualitative methods that have been performed with the aim of identifying and searching for the factors of resilient spaces.

From the theoretical aspect, in the first step, the different views and theories related to contextualist approach were obtained by meta-analysis method and the physical, historical, environmental and socio-cultural components of context on which there was a scientific consensus were also extracted. Contextualism is an approach that is formed by paying attention to the set of physical and non-physical values in an environment. Considering these components and coordinating with the context will lead to the continuity of values; longevity of vitality and high adaptability of spaces; and thus the resilience against change and evolution over time. The present study, in the physical context investigated the integration and coherence of structure, function, and also vision. The cultural context was dealt with the conformity with religion, values, beliefs, meaning and also the

* Corresponding author:

E-mail: Architect_ik@yahoo.com

association of the spatial organization with Iranian lifestyles. In the historical context, the use of historical types of architecture, relationship with the traditions and visual and collective memories and in the environmental context, the adaptation to weather conditions such as environmental comfort, climatic adaptation and respect for environmental capacity were considered. Then, in the second step, by analyzing and discussing resilience issues from the perspective of adaptive resilience approach, the characteristics of adaptability and reactivity as effective strategies in the resilience of spaces were extracted. By analyzing the spatial dimension of resilience, two characteristics of flexibility and variability were deduced as decisive capabilities for resilience of systems aimed at understanding and proving the research problem. Based on the foregoing, in this study, four capabilities were defined representing the resilience of spaces.

In adaptive capability, the ability to adapt to variables and new conditions were considered. In reactive capability was investigated the coping strategies or in other words, spontaneous resilience of users. Indicators of these two capabilities are reconfiguration, reorientation; growth, local attractiveness, access, attribute interaction, interaction of components and features, experience and awareness, programmed and spontaneous reaction, self-organization, and social system diversity. Based on the findings of the previous studies, some indicators have been introduced to measure flexibility which include polyvalence, fluidity, diversity, the flexible of institutions and networks in decision-making and problem solving, the sense of belonging, and optimal fit mass into space. Considering the theorists' views on the indices of change of patterns and processes, the spatial-temporal activity chain, trusted partnerships, social networking, and users' ability to modify structures to measure the capability of spatial variability were discussed in this study. As a result, theoretical framework was accomplished by extracting the components of context and spatial capabilities based on the findings of the studies.

From the operational aspect, the components of context as an independent variable, spatial capabilities as a mediating variable, spatial resilience as a dependent variable and individual factors as a controlling factor were considered in this research. In order to collect data, library study and field methods were used. Quantitative data collection tool was a questionnaire based on the research variables and demographic characteristics of the respondents with 69 items to evaluate the views of the clients of Tabriz historic bazaar and the tools for collecting qualitative data included direct observation and documentary studies on environmental variables. The target population of this study was selected by Cochran sampling with 95% confidence level constituting 357 individuals. Cronbach's alpha coefficient was used to estimate the reliability of the questionnaire. The obtained value was 0.899; accordingly, the research tool can be considered appropriate and the results reliable.

Quantitative data analysis was carried out through mean test, structural analysis and multivariate linear regression and using SPSS and LISREL software. In order to explain the present situation, prioritize and rank the components and indices, t-test and box plot diagram were employed. Path analysis was employed to find out the relationships between the variables and their direct and indirect effects. Regression analysis was also used aimed at investigating the relationship between the indicators and variables. Inductive reasoning strategy was employed to analyze the qualitative data. Finally, by comparing the results of quantitative and qualitative data, the indicators of spatial capabilities and contextual components affecting resilience were analyzed and categorized.

Discussion of Results

In line with the purpose of the research, the findings showed that among the individual factors, three factors of age, level of education and economic status affect the level of contextualism. According to the results of the mean test, the resilience of the historic bazaar of Tabriz is at an optimal level based on the spatial capabilities and contextual components, and the historical context and flexible capability are at their best. The results of structural and regression analyses indicate that there is a significant relationship between all variables of the research. According to the results of path analysis, all the governing relationships in the structural model are significant. In this regard, in contextual variable, the highest path coefficient belongs to socio-cultural and climatic-environmental component (0.70). The lowest path coefficient belongs to physical component (0.52). In the spatial capabilities variable, the adaptive and reactive components have the highest path coefficient (0.77). Therefore, there is a direct and significant relationship between the capabilities of space and the components of context with spatial resilience. And the most significant effect of contextualism on resilience is through spatial capabilities; thus, the indirect effect of contextualism on resilience is more significant than its direct effect. So, the environmental and cultural contexts and the adaptive and reactive capabilities of space have the most impact. A comparative study and analysis of the quantitative and qualitative findings of the present study showed that the contextual space of Tabriz bazaar has been able to maintain its coherence in the perceptual, semantic, visual, functional and structural components over a long period of time, without losing its identity against the disorders, and continue its physical, functional and semantic vitality. The operational findings on the capabilities of the resilient space are in agreement with the theoretical findings. In addition to the indicators in the theoretical findings, other indicators were identified as effective factors in the continuity of vitality in this study, such as increasing new units, physical permeability (multiplicity of accesses), network communications of space, social

security, the planned strategy of global bazaar registration and its effect on increasing users' presence, and multifunctional space. Therefore, using the capabilities of space, the contextual space can survive over a period of time without losing its identity by maintaining performance.

Conclusion

In this research, first the relevant and effective factors of context were identified and then the spatial capabilities influencing the subject were extracted from the adaptive perspective and spatial dimension of resilience. The theoretical framework of the research was also investigated. In the sample, the mentioned factors were tested quantitatively and qualitatively. The results of the questionnaire and field and documentary studies showed that the resilience of Tabriz historic bazaar is at a good level, and the historical context and flexible ability are at their best. There is a direct and significant relationship between the contextual components and spatial capabilities with resilient space. The most significant effect of contextual components on spatial resilience is through spatial capabilities. The conclusion to be drawn is that the indirect effect of contextualism on resilience is more significant than its direct effect. The environmental and cultural context and the adaptability and reactivity of space, and the physical context and flexibility of space have the most and least impact, respectively. Therefore, the physical, cultural, historical and environmental components of context as the primary and the most influential factors on the continuity of spatial vitality, and the capabilities of adaptability, reactivity, variability and flexibility of space as inherent potentials or resilience strategies and mediating factors of resilient bazaar are considered important.

Therefore, the contextual space over time can lead to the continuity of spatial vitality by maintaining its semantic, perceptual, visual, functional, and structural coherence. Also, achieving resilience which reflects the continuity of life, is the result of increasing the capacity of space to deal with crises which is provided by factors such as the capabilities of adaptability, reactivity, variability, and flexibility of space to improve the existing conditions.

To put it short, the components of context, in conjunction with the spatial capabilities, leads to the resilience of space. However, the purpose of this research was to identify the causes and not to design strategies within the scope of this research and developing it requires further research. It can be concluded that considering the conditions of the context and these capabilities over time can be a good step towards improving the status of resilient space. One of the achievements of this research was to present the factors that promote the spatial resilience which can lead to a new method of designing spaces and assessing the strategies of resilience to promote urban resilience.

Keywords: contextualism, path analysis, resilience, spatial capabilities, Tabriz Historic Bazaar.

Investigation of Water Footprint and Ecological Footprint of Passive Hybrid Cooling System

Mahnoosh Eghtedari¹, Sbbas Mahravan^{2*} Maryam Ansarimanesh³

1. Ph.D. Student, Department of Architecture, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran (Email: mahnoosh.eghtedari@yahoo.com)
2. Assistante Professor, Architecture Department, Razi University, Kermanshah, Iran
3. Assistante Professor, Department of Architecture, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran (Email: m.ansarimanesh@iau.ksh.ac.ir)

Received: April 30, 2019

Accepted: June 1, 2019

Extended Abstract

Introduction

The rapid growth of global population has placed an immense stress on the demand of natural resources and contributes to the destruction of the natural environment. As the planet is now consuming natural resources in the production of goods and services faster than the environment can regenerate, strategies are urgently required to manage the ecological assets in a more effective way. The planet has biophysical limits on natural resources production and waste absorption. Buildings are one of the main factors in energy consumption and greenhouse gas emissions. Buildings consume about 40% of global energy consumption. All building services such as heating, ventilation, and air conditioning (HVAC) systems consume more than 60% energy in buildings, which is mainly supplied by fossil resources. Today, because of the need for an effective method to achieve efficient energy and biocompatible architecture, the use of natural ventilation systems in buildings has become more significant. One of the methods to create comfortable conditions in the interior is a use of evaporative cooling in the cooling systems. Unlike air conditioners, evaporative cooling can be considered as an acceptable solution for sustainable construction, which reduces energy consumption and greenhouse gases. Evaporative cooling is widely used as a passive cooling method in the built environment. In the system, the movement of air on a wet surface causes the water evaporation through the air energy absorption, thereby reducing the temperature and increasing the amount of vapor contained in the air. We need indicators to demonstrate the current carrying capacity of the Earth so that decision makers are better informed to set goals, establish options for actions, and monitor progress regarding stated goals. Footprint is a quantitative measurement of natural resources and it is used to assess the extent of human activities impact on global sustainability. Ecological footprint was initially developed by Wackernagel and Rees in 1992, and is now widely used as an indicator for environmental sustainability. The international average water footprint is 7452 (Gm³/ year) and this amount is reported to be 102.65 (Gm³/ year) for Iran.

Numerous studies have been conducted on the footprints of buildings in the field of water consumption and fossil fuels. (Kandananond, 2019) calculated the amount of water used to produce fuel and electricity by calculating the footprints of water in various residential, office and educational buildings and showed that diesel fuel has the highest water consumption 857 (Litr/ Kg). Heidari et al. (2017) conducted a study on the environmental impact assessment of educational buildings using ecological footprint method. In this study, the ecological footprints of the operation stage of the building, which included the energy consumption of the faculty, water consumption, production waste and the infrastructure of the building, were examined. Heidari et al. (2017) states that most of the ecological footprint of the faculty is related to water consumption per year, which is equal to 5.90 gha/ year. The highest energy consumption after water is the energy consumption of fossil fuels, which is equal to 24.87 gha/ year. Haghparast et al. (2017) calculated the ecological footprint. The scope of this research included the preparation of raw materials for production, transportation, installation and finally recycling of materials. The calculated ecological footprint of the studied samples includes (construction) of embodied energy in consumables, (operation) of energy consumed during operation, water consumed during operation and (land used) land occupied for the building. It was the outdoor or green space. The results of the

* Corresponding author:

E-mail: mahravan@razi.ac.ir

studies showed that the highest ecological footprint of the two buildings is related to the energy field and is equal to 1.9401 hec/ year.

Various studies have been conducted on the cooling rate of passive evaporative cooling systems, solar chimneys and hybrid systems. Bahadori *et al.* (2008) designed two new wind towers in the city of Yazd, Iran and tested them in September. One of the wind towers was equipped with wetted curtains suspended in the tower column and the other one with wetted surfaces. The cooling performance of the two new systems was compared with the conventional system. The experimental results showed that the efficiency of both new units with evaporative cooling systems was better than that of the conventional unit. Further, the experimental results showed that the traditional type reduced the air temperature by 4°C, while the windcatchers with wet surfaces and wet curtains reduced the air temperature to 11 and 14°C, respectively, both of which reduced the air temperature more than the traditional type did (Khani & *et al.*, 2017). An experimental study of modular windcatcher design using wet surfaces in Kerman for ten consecutive days showed that the highest air temperature obtained using this new design is 13.3°C and the lowest is 5.7°C is the average that can reduce the air temperature by up to 10%. Maerefat and Haghighi (2010) used a combination of solar chimney and evaporative cooling duct for natural ventilation of the chamber. Research has shown that the system is able to keep indoors at a comfortable temperature.

Materials & Methods

The Hybrid Passive Cooling System (HPCS) consisted of two distinctive systems: the Solar Chimney (SC) and Evaporative Cooling Cavity (ECC). The ECC system was connected to the northern view of the room and SC system was installed to the southern view of the room. The air entered the tower via the openings of the head tower in all directions and passed through the clay cylinders. In this section, the air is cooled and diverted downward. The SC system creates sufficient temperature difference between the interior and exterior by maximizing the solar energy gain and performed air ventilation in the SC and ECC systems. The proposed hybrid system was built in the campus of Azad University, Kermanshah branch in August and was tested from August 4th to 7th. In order to calculate the efficiency of the proposed system, on August 4th to 7th, the temperature, humidity, and wind speed of the interior room were measured by considering the HPCS. To evaluate the water consumption of the HPCS, two scenarios were considered and their results were compared with each other.

Scenario 1: On August 4th-7th, the amount of water reduction inside the clay cylinders was measured from 9:00 AM to 3:00 PM.

Scenario 2: On August 18, the room temperature and humidity were measured from 9:00 AM to 3:00 PM.

Dimensions and size of the HPCS was: A room with 2 m×2 m×2.35 m (L×W×H) dimensions with 10 cm -thick walls and 35 cm-thick ceiling without air filtration. A SC with 1 m height, 60 cm width, 17 cm air gap, and 45°C tilt angle. The front side of the SC consisted of a 15 mm-thick glass glazing and the rear part included a 1 m-high absorber wall made of a black-painted aluminum sheet. A 40 cm × 10 cm air outlet of SC placed 20 cm below the ceiling. The ECC system built with a length of 3.25 m and 0.6 × 0.4 m cross-section. Each air inlet opening of the wind tower is 40 cm × 40 cm and air exit opening is 30 cm × 30 cm. Four clay cylinders installed in the cavity, are 20 cm diameter, and 90 cm height. Testing was performed for ten consecutive days at around 9:00 am, noon, and 3:00 pm during the hottest summer days. In order to calculate the efficiency of the proposed system, two scenarios were considered and the results were compared with each other.

Discussion of Results

Cool performance of HPCS: The lowest temperature was recorded 21.1°C at 9:00 AM on the 5th of August. The lowest temperature is noon on 22.9°C and on the 6th of August. At 3 PM, the lowest air temperature of 23.72 was reached on the 5th of August. The highest difference between the temperature of the inlet windcatcher and the outside environment is 16.3°C, which is on the 7th of August and at 3:00 PM. Based on the results, the highest RHs of the outlet air from the tower at 3:00 PM were 60.7% on the 6th of August. The lowest RHs of the outlet air from the tower at 3:00 PM were 52% on the 5th of August. Based on the results, the ECC system can increase the RH of air by an average of 34%. The highest outlet air velocity of the tower is 0.72 m/s, at 3:00 PM on the 5th of August. The lowest air velocity is 0.5 m/s at 9:00 AM on the 6th of August.

The amount of water level reduction in cylinders in the windcatcher (Scenario 1): The highest reduction in water level every three days is the cylinder 2 at 3 PM. The lowest decrease in water level was obtained in cylinder 3 at 9:00 AM. The lowest average decrease in water volume is related to the third day of the experiment on 5th August and the highest average decrease in water volume is related to the second day of the experiment on 6th August.

Water and electricity consumption of evaporative cooler in scenario 2: To investigate scenario 2, on August 18, the temperature and humidity inside the room and the outside environment were measured from 9:00 AM to 3:00

PM. The lowest and highest levels of indoor humidity are 16% at 3:00 PM and 27% at 12:00 AM, respectively, while the outdoor humidity is 13% at 3:00 PM and 19% at 12:00 AM. The evaporative cooler lowers the indoor ambient temperature by an average of 5% and increases the ambient humidity by an average of 7%.

Comparison of electricity and water used in scenarios 1 and 2: The amount of electricity consumed in Scenario 1 is zero, but in Scenario 2, this value is 12112.9 kJ/ day. The environmental footprint of electricity consumed in Scenario 1 is zero, but in Scenario 2, it is 1.05 Gb/ year. The water used in Scenario 2 is 0.04 m² more than Scenario 1.

Conclusions

This study aims to investigate the ecological footprint and water footprint of the Hybrid Passive cooling system and compare it with evaporative coolers. The results showed that the chamber can provide comfort conditions with zero energy consumption by using a hybrid system during the hottest days of the year from 9:00 AM to 3:00 PM. The power consumption of the evaporative cooler in the 3 months of summer is 1.13 Gj, while the power consumption of the designed hybrid system is zero. The ecological footprint of the power consumption of this system is zero, while the ecological footprint of the evaporative cooler is 1.05 (Gj/ year). From the data obtained, we conclude that the passive hybrid cooling system has the lowest ecological footprint of water and electricity compared to evaporative coolers. The system is also able to provide indoor comfort on the hottest days of the year.

Keywords: ecological footprint, energy consumption, passive cooling system, water consumption.

Gender Gap in Environmental Activism: A Sociological Analysis

Leila Alavi *

Assistant Professor, Sociology Department, Imam Khomeini International University, Qazvin, Iran

Received: April 29, 2019

Accepted: June 1, 2019

Expanded Abstract

Introduction

Environmental activism is a type of environmentally responsible behavior that people engage with in order to protect nature. Sociologists have done many studies about the differences between activists and others, but less attention has been paid to gender differences among activists within environmental movements. Women are more concerned about potential environmental problems than men, so this study assumes that women are more likely to participate in environmental movements.

The main question of this study is whether women members of environmental NGOs are more active than men? And is the level of activity of men and women in environmental organizations different?

Theoretical literature views the impact of gender on activism as different from the impact of gender on other environmentally responsible behaviors, and it is believed that the relationship between gender and environmental activism is determined by cross-factors. As most environmental activism take place outside the home, gender division of labor in to domestic and wage employment has restricted women's access to environmental activism and participation in environmental movements.

Men have more access to higher job opportunities and higher wages than women. Men's greater access to economic resources and opportunities in society makes women dependent and put them in lower status compared to men. The power of men in different fields brings them more power and makes women weaker in the social sphere. Women gradually lose the opportunity to compete with men in their public and private lives. Hence, they turn to lower jobs wages. Unequal division of labor creates ideologies, norms, and stereotypes about men's competencies toward women. On the other hand, responsible environmental behaviors except environmental activism, and occur in everyday behaviors- which are often domestic and unpaid- and among women. Therefore, women are more likely to engage in environmentally responsible behavior than men. Being a mother has a special role in environmental awareness and activism, and this is due to the way women are socialized for care and support roles. Theoretically, women are expected to be more prone to environmental activism if they are mothers.

Various studies have reported conflicting effects of gender on activism. On the one hand, the fields of environmental sociology and ecofeminist theory show that women are more practical than men for social and biological reasons. This literature makes us expect more pragmatism from women, especially mothers. On the other hand, social movement theories represent different demographic factors that impede women's participation in environmental movements, because roles assigned to women cause time constraints to fulfill other commitments.

Materials and Methods

Based on the questions and theoretical literature of the research, the hypotheses are:

- Women are more environmentally active than men.
- Women have a higher rate of environmental activism than men, by controlling the effects of other variables.
- The set of independent variables affecting women's environmental activism are different from the set of independent variables affecting men's environmental activism.

In this paper, activism is seen as a continuous variable from inactivity to sustained activism. Therefore, it is about different levels of activism, not activism or non-activism. There are different types of activism in society. In most social and political science studies, the focus is on high-cost and high-risk activism, but in this article, we focus on low-cost and low-risk actions that members engage in routine activities of NGOs.

The statistical population are members of the environmental NGOs of East Azerbaijan province who at the time of conducting the research were recognized as official members and completed the membership form. The latest official statistics of the environmental NGOs in East Azerbaijan is for 2019. There were 23 environmental NGOs in East Azerbaijan. Fields of activity of these NGOs are:

- Education through workshops, seminars and specialized programs, promoting environmental culture among children, students and women
- Environmental protection activities such as green space development, nature cleansing, environmental and natural resources surveillance, creation of wildlife sanctuaries in nature and development of natural areas and tree planting
- Specialized research programs in the field of environment, such as study and rehabilitation of degraded ecosystems and the reintroduction and rehabilitation of endangered animal and plant species, also the complex issue of water in the region of Azerbaijan
- Development of ecotourism in the province, entrepreneurship, employment and change of livelihood in order to protect the environment, programs to support farmers with organic and natural products
- Pursuing financial and spiritual support to the benefactors of the province in order to implement the above programs.

They have obtained activity license from various government institutions, such as Provincial Government, Governorate, National Youth Organization, Physical Education Organization, Ministry of Science, Research and Technology and Department of Environment. Number of statistical population is 15365; 8050 women and 7315 men. This survey was conducted with a sample size of 375 people by proportional stratified sampling. Sample size is determined by Cochran formula with error of 0.05.

In the statistical model, the impact of gender as an independent variable is measured along with age, income, and education as control variables on activism. Environmental values, association with other actors, frequency of communication, and level of movement identity are also examined. Data were collected through a questionnaire. Part of the questionnaire was self-constructed and the other part was taken from other studies. The measurement of independent variables such as social bond rate, frequency of communication and level of environmental identity has done by the questionnaires related to previous studies.

The average participation of males (27.67%) is higher than of females (27.10%) for total items, but this difference is not significant. Multivariate regression was used to predict activism based on independent variables. Logarithmic conversion has been used to use regression analysis in some variables that were not consistent with regression analysis defaults. Women are no more active environmentally than men with controlling variables such as age, education, duration of membership in NGO, and income. Being a parent of men and women does not have a significant impact on activism. Activism can be better predicted by age and duration of membership in NGO than other variables. In general, younger members with longer membership periods and more ties with other members who experience more communication and those who have a greater level of movement identity are more active than the rest. The lack of a significant relationship between gender and activism may reflect the cross-cutting effects that have been reported in the research literature. Most variables jointly predict male and female activity, and the predicted variance of the dependent variable is almost similar by the independent variables in women (40%) and men (47%). In both men and women, younger people have more connections with other members of the NGOs and are more involved in communicating with environmental issues and have a higher level of shared identity with NGOs, and ultimately more environmental activism than other members.

Discussion of results

Women have more environmental concerns than men without having more environmental participation. How can these findings be reconciled?

Although, these findings appear to be inconsistent, they are consistent with the conceptual model. In the model, there are enhancing variables (such as environmental values) and limiting variables (such as biographical access) as mediators of the relationship between gender and environmental activism. However, the limitations of environmental activism appear to have little effect on the responsible environmental behaviors that emerge in the context of everyday life. Thus, theoretically, the impact of gender on environmental activism and environmental responsible behavior will not be similar. In fact, the formation of theoretical literature on gender and environmental activism is dual.

There are conflicting pressures for women's activism in the field of the environment, including women's double employment in the domestic and social spheres, which results from the gender division of labor and leads to restrictions on women's activism. To illustrate, it is argued that women may be more environmentally concerned than men, but the scarcity of resources will likely limit their activism. In fact, when women do their housework, they limit their time to participate in environmental activities compared to men. Although the gender division of

labor in two domestic and social domains has clear implications for environmental activism, this division of labor operates different at different times and places.

The question is, based on the results of this study and comparing it with the results of other studies, why do these restrictions prevent women from environmental activism and not from responsible environmental behaviors? According to previous studies, environmental responsible behaviors in women have been reported more than men. Many environmental conservation behaviors are in the realm of homework and day-to-day affairs and behaviors such as buying organic products, disposing of waste, using less harmful detergents for the environment, and using public transportation are mostly done by women.

Conclusion

Finally, the findings and results of this study can be useful to environmental NGOs. Women's organizational membership is a resource that can enhance even the smallest and least important aspects of their environmental behavior. If environmental movements and their NGOs want to change people's daily consumption patterns and tend to take responsibility for environmental issues, focusing on women is probably the most effective strategy. In order to make women more active and more involved in key roles in movements, their responsibility for home and child care should be reduced, otherwise gender-biased effects will continue to lead many women with high environmental concerns, to supportive and insignificant roles in environmental organizations.

We have reviewed evidences that reveal a cultural and social pattern of women's protecting behaviors about their families and environment through household practices. We also described the development of gender theorizing in sociology of work, an area where the gendered division of domestic labor is explained as problematic. Our analysis pointed to the need to critically theorize gender-environment relationships by highlighting different associations between gender and engaging in environmental activism.

Keywords: biographical availability, environmental activism, gender, gender division of labor.

Environmental Study of “Village” and its Effects to Judging about the Rural Land Use Change (Case Study: Ranching in Environment of a Village in Unification Judgment No 760 of Supreme Court)

Hassan Mohseni *

Associate Professor, Private and Islamic Law Department, Faculty of Law and Political Sciences, University of Tehran, Tehran, Iran

Received: June 11, 2019

Accepted: June 1, 2019

Expanded Abstract

Introduction

Village is the principal subdivision of territory. In Law of Territory, it is accepted that a small society in villages contributes to create a city and cities to big city and so for to province and capital and country. This meaning is not vied from its philosophical dimension. What is the reality of village that necessitate to have such a deep role in our territorial subdivision?

It is rarely discussed in law and rarely is a challenge in its dimension. The reality is that the works are done in village is completely different from what is doing in a city and or in bigger cities. The question is that if the notion of work and the example of land use in villages should be compatible by that reality of village? First, approach in confronting to village and farms and gardens could be that approach which is currently accepted in private law and property law. The man who is the owner of a land or garden has the ownership on it so he can do anything he will on his land or his garden. There is not any restriction. This approach can create a kind of concurrence between village and city to being a city in future by predicable defeat of village in that unfair competition.

Another approach is that there should be some administrative definition of land using in village and so, controlling that using legally. Also, this approach can kill the reality of village. In the other word, by changing the people's views in every village, the village will simply be changed to other smaller or larger community.

So, it is clear that our questions in this research are that what is the village? What is its reality? What is its importance to keep the village for ever to being always village and how can prevent the works that are inconsistent to the reality and philosophy of village?

After the issuance of two conflicting judgments from the Fifth Branch of the Qazvin Province Court of Appeals and the First Branch of that province, that first of which was issued as follows:

“According to Paragraph 4 of Article 1 of the Law Amending the Law on Preservation of Agricultural Lands and Gardens (1979 October 23) and that according to this Paragraph, the change of agricultural lands to animal husbandry is in fact considered to optimize agricultural products and is not subject to change of prohibited land use. Therefore, considering that the action by the accused is not considered a crime according to the legal license, while accepting the retrial and rejecting of the above-mentioned judgments issued by the First Branch of the Court of Appeal of Qazvin Province and the General Court of Esferurin City in this regard, according to paragraph A of the article 177 of the Code of Criminal Procedure and bans the prosecution of the accused.”

The judgment is final and the second sentence reads as follows:

“Considering the legislator's stipulation in Article 1 of the Amendment Law on the Protection of Land Use and Agricultural Lands Law approved in 2006 and the following note of that Article, any change of land use without obtaining permission from the competent legal authorities is subject to the general prohibition which is mentioned in the law, so by accepting the Appeal Request and the rejecting of the judgment of first instance court in accordance with paragraph B of Article 450 of the Code of Criminal Procedure approved in 2013, the case will be returned to the first instance court for merits.”

The judgment is final. The Supreme Court notified about the conflict of judgments of the branches of the courts of appeal of Qazvin province, so that the General Assembly of that court can propose a Unification Judgment so on.

The General Assembly of the Supreme Court, after consulting, voted as follows:

"According to the interference from Note 4, added to the Article 1 of the Law on Preservation of Agricultural Lands and Gardens, establishment of Ranching in village and other examples mentioned in that with the Permission of Agricultural Organizations and by respecting the regulations and standards, is not change of land use of farms and gardens, and is a sort of optimizing the agricultural production and it is not change of Land Use and finally it is out of the scope of Article 3 of the amendment to the said law Accordingly, the decision of the Fifth Branch of the Court of Appeals of Qazvin Province, insofar as it is consistent with this opinion, is recognized by a majority of The General Assembly of the Supreme Court, as correct and legal judgment. According to Article 471 of the Code of Criminal Procedure, this judgment is binding on the branches of the Supreme Court and the courts and other authorities, both judicial and otherwise".

According to author's opinion this Unification Judgment is not merely a judgment; it is a judgment which rooted to the philosophical fundamentals of the notion of Village. We will discuss about it.

Materials & Methods

According to Article 471 of Code of Criminal Procedure:

"Whenever different Judgments are issued by different branches of the Supreme Court or the courts on different cases, including legal, criminal and non-contentious matters, with different inferences from the laws, the President of the Supreme Court or the Attorney General shall be informed in any way. They are obliged to request the opinion of the General Assembly of the Supreme Court in order to create unification of law. Any judge of the branches of the Supreme Court or the courts or prosecutors or attorneys may also request the opinion of the General Assembly which would be issued as binding judgment on the matter by stating the reason through the President of the Supreme Court or the Attorney General. The General Assembly of the Supreme Court shall be chaired by the President of the Supreme Court or his Deputy and in the presence of the Attorney General or his representative and at least three-quarters of the Presidents, Advisors and Deputy Members of all branches. A majority judgment in similar cases is binding for the branches of the Supreme Court and the courts and other authorities, both judicial and otherwise; But it is ineffective against the final judgments...."

So, in Iranian legal system, this judgment is very important and can develop our legal system by choosing a very practical interpretation of enacted law that have interfered differently by courts. Our Supreme Court as Iranian Higher Court of Justice by its Unification Judgment which is obligatory to all judicial courts and administrative authorities and bodies of our country, can guide our judicial system. The Union Board of Branches of Our Supreme Court have rend some judgments about "Land Use of Farms and Gardens" (such as Judgments No 707, 724 & 730). This unification power is a hugely accepted as a way for unification of law.

In addition of those judgments, one of philosophical judgments of our supreme court is the judgment No 760 that is issued in 11/07/2017. Our supreme court in this judgment have said:

"Establishment of Ranching in village by respecting the regulations and standards is not change of land use of farms and gardens."

This judgment apparently is about Land Use but in my opinion this judgment regards deeply to the philosophy of village; the philosophy that is rooted in other sciences. So, our material in this paper is the judgment No 760 of Iranian Supreme Court and our method is based on critics and survey on this judgment by application of the results of other sciences to that judgment; We bring this judgment before an Environmental Scientist or City or Village Programing Scientists. Our perspective is having mutual comprehension between Lawyers and Environmental Scientists.

Discussion of Results

In this research, we have discussed about our Supreme Court Unification Judgment and its Introductory Official Report as such as Our General Prosecutor's Opinion. We endeavored here to clarify the roots and foundation of that great judgment for protecting the notion of village.

In author's thought, the mentioned judgement of our Supreme Court could be seen as first step for confronting by village in philosophical studies and can guide our future jurisprudence before lower tribunals and courts which are continuously battling every day by that unfair changing of the Use of Land as a Modern Pest of Farms and Gardens. We discussed here that the land use is predominately a matter of philosophy and we should change our views for the remedy of unfair changing. We cannot close our eyes to economic and social included cultural aspects of changing the land use. It is not only a matter of law of property or the law of territorial division, but also it is a matter of economic and social and cultural notion. So, a lawyer and a professor of law cannot realize

the reality of land use and changing of that land to other beneficial using unless he observes that roots and foundations before other scientists.

It seems that the remedy and the approach and the essence of discussion should be based on the reality of village and not on the subdivision in Law of Territory of Law of Property. It should be real and natural and not be an artificial conception. This reality is found its foundation inherently in nature; the foundation that can prevent any forced and inconsistent invention of human kind in village. The law shall defend this reality; it ought to open its eyes for seeing, prevent any offensive attack to the village and protect its philosophical notion.

The judgment No 760 will be the beginning but the base stone of every development in a country that has suffered greatly from the change in the use of agricultural land and gardens, and there will always be the growth of urbanization and then the creep of urbanization towards the village.

By this study as an example of judicial feedback on their ideas, environmental scientists can be seen the result of their efforts and could be optimistic about the growth of philosophical reflections in the field of environment generally and in the notion of village. In other similar cases, they can think about basic ideas so that jurists, lawyers, and judges can understand the reality of the judicial phenomena from these environmental perspectives, and thus would take a more effective step toward protecting land use and the concept of village.

The Supreme Court has taken a step that is different from other judgments. The Supreme Court has turned its attention to alignment and has taken the middle approach which is philosophical one.

Conclusions

The definition of "land use" aimed for long or short term program of its utilization. Alongside of this definition that needs some civil or penal rules to sanctioning, the philosophy and the nature of some phenomena can also defining a kind of land use which should be called Natural Land Using. Village is one of these phenomena. What can define the land using in village, is the natural coexistence with the nature of village. This is the perspective to seeing the village which is known in environmental studies and city or village programing sciences but is not current in legal problem and law. The focus of law in this matter is merely on sanctions. Not with standing that mentioned focus, we should observe the judicial discourse clearly so when our Supreme Court holding Unification Judgment No 760, that sayes establishing a ranching in village according the regulations and standards, in author's opinion is not change of land use, that judgment should not be regarded as a judicial approach. It is a philosophical perspective which is principally and methodologically an instructive and guiding judgment.

The reality of village is not the only thing that the legislature has considered it as a main or basis measure for the division of the country. It is not artificial. It's environmental and real. This fact is based on coexistence with nature, which prevents it from invading and destruction or denaturation. The law must defend this fact; He shall open his eyes to see it; Avoid attacking it and uphold it.

The fact is that in our country less attention is paid to the philosophy of the village. The village has become a case of return to nature by those who do not want the nature to coexisting phenomena; In order to have it, they want to make up and recuperation for the shortcomings and disadvantages of living in the city, and because they come to the village, they change the culture and civilization there, creating a kind of competition for the villagers in the face of the coverage, dialect, behavior and character of the town's people and the result is definite changing of rural lands to others. The tragedy of village's death and the acquisition and ownership of these lands and the change of its identity is the result of non-respecting to that philosophical basic.

There are many villages that have become uninhabited and there are many agricultural lands and gardens that have been changed with the change of use. These changes are not in favor of the truth of the village, nor are they in favor of the truth of the city.

In the unanimous Judgment No. 760, the Supreme Court apparently decided to resolve the dispute between the courts and considered the accurate judgment and tried to unify the procedure and the decisions of lower courts; but, in the opinion of the author, due to the legal approvals and legislative records, he considered: "Establishment of Ranching in village by respecting the regulations and standards is not change of land use of farms and gardens." This philosophical attitude of the Supreme Court is very valuable and can be a guide for solving other judicial challenges in the field of Environmental Law.

Keywords: coexistence, harmonized change, village.

Investigation of Seasonal Variation Effects on Household Hazardous Waste Composition and Generation Rate in Tehran and Proposing Environmental Solutions to Prevent and Reduce

Houman Gholampour Arbastan¹, Saeid Gitipour^{2*}

1. Ph.D. Candidate in Environmental Engineering, Technical Collage, University of Tehran, Tehran, Iran (Email: H_Gholampour@ut.ac.ir)
2. Full Professor, Environmental Engineering Department, Technical Collage, University of Tehran, Tehran, Iran

Received: August 3, 2019

Accepted: June 1, 2019

Expended Abstract

Introduction

Household waste, which is any waste generated from domestic source, represents over two-thirds of the municipal solid waste (MSW) stream and internationally a large part ends up at landfills. A small portion, typically 1% by weight is defined as household hazardous waste (HHW). In US legislation, HHW is described as “Leftover household products that contain corrosive, toxic, ignitable, or reactive ingredients.” In Europe, the term HHW is defined as “Such wastes that could potentially increase the hazardous properties of municipal solid waste when landfilled, incinerated or composted.” A broader definition is provided by the UK National Household Hazardous Waste Forum (NHHWF): “Any material discarded by a household, which is difficult to dispose of, or which puts human health or the environment at risk because of its chemical or biological nature.” According to Article 2, Paragraph 3 of Iran Waste Management Act, any wastes requiring special care due to containing at least one of the hazardous components of poisonous, pathogenesis, explosiveness, inflammability, corrosiveness and the likes. Those medical wastes, as well as some part of ordinary, industrial, and agricultural wastes which needs to special management, are included as specific wastes. Furthermore, based on Executive Regulation of Waste Management Act, the special component of domestic and agricultural waste, is not considered domestic waste but the responsibility of its executive management is for the domestic waste executive management which is municipality. According to World Bank report in 2018, about 87% of the produced wastes are being buried with different methods in Iran like other Middle Eastern and North African countries. Based on this report, 52.7% is related to open dumping, 14.1% to controlled landfilling, 10.8% to sanitary landfill and 9.4% to unspecified landfill sites. Leachate contains inorganic and organic elements. Xenobiotic organic compounds (XOCs) and heavy metals are generally classified as the hazardous substances occurring in leachate. Hazardous XOCs and heavy metals can be toxic, corrosive, flammable, reactive, carcinogenic, teratogenic, mutagenic and ecotoxic, among other hazards, and can also be bioaccumulative and/or persistent. MSW landfill leachate analyses permit identification of the commonly found XOCs and heavy metals derived from waste with a domestic origin. Moreover, cosmetic wastes, lotions, detergents, batteries and fluorescent lamps which are all categorized as HHW in municipal waste stream, may noticeably increase siloxane and mercury-containing vapors in the gases emitted from the disposal sites and landfills. Apart from the mentioned environmental effects, the significant costs of transportation, pre-treatment and dispose of the HHW can be pointed out as the economic effects of these wastes. Workplace accidents and work-related illnesses of household waste collectors and job dissatisfaction are the social effects of HHW management. Quantification and characterization HHW is an important and meaningful step for the promotion of appropriate HHW management and source separation of this kind of waste

* Corresponding Author:

E-mail: Gitipour@ut.ac.ir

Material & Methods

Sampling

Environmental problems associated with waste generation are among the societal changes in which the household plays an important role. Consumption patterns and life-style influence a household's waste generation. Therefore, we used the household as the basic unit of analysis, one year as the large cycle, and weeks of various seasons as the small cycles in this study, household's waste generation. Therefore, we used the household as the basic unit of analysis, one year as the large cycle, and weeks of various seasons as the small cycles in this study. In each season, to obtain statistically significant results, we investigated 600 households in all over the 22 districts of Tehran. All of households participating in the study, 600 (from 22 different districts of Tehran) participated in all four stages of the survey.

Study area

Tehran, the capital city of Iran and the center of the province of Tehran, located in north-central Iran at the foot of the Elburz mountain range. Tehran is Iran's largest city and one of the most populous cities of the world. The center of the city is on latitude 35°41' N and longitude 51°26' E. Tehran is located on the steep southern slopes of the Elburz mountain range, which traces an arc along the coast of the Caspian Sea in northern Iran. The metropolis of Tehran is divided into 22 municipal districts, each with its own administrative center. 20 of the 22 municipal districts are located in Tehran County's Central District, while the districts 1 and 20 are respectively located in the counties of Shemiranat and Ray. Although administratively separate, the cities of Ray and Shemiran are often considered part of Greater Tehran. According to the last nationwide census in 2016, population of Tehran is 8,693,706 persons and the families living in this city is determined to be 2,911,065. Based on these results, the average size of family in Tehran is about 2.99 persons.

HHW classification

Once the generation analysis was obtained, materials, packages, and containers were separated according to the classification suggested by literature. Waste categories were: (1) home cleaning, (2) automotive maintenance, (3) batteries, (4) medicines, (5) biological-infectious (syringes, dialysis equipment, used bandages, and etc.), (6) gardening, (7) self-care products, (8) home maintenances, (9) fluorescent lamps, (10) miscellaneous. The last category included all containers and packaging that could not be categorized in the other nine. The HHW classification included the number of packages or containers found in each category. Also, the total weight of each category was recorded, and whether the container still had some material left in it or not. According to previous studies, to mark any leftover as positive, it should represent at least 1% of the product.

Sample size determination

Since covering the whole metropolitan area with 9 million people is almost impossible, a representative sample with similar characteristics to Tehran's population is randomly selected and studied. Therefore, Cochran Equation is used to determine the size of a finite sample from the infinite society of Tehran. Assuming the maximum variability, which is equal to 50% ($p=0.5$) and taking 95% confidence level with $\pm 4\%$ precision, and the population size is 2,948,446. So sample size is calculated 600 households in all over the 22 districts in Tehran.

Determination of domestic solid waste generation rate and HHW composition

Solid waste sampling was carried out during the summer of 2018. Bags were collected daily for seven consecutive days. Once the bags were gathered from the area, each bag was individually weighed. Refuse was hand sorted and individual components were also weighed. Categories and sub-categories corresponded to the format described elsewhere. Once each part was categorized, each tray was weighed, taking care to note if the final sum corresponded to the total weight (kg) of the bin bag. The procedure was performed for each individual bin bag. For each household, the weight of solid waste was averaged throughout the whole period. The result indicated the average solid waste generation per household (kg/ household). Parallel to the solid waste generation analysis, packaging and containers of hazardous wastes were selected and sorted, according to the classification proposed by previous studies. HHW was classified according to ten categories, as mentioned before. After categorization, each group was weighed, including the weight of the containers per product plus any product remaining inside the container. Finally, average generation rate and the composition of HHW in different seasons was calculated which will be presented in this paper.

Statistical analysis

SPSS Statistics 25[©] software was used for statistical analysis of the data. Skewness and kurtosis of the graphs of data are utilized as the criteria for normalization evaluation using Shapiro-Wilk techniques of normalization evaluation.

Discussion of results

Shapiro-Wilk analysis showed that the household hazardous waste generation in different season in Tehran are normally distributed with no significant statistical deviation ($\text{sig} > 0.05$). During the sampling period, 6473.56, 6863.05, 6530.29, and 6097.61 kg mixed solid wastes were collected from 600 households in Tehran in Spring, Summer, Autumn and, Winter, respectively. The most tendency for producing HHW is in summer with 105.33 kg and the less is for autumn by 79.98 kg. The results indicate that the rate of HHW generation was 6.26–8.25 g/person/ day, which accounted for 1.22-1.58% of the household solid waste stream. The largest category in this fraction was home cleaning products.

Conclusions

The results of the present study, which determine the composition and production rate of hazardous household waste in Tehran, indicate that the per capita rate of hazardous domestic waste production in Tehran is higher than the per capita values obtained in all domestic studies such as Isfahan, Amirkola. Based on the comparison HHW generation in Japan, Switzerland, China, Indonesia, Malaysia, Mexico, and Denmark, indicating generation HHW in Tehran higher than in the country of Japan, Switzerland, China, and Indonesia, but is smaller when compared to the generation HHW in Malaysia, Mexico, and Denmark. Indeed, a notable difference exists among the results, which can be explained by differences in the time the investigations were conducted, country characteristics, methodology and proposed objectives. Seasonal rates of HHW generation are summarized in this paper. On average, a higher rate of HHW generation of 8.25 g/ person/ day was observed in winter, which was most likely caused by the celebration of Iranian ancient Nowruz. Most household follow the custom of cleaning their houses to give a warm welcome to their family members, relatives and friends before the new year Festival. Finally, this study found a high disposal rate for used home cleaning containers in the winter survey period (e.g., oven cleaners, all-purpose cleaners, laundry detergent, powder or liquid). Generally, most Iranian households do not throw low value items away except when important events.

As noted above, it can be concluded that the most part of the household's hazardous waste can be significantly reduced by increasing the awareness of citizen to consume the product entirely and also clean the containers. Given the results of the present study and the possible effects of these substances on landfill sites, further studies on leachate compounds and emitted gas from landfill sites are strongly recommended.

Keywords: generation rate, household hazardous waste, seasonal variation, special waste, waste composition.

Application of Graph and Least-Cost Theory to Urban Green Space Network Development and Enhancing Landscape Ecological Connectivity (Case Study: Tabriz city)

Hasan Mahmoudzadeh^{1*}, Hasan Masoudi²

1. Associate Professor, Faculty of Planning and Environmental Sciences, University of Tabriz, Tabriz, Iran

2. MSc., Faculty of Planning and Environmental Sciences, University of Tabriz, Tabriz, Iran (Email: Masoudihsn@gmail.com)

Received: September 3, 2019

Accepted: March 2, 2020

Expanded Abstract

Introduction

Urban areas, including the most sophisticated landscapes and mosaics, consist of natural and artificial elements that accommodate different types of land use and are the main attraction of the human population due to the numerous services provided. Population growth and the need to meet human needs have led to the expansion of the use of natural resources and the conversion of ecosystems to urban areas, and by increasing urban construction, the demand for land has intensified in many countries, especially developing countries. The need for land and housing, which is constantly increasing today, leads to land use change and land fragmentation. Landscape disruption is a human process and a dynamic process over time involving changes in the type of land cover and the breakdown of a single habitat or ecosystem into discrete parts. Green spaces are recognized as part of urban landscape and remnants of natural habitats in the city that have numerous social, economic and environmental functions and benefits and play an important role in sustainable development and ecological integration in landscape. However, in recent decades, the expansion of cities and rapid urbanization have destroyed and transformed these spaces into smaller parts, which not only endangers the health of ecosystems, but also impacts the quality of life of citizens and residents of these areas. In this regard, various studies have found the most effective way to deal with the problems of urbanization and ecological cohesion is to strengthen the rational and sustainable relationship between human, city and nature resulting in the emergence of concepts such as ecological networks. The concept of ecological networks is used as a sustainable and appropriate approach to improve the ecological values of urban green spaces and generally through protecting existing green spaces, creating new spatial forms, repairing and maintaining existing connections between green patches, and constructing corridors or corridors. A new ecology is developing. Tabriz as the largest city in the northwest of the country, is the most important center of population attraction in this region of the country and is constantly expanding its physical reach. In recent decades, the city has witnessed many changes in the amount and type of urban uses, especially in the ecological arena, due to rapid population growth and urbanization. So, many of the city's gardens and landscapes have become over time demolished, fragmented, and reused. In this regard, this research has been designed with the aim of ecological analysis of landscape of Tabriz city and presenting solutions to improve its condition.

Materials and Methods

Tabriz city is located in the center of East Azarbaijan province in the northwest of Iran and is the largest city in the region with an area of 131 km² and a population of over 1.7 million people. The present study is applied in terms of purpose and descriptive-analytical in nature. In order to achieve the aims of the research, library studies were carried out and then based on the studies, the research framework and the required data were prepared and finally, the results and findings of the research were obtained. The conceptual model of research, based on the research background and the authors' studies, consists of two main steps: First, the ecological continuity assessment of Tabriz metropolitan landscape based on the continuity indices and identifying the most important

* Corresponding Author:

E-mail: mahmoudzadeh@tabrizu.ac.ir

urban green spots. Then, design the optimal corridors and build an ecological network based on the findings of previous steps using graph theories and minimum cost were done.

To evaluate the ecological continuity of Tabriz, two of the most important indices (Cohesion and IIC) at grade level and stain were measured and analyzed using Fragstats 4.2 and Conefor 2.6 software. The Cohesion Stability Index (Cohesion) calculates the degree of consistency and consistency of patches on the landscape based on measurements of the area and environment of the patches, which can be measured in Fragstats software. The Integrity Index (IIC) measures the functional consistency of the landscape using the concept of graph theory using Conefor software. Finally, by analyzing the results of the correlation indices, the most important green spots (core or core spots) of Tabriz were identified. These spots play an important role in the creation of continuous green networks and consequently increase the connectivity of urban ecological spaces and promote the quality of urban environment.

In the second stage of research, using the most important green spots, using Linkage Mapper tool, based on graph and minimum cost concepts, the ecological continuity of Tabriz city and continuous network of corridors and ecological spots were improved. This requires three input data (patches or core habitats in vector format, resistance or cost layer, and Euclidean patches text file), obtained by various tools in ArcMap software. By calling all of the Linkage Mapper software input files and applying the appropriate settings, the lowest cost corridors are plotted, passing mainly the areas where the coverage is less resistant.

Discussion of Results and Conclusions

The results of Cohesion index measurement in Fragstats software, based on the type and nature of land use in the landscape of Tabriz metropolitan area indicate that the lands constructed in Tabriz metropolitan area have the highest correlation with 99/751 and the available ecological spaces (lands). Water, gardens and green spaces are the least correlated among land cover. The analysis of IIC index also shows the most consistency of spots 32, 33 and 34 in landscape of Tabriz city. Finally, analysing the results of the correlation indices analysis (IIC and Cohesion). Also, Google images of green spots of higher importance (based on the patch area and its location in landscape) in Tabriz were used. These spots, which are generally located on the outskirts of the city, play a key role in creating a continuous network of spots and corridors and improving environmental quality.

To improve the ecological connectivity of the landscape, a network of low-cost corridors may be proposed, which usually extend to areas with less land cover, less resistance to displacement and networking. For this purpose, the highest resistance (100 and 80) was made to urban areas and the least resistance (1-50) for green lands (parks, gardens and agricultural lands), vacant land and irrigated lands as the most suitable areas for networking. Given the weight intervals and cost layers, the corridor network only crosses the points of least resistance and connect from one habitat core to another. Finally, communication corridors based on the least cost and graph theory were identified by Linkage Mapper software, which connect the most important green spots in Tabriz metropolis.

Most of the corridors created were drawn around the city like a green belt, mainly due to the location of the main habitats in the suburbs. The central part of the city is also very resistant, so it is not possible to create ecological corridors in this part of the city. The main idea of this research is to create corridors, use of green lands, urban rivers, as well as waste and vacant land in the city that has been abandoned or owned by incompatible land uses. Proper utilization of vacant and waste land for the development of urban ecological networks can provide many ecosystem and social services to residents and improve the quality of urban environment.

Studies at the Tabriz metropolitan area show that the destruction of habitat and urban green patches has been the result of years of poor planning and land management, which would be even more difficult if continued. Therefore, based on the results of this research, using the principles of land landscape ecology and concepts in graph theory and the least cost can be used to simulate and analyse ecological networks and ultimately to provide optimal solutions and operational solutions and optimal development of urban ecological networks.

Keywords: ecological network, graph theory, landscape connectivity, landscape fragmentation, least-cost theory.

Optimization of the Electrolysis Process Efficiency to Improve the Anaerobic Baffled Reactor Performance by Controlling the pH Value for Wastewater Treatment

Gagik Badalians Gholikandi^{1*}, Behnam Inanloo Beklar², Maryam Amouamouha³

1. Associate Professor, Faculty of Civil, Water and Environmental Engineering, Shahid Beheshti University, Tehran, Iran
2. MSc., Faculty of Civil, Water and Environmental Engineering, Shahid Beheshti University, Tehran, Iran (Email: Behnaminanloo@yahoo.com)
3. Ph.D., Faculty of Civil, Water and Environmental Engineering, Shahid Beheshti University, Tehran, Iran (Email: amouha@gmail.com)

Received: August 17, 2019

Accepted: January 24, 2020

Extended abstract

Introduction

In this research, in order to improve the performance of conventional ABR reactors, the use of electrolysis process under optimum conditions by controlling the pH value and minimum electricity consumption on a laboratory scale has been investigated.

In anaerobic reactors, the pH value is strongly influenced by the quantity of carbon dioxide contained in the biogas. Significant variation of pH value and alkalinity occurs because of substrate influence, and acidic-alkaline compounds production during organic matters decomposition process. In this reactor, methanogenesis bacteria is very sensitive to changes in pH value and alkalinity. Therefore, maintenance of optimum operation conditions is mandatory. The suitable pH value for the anaerobic reactors performance is in the range of 6.8-7.2. The alkalinity is initially in the form of bicarbonate. According to Reaction (1), it is in equilibrium with existing carbon dioxide in biogas, at a certain pH value.



For pH controlling in an electrochemical system using metal electrodes, electrolysis of water takes place by means of an electrical current to maintain load balancing. Water electrolysis occurrence results in oxygen and proton formation in the anode sector, also hydrogen and hydroxide in the cathode sector. Consequently, the pH value increases close to the cathode, while reducing pH value is observable in the anode sector. By the reducing pH value around the anode, Reaction (1) proceeds towards the production of carbon dioxide and hydroxide. After the power outage due to the low carbon dioxide solubility in accordance to Henry's law, this reaction becomes irreversible. As a result, the main reason for pH increasing due to the electrolysis is the displacement of the bicarbonate balance and the release of carbon dioxide gas around the anode. Various parameters impact electrolysis process, including electrode material, initial pH value, electric current density, electrolysis process duration, and distance between electrodes. In this study, in order to optimize the electrolysis process for pH recovery, these factors were investigated on a setup in laboratory scale.

Materials and Methods

In order to improve the anaerobic baffled reactor performance, laboratory studies to investigate the electrolysis process effect on the pH value controlling were conducted. Thus, several samples were taken from different chambers of the reactor and the effective parameters on electrolysis process were investigated by focusing on the pH value. Samples were affected by electrolysis using two identical electrodes of iron, stainless steel, copper, aluminum and brass with 12 cm length, 6 cm width and 1 mm thickness at different distances and different contact surfaces.

At each stage of the laboratory studies, in order to get closer to the real conditions during an organic shock, the initial pH value of the wastewater sample was adjusted to the range of 5.00 to 6.50 by using sulfuric acid. Also, with conducting electricity, the capability of each electrode material were investigated. After a period of time

* Corresponding author,

Email: badalians@yahoo.com, G_Badalians@sbu.ac.ir

required for pH recovery, the electric current was cut off and the pH value, concentration of released metals, electrolysis time and electrical current density were measured. All experiments were performed according to the standard methods.

In the experiments, synthetic wastewater (COD = 700 ± 40 and TDS = 633 ± 4 mg/L) was investigated. The wastewater was prepared using molasses, ammonium chloride (0.007 g/g COD) and potassium di hydrogen orthophosphate anhydrous (0.0006 g/g COD). The temperature and pH value of the wastewater were 45 ± 1 °C and 7.77 ± 0.04 , respectively.

Discussion of Results

Investigating the effect of electrodes material

At this stage, five types of iron, stainless steel, copper, aluminum and brass electrodes were tested under the same conditions, and the electrolysis time needed to revive a pH value was obtained. The results showed that the iron electrode can revive a pH unit of the sample in a shorter period of time and also a less electrical energy consumption. Furthermore, according to the results of the spectroscopic test and the inhibitory concentration for each material, it can be seen that copper and brass electrodes cause a release of copper metal more than the permitted limits. Therefore, they are unsuitable for use in this regard.

The results of the economic survey showed that the cost of iron electrode preparation is much lower than the others. Considering all aspects, the iron electrode is the most suitable material for using in the ABR reactor.

Investigating the effect of distance and contact surface of electrodes with wastewater

Under the same conditions, increasing the distance and the contact surface of electrodes can decrease and increase the electrical current, respectively. The reason is the direct relation between the electrical resistance of the solution with the distance of electrodes, its inverse relation with the contact surface of electrodes, and Ohm's law on electrolytes. These effects can neutralize each other, which is important in an economic point of view.

Investigating the effect of electrolysis time

By increasing the electrolysis time, the pH value also increases. While the rate of rising pH is decreasing, as time elapses, the increase of hydroxide and alkalinity occur according to Reaction (1). As a result, due to the buffering properties, the resistance to pH changes increases and this reaction stops. By applying the electrical current density of 8 mA/cm^2 to the iron electrodes, after passing 1.5 hours, the pH value reaches to 9.5. This suggests that by increasing the time, the efficiency of the system and the electric energy consumption will increase.

Investigating the effect of electrical current density

The rate of metal dissolution in wastewater is a function of the electric current density. The increase in the current density causes an increase in the exchange of electrons, which in turn accelerates the electrolysis process. As a result, the efficiency of the electrolysis process increases for the pH recovery. In this study, based on the amount of pH recovery and electrical energy consumption in 1.5 hours, the range ($8\text{-}11 \text{ mA/cm}^2$) was selected as the best range for the current density in laboratory scale.

Investigating the effect of TDS

Concentration of total dissolved solids (TDS) is one of the parameters affecting the current density. Whenever the concentration of these substances is high, the number of charged particles, which are actually electron carriers, will increase. Therefore, the electron transfer is facilitated and accelerated.

Investigating the effect of initial pH value

In order to establish acidic conditions for investigating ability of the electrolysis process with the aim of returning the pH value to neutral and alkaline conditions, initial pH value was determined in several steps in the range of 5.00, 5.50, 6.00 and 6.50. By performing the electrolysis process under optimum conditions, it was found that the lower range of the initial pH value will result in the easier pH recovery. The reason is an increasing in the dissolution of iron atoms by reducing the initial pH value.

Conclusions

Based on the results of previous researches regarding efficiency of electrolysis process to improve the performance of anaerobic reactors, in this study, optimization of the process was investigated on laboratory scale. Based on the obtained results, it can be concluded that the electrolysis process under optimum operation conditions in terms of operational and economic parameters is an appropriate option for upgrading the anaerobic baffled reactors performance.

Keywords: anaerobic baffled reactor, electricity consumption, electrolysis process, pH adjustment, wastewater treatment.

Management Model Presenting for the Continuation of Activities and Services After the Crisis (Case Study: The Headquarters of Tehran Water and Wastewater Company District 3)

Gholamreza Nabi Bidhendi^{1*}, Aghil Olya²

1. Professor, Department of Environmental Engineering, School of Environment, College of Engineering, University of Tehran, Tehran, Iran

2. Ph.D. Student, Department of Crisis Management, Research Institute of Shakhesh Pajouh, Isfahan, Iran (Email: Farolya@yahoo.com)

Received: May 30, 2019

Accepted: March 2, 2020

Extended abstract

Introduction

Water and residue companies, both urban and rural, are legally responsible for providing adequate safe drinking water. Disruption of water quality and its distribution can be caused by emergencies such as natural disasters, distress, and deliberate actions. Any disruption in quality and access to safe drinking water after a natural disaster can cause widespread disruption in the city and add to problems during a crisis; Therefore, the continuation of the activities and services of this unit during a natural disaster such as an earthquake can help a lot in crisis management and increase the flexibility of the city and cause the rapid return of the city to its normal state.

The Business Continuity Plan strives to provide the organization with the appropriate response and timely response to the crisis to bring the organization to a level of readiness that can provide services to its customers in the shortest possible time and based on pre-defined plans. Resume and, at best, go through the transition from a critical situation to a normal one. Proper implementation of this plan, while creating the ability to react and respond appropriately to crises and reduce the time to return to normal, can achieve various achievements such as expanding the preventive approach instead of passive in the face of crisis, reducing insurance costs, creating a sense of trust and reliability, providing customers, users, and related organizations and significantly reduce the direct and indirect costs of a crisis.

One of the most important factors in increasing or decreasing the amount of damage and the number of human losses during natural disasters is the presence or absence of a crisis management system. One of the methods that can be used to prepare and compile crisis management and planning principles, and recently used in books written on crisis management, is to use the comprehensive process of crisis management and its phases to classify and present principles. In this model, crisis management principles are divided into four phases (prevention and reduction of effects, preparedness, coping, recovery), which include both planning and management.

Materials and Methods

In this study, library studies, reference to relevant organizations and field visits, and interviews with experts on urban issues and crisis management have been used. Analysis hierarchical process (AHP) has also been used for the required analyzes. First, the general framework of the extraction plan has been extracted using library studies and the use of international experience in the field of post-disaster Business Continuity Plan. Then, questionnaires were designed to fill this sample and localize it for the headquarters of Water and Wastewater Company District 3 of Tehran. After compilation, these questionnaires were distributed among experts active in the field of crisis management, water, and wastewater in the city of Tehran's District 3. In the first part of this questionnaire, the necessary measures to continue the activities before, during, and after the accident in the headquarters area of Tehran Water and Wastewater Company District 3 have been questioned. After collecting the questionnaires, this part of the questionnaire was analyzed through SPSS 19 software and a two-sentence test. The output of this test is included in the Business Continuity Plan. In the second part of the questionnaire,

* Corresponding Author:

E-mail: ghhendi@ut.ac.ir

through the hierarchical structure, the person in charge of accident management and management in the company, as well as alternative sites for the continuation of the company's activities and services after the accident, were questioned. Experts have rated the questionnaires based on the AHP principles. Finally, using the Expert Choice 11 software and analyzing the data given by the experts, the options that have the highest score for this question have been identified. The use of qualitative and quantitative criteria, as well as the ability to adapt to judgments, are features that determine the AHP method to determine the coefficient of the importance of the parameters used in the research, to identify and select a suitable alternative site and project command to continue ABFA headquarters activities after the Earthquakes show. The first step in the hierarchical analysis process is to create a hierarchical structure of the subject matter in which the goals, criteria, options, and relationships between them are demonstrated. The next steps in the hierarchical analysis process that will be used in this research are weight calculation (coefficient of importance) of criteria, calculation of weight (coefficient of importance) of options (different types of alternative sites and different people for project command responsibility) and finally, logical compatibility review of judgments.

Discussion of Results

In this study, a responsible organizational chart is presented. It's necessary to take a series of measures in places and buildings that are important or have a higher level of vulnerability in terms of performance, to take the first steps to deal with, and respond in the same place in critical or emergencies. To determine the crisis command was experts evaluated the Business Continuity Plan approach, parameters such as the individual's organizational strength to command in times of crisis and better performance and efficiency in times of crisis. Scoring and prioritization were done using the AHP method. The results of this analysis, which were obtained by entering the requested information from 10 experts in the Expertchoice11 software, show that the head of Water and Wastewater Company District 3 of Tehran, has been selected as the best person to command the crisis from the experts' point of view.

The correct and appropriate response to a crisis in the organization requires a team to lead and support response and recovery operations. Team members must be selected from experienced and trained staff who are aware of their responsibilities. The number and scope of teams' activities can include command and control teams, which include a crisis management team and a response, continuity or recovery management team, and operational teams.

To select an alternative site for the continuation of Water and Wastewater Company District 3 of Tehran's organizational life, parameters such as organizational policy, cost of equipment and maintenance, earthquake vulnerability, and maximum allowable time for the company's inactivity were evaluated by experts and options based on AHP guidelines. They scored points against each other. These scores were then entered into the Expertchoice 11 software and analyzed. The obtained results showed that the experts gave the maximum score to the hot site, and the warm site is in second place. The first step in the Business Continuity Plan should include an organizational structure that often takes the form of a committee that ensures the executive guarantee of senior executives and defines the role of senior executives and their responsibilities after studying and review the BS-25999 standard. And the localization of this standard, based on the organizational criteria of the Water and Wastewater Company, led to the introduction of a committee to continue activities and services before the crisis and a responsible organizational chart at the time of the crisis.

Conclusions

Predicting and determining an alternative site to continue the company's activities after the crisis is an important issue in the Business Continuity Plan. Among the options and according to the appropriate criteria, as well as questions from relevant experts and scoring based on AHP principles and analysis and analysis of the results of the questionnaire with the software Expertchoice 11, the hot site was selected as the best site to continue the activities and services of Tehran Water and Wastewater Company District 3. A hot site is a well-equipped and multi-purpose site that also has staff at the time before the accident. This site can be activated in the shortest time after the accident, and in the time before the accident, administrative activities can be performed in it. For the continuity plan to always be up-to-date and scalable, it must be continuously tested and revised, as provided in the 2-year timeframe for this issue.

Keywords: BS-25999 standard, business continuity plan, crisis management, earthquake, Tehran Region 3 Water and Sewerage Company Headquarters.

Evaluation of Risk Potentials and Determination of Zn, Pb and Cd Source in Soil around Angouran Mineral Processing Complex

Zahra Sheikhi Alman Abad¹, Hossein Pirkharrati^{2*}, Monir Mojarrad³

1. Ph.D. Student of Environmental Geology, Department of Geology, Faculty of Science, Urmia University, Urmia, Iran (Email: Z.Sheikhi@urmia.ac.ir)
2. Associate Professor, Department of Geology, Faculty of Science, Urmia University, Urmia, Iran
3. Associate Professor, Department of Geology, Faculty of Science, Urmia University, Urmia, Iran (Email: M.Modjarrad@Urmia.ac.ir)

Received: October 4, 2019

Accepted: January 26, 2020

Extended abstract

Introduction

The intensity of human activities throughout the recent decades has led to significant changes in the balance of nature. Recent industrial development has resulted in a remarkable increase in pollution loads imposed by toxic metals, which are a significant environmental hazard for invertebrates, fish, and humans. The factories which concentrate and process heavy metals increase their levels in the soil. Exposure to heavy metals increases the possibility of health risks for residents in the area.

Soil is a bed to accumulation of nutrient and pollutant and plays an important role in environmental sustainability. Among all types of soil pollutants, heavy metals are considered as a major threat to environmental health due to their non-degradability in the environment and their long life span. Heavy metals are naturally present in the earth's crust. Rocks and minerals have a high impact on the concentration of elements in the soil and sometimes increase the elements concentration in the soil beyond the permitted level. Besides, the human activities such as mining and related processing cause heavy metals propagation in the environment.

Angouran Mineral Processing Complex includes lead and zinc concentration complexes along with the zinc factory and is located in Dandi Industrial Zone in the Mahneshan, Zanjan province in Iran. AMPC has a production capacity of over 23,000 tons per year and is one of the largest producers of Iran with more than four decades of operation. It is located in the Angouran protected area which is one of the oldest protected areas of Iran with a total area of 1,250 km². Almost 300 km² of this area constitutes the Angouran wildlife refuge. Ghizil Ozen and Angouran Chay rivers flow through the area, which is home to dozens of aquatic bird species, seven amphibian species and eight fish species. Many of the rare animals of Iran are found in this area. There are about 200 plant species in Angouran. It is located in a protected area and expands metal industries. The main activities of its inhabitants are agriculture and animal husbandry. The area which is under cultivation of agricultural and horticultural products in Mahneshan city comprises 11% of the total area of Zanjan province. Moreover, 81% of this area is utilized for the cultivation of annual agricultural products and 19% of it is used for the cultivation of horticultural products. The accumulation of industrial, agricultural and animal husbandry poles along with the habitats of different species in one area can potentially have some environmental problems which need to be investigated. This issue stems from the fact that the development of industrial activities, especially processing and concentrating units of heavy metals, increases the concentration of these metals in soil and other environmental sources and exposes humans to them. These elements gradually accumulate in the soil due to low mobility, and their entry into the food cycle and the environment causes problems for human health and other living organism. Studies showed that in Dandi industrial zone, the environment of the region, was negatively affected by the accumulation of waste being left as cake on the margins of rivers and streams or open (mainly agricultural) lands. This cake, which is in fact waste from flotation and smelting of lead and zinc and concentrate production processes, may have lost most of its lead and zinc from an industrial perspective. However, from an environmental point of view, it contains amounts of other potentially toxic elements including As, Cr and Co which greatly exceed the allowable limits. Moreover, their study showed that waste pools or effluent pools were another major risk factor for the environment of the region. The agricultural soil of this area was affected by these contaminants and had major environmental anomalies.

* Corresponding Author:

E-mail: H.Pirkharrati@Urmia.ac.ir

Hence, the purposes of this study were to determine the spatial pattern of Zn, Pb and Cd spreading around Angouran Mineral Processing Complex, to investigate their potential risk using different environmental indices, to identify ecological risk and carcinogenic risk, and to determine the contribution of anthropogenic and geogenic origin.

Materials and Methods

Angouran Mineral Processing Complex, with geographical coordinate of 36°34'20" N and 47°37'40" E. The area is located in a metamorphic complex of the Sanandaj-Sirjan microplate in the Zagros orogenic belt affected by the Tertiary to Quaternary volcanic activities as well as the geothermal activities of the Urumieh-Dokhtar zone. It is composed of the present age river banks and alluvial deposits in the center along with conglomerate and red tuffs in the northern part.

About 15% of the area is irrigated and its 70% is used as pastures. It has been one of the protected areas of the environment and has enabled tourism activities in order to preserve and restore plant and animal habitats for four decades until the present day.

Soil sampling was done from 0-20 cm depth in June 2016 (n=74). After preparation of the samples, they were sent to the Zarazma laboratory for analysis of Zn, Pb and Cd by ICP-OES. In order to analyze the total concentration of heavy metals, the samples were digested using the four-acid digestion method, including hydrofluoric acid, perchloric acid, nitric acid, and hydrochloric acid. For this purpose, each air-dried sample was weighted in a crucible, 5 ml concentrated nitric acid was added to it, and it was kept at ambient temperature for 30 min. Then, 10 ml of perchloric acid and 2 ml of concentrated hydrofluoric acid were added to it. It was placed on a heater, and its temperature was increased to 100°C. Since this method's goal was the complete digestion of the solid sample, the addition of hydrofluoric acid continued until the sample became transparent. In the end, 10 ml of concentrated hydrochloric acid was added, and the sample was kept at the same temperature for 10 min. After the sample was cooled, it was transferred to a 50 to 100-ml volumetric flask, and it was brought up to the volume using double-distilled water. All chemicals used in this study were provided by the credible German Merck brand.

Analytical duplicates/replicates, standard reference material (OREAS 24b, and GBM908-10), and blank reagents (with an accuracy of 4% to 6%) were used for QA/QC. The detection limits for Cr, Co, As, Ni and Cu were 1, 1, 0/5 and 1, respectively. Statistical analysis of the data and index calculations were performed using Excel and SPSS software. Also, PMF 5.0 EPA (Positive Matrix Factorization) software was used to determine the source contribution to metal dispersion. Applied indices include enrichment factor (Ef), Geoaccumulation index (I_{geo}), pollution load indices (PLI) and modified pollution degree (mCd), ecological risk potential (PERI) and cancer risks (CR).

Discussion of Results

Soil in the study area is in a poor and serious condition that threatens agriculture and animal husbandry, the main activities beside the industrials. Zn had the highest concentration with an average of 1648.1 ppm in the region and followed by Pb and Cd with mean of 467.9 and 9.8 ppm, respectively.

The high coefficients of variation of metals showed the effect of anthropogenic activities on their distribution in the region.

The I_{geo} mean for Pb, Zn, and Cd were 1.7, 2.0, and 0.4, respectively, which indicated average contamination of Pb and Zn and non-contaminated to intermediate contamination of Cd. I_{geo} 's result showed that the metals accumulation order was Zn > Pb > Cd. The extent of metal contamination was -2.4 to 8.9 for Pb, -0.4 to 8.3 for Zn, and -2.4 to 7.1 in terms of Cd, suggesting negative values for these metals which are in the range of non-polluted soils. High Cd contamination was observed only in 4.9% of the samples while EF showed high Cd enrichment (72/1). The mean Ef calculated for Zn, Pb and Cd were 37.1, 45.7 and 72.1, respectively, suggesting strong enrichment for Zn and Pb, but extremely strong for Cd. Cd is the most mobile metal in the soil and is likely to be absorbed through the plants roots. The enrichment degree for all three metals in the region is wide. Contamination severity ($Ff > 10$) in total observed for Zn, Pb and Cd in 29.6%, 25.6% and 59.4% of samples, respectively, which indicates very high impact of anthropogenic contamination sources. Given the various toxic effects of metals on the human body, the PERI index of metals in the soil varies from 42.8 to 35500.5 and showed a high environmental risk for Cd than for Zn and Pb. Based on classification, 35% of sampling points showed high ecological risk.

The metal contamination degree in the soil was higher than expected. In the study area, mCd ranged from 0.8 to 723.4 and 60% of the samples showed high contamination. PLI calculation showed that contamination range is between 0.7 and 627.8. The contamination range calculated by mCd and PLI revealed that 60% and 40% of the area is in very poor and inappropriate condition.

CR for adults ranges from 0.2×10^{-2} to 0.5×10^{-5} while the mean is 0.1×10^{-3} . Unexpectedly, Zn with an impact of 96.9% had the highest share in the carcinogenic risk of ingested contaminated soil. CR for children varies from 0.4×10^{-2} to 0.9×10^{-5} with a mean of 0.2×10^{-3} . Similar to the results obtained from adult CR, Zn with 99.1% had the greatest effect on the carcinogenesis probability due to ingestion. Based on the CR classification, the risk was middle and upper class for children.

The CR calculation for children and adults showed that the ingestion risk of contaminated soils contain Zn had the greatest effect on the risk of carcinogenicity and health problems. Absorption via skin and respiration of Zn, Pb and Cd were the next highest risk factors.

PMF model was used to quantify the different sources contribution in Cd, Zn and Pb pollution. Comparing the metals prevalence in each factor and the information obtained from the regional field for the probable source of heavy metals, two factors were considered to the probable source of the heavy metals. Geogenic origin was the first-factor and anthropogenic origin was the second one. According to the results, the concentration of Zn in the second factor was 99% while in the first factor was 1%. Pb and Cd the second factor were estimated to be 90.2% and 95.7%.

Conclusions

This study was carried out to investigate the carcinogenic and non-carcinogenic health risks of Zn, Pb and Cd in the soil around Angouran Mineral Processing Complex, which includes lead and zinc concentration complexes and zinc production factory. This area was selected due to the fact that it is environmentally sensitive. Moreover, in addition to industrial activities including the concentration and processing of heavy metals, it is used for agricultural activities, pastures, and animal husbandry. Lastly, it is the habitat for various and rare animal and plant species.

Concentration result showed that the metals order was $Zn > Pb > Cd$. It can be concluded from the Igeo and Ef index that samples collected from this area have enriched and contaminated by the examined heavy metals. Based on PERI classification, most of sampling points showed high ecological risk and showed a high environmental risk for Cd than for Zn and Pb in the study area.

mCd and PLI result showed a significant risk in agricultural land use. In developing countries, there are very few studies which have examined the exposure to heavy metals. Soil and dust ingestion was a potential source of exposure to environmental chemicals for both adults and children. Children may, in particular, consume large amounts of soil because of their tendency to play on the ground and carry the soil coated objects to their mouths. Due to the wide range of industrial activities in the region, agriculture in the study area poses a greater risk of carcinogenicity for the adult population. This issue stems from the fact that the farmers' ingestion of soli particles which stick to their hands, dermal exposure during farm work hours, or inhalation of polluted soil and dust pose a higher risk.

According to an obtained results from PMF model, the greatest impact on Zn concentration in the region is due to anthropogenic activities. Therefore, there is a need to reduce the risk of exposure to soil metals in order to maintain the health of the residents' health and sustainability of the environment and animals in the area, including soil refining.

Keywords: Angouran mineral processing complex, anthropogenic, ecological risk, enrichment.

Optimization of Meteorological Variables to Predict Air Pollutant Concentrations for Use in Artificial Neural Network Model to Reduce the Cost and Time of Analysis

Afsaneh Ghasemi¹, Jamil Amanollahi^{2*}, Mohammad Darand³

1. MSc., Department of Environment Science, Faculty of Natural Resources, University of Kurdistan, Iran (Email: afsanehgh.991@gmail.com)
2. Associate Professor, Department of Environment Science, Faculty of Natural Resources, University of Kurdistan, Iran
3. Associate Professor, Department of Climatology, Faculty of Natural Resources, University of Kurdistan, Iran (Email: m.darand@uok.ac.ir)

Received: October 31, 2019

Accepted: March 11, 2020

Extended abstract

Introduction

Today, air pollution is one of the main and most harmful problems in human societies, which has caused many environmental problems. Air quality is changing daily, even when the amount of pollutants entering the air is constant, factors that determine climate change, such as wind speed, wind direction, air mass thermal profile, amount of solar energy to perform photochemical reactions, wind duration or rainfall, alter air quality specifically. The air has a limited capacity and does not tolerate the discharge of various wastes and toxins that humans enter today.

Air pollution in cities is always a permanent and serious threat to the health and safety of the community and the environment. Recent studies show that the potential effects of air pollution on human health include increased mortality, increased hospitalization, and increased physiological changes in the body, especially respiratory and cardiovascular function. The exponential increase in population has led to rapid deforestation, rapid growth in industries and multiplicity of vehicles. Accelerating unmanaged urban development has led to a change in the chemical composition of the atmosphere which is associated with human activities. Industries, vehicles and other natural or human resources add a huge amount of air pollutants to the environment, which will lead to the destruction of air quality, and this has led to damage part of the environment. Predicting air pollution before increasing the level of these contaminations and prompt alarm can contribute to the health of the community. On the other hand, an increase in the number of independent variables would increase the cost and also increase the time required for predicting air pollution. Therefore, in this study, Forward Select (FS) technique was used to obtain the most suitable combination of independent variables with the most accurate prediction of specific contaminants in the artificial neural network (ANN) model.

Material and Methods

Kermanshah is an extensive city in the west of Iran country having industries and thunderstorms. The total population of Kermanshah city was 1952434 in the 2016 population census and its area is 250.45/4 km². This city is located in the middle of the western part of the country between a geographic orbit of 33°41' N to 35°17' N latitude of the equator and 45°24' E to 48° 0.6' E longitude of the Greenwich meridian. In this research, relative humidity, temperature, dew point, precipitation, pressure, wind speed, and visibility with the previous day's pollutant concentration were used as independent data. The Bureau of Meteorology (main synoptic station) of Kermanshah provided the meteorological data from 2014 to 2016. The five pollutant data consisting of Sulphur dioxide (SO₂), particulate matter PM₁₀, carbon monoxide (CO), nitrogen dioxide (NO₂), ozone (O₃) related to the air quality of Kermanshah were acquired from the Department of Environment (monitoring station) in Kermanshah from 2014 to 2016. The collinearity indicates that an independent variable is a function of the other variables. The Multi-collinearity test means that there is a linear relationship between two or more independent variables in the regression. If the collinearity of a regression equation is high, it means that there is a high dependence between the independent variables and it may not have a high validity due to the high

* Corresponding Author:

E-mail: j.amanollahi@uok.ac.ir

coefficient of determining the model. In other words, although the model looks good but has no significant independent variables. Therefore, if the variables have a large linear relationship, the estimated statistics and regression coefficients may not be able to show the unique role and effect of each of the independent variables.

Multi-collinearity test was performed to remove additional input variables in SPSS software. The correlation between the independent and dependent variables is measured by two indicators of Variance Inflation Factor (VIF) and tolerance. The Variance Inflation Factor (VIF) indicates how much the variance of the estimated regression coefficients has increased since there are no correlated variables in the model. If the value of this index is close to one, there is no linearity. The relative tolerance factor is the relative scatter of a variable. If its value is close to one, it means that in an independent variable a small part of its scattering is justified by other independent variables, and if this value is close to zero, it means that one the variable is almost a linear combination of other independent variables. If the VIF values of the independent variables are more than 10 and tolerance is less than 0.2, then it can be said that the model is suffering from multi-collinearity.

To quantify the severity of the multi-collinearity, tolerance and Variance Inflation Factor (VIF) results were used. The Forward Selection (FS) method is based on regression and was used to select the best subsets of input variables. The Forward Selection (FS) technique has been used by many researchers to build powerful predictive models. This method is based on the degree of dependence of the independent variables with the dependent. After that, the variable that creates the most dependence with the dependent variable is considered as the first input and the variables with less dependence constitute a set of subsequent inputs. This step is repeated $n-1$ to evaluate the effect of each of the variables on the model output. A subset of the input variables is obtained to predict the outputs. The linear relation between variables created several models for each pollutant. Then the application of Multi-Layer Perceptron (MLP) network was used to predict pollutants in Matlab software.

To reduce errors and increase accuracy in forecasting, both independent and dependent data were normalized between zero and one. Neural networks are nonlinear models that are widely used to identify systems, predict time periods, and pattern. These networks can be tools for the flexibility of nonlinear regressions, which are generally composed of one or more layers with different neurons. The structure of the neural network typically consists of three layers, the input layer that distributes the data in the network, the hidden layer that processes the data, and the output layer that extracts the results for specific inputs. The Multi-Layer Perceptron (MLP) network has a hidden layer, and the flow of input to the network takes place in a forward path from layer to layer. There are two kind of signals in the Multi-Layered Persephone (MLP) network, the function signal that travels in the path of departure, and the error signal that propagates in the return path of the network. One of the features of this network is its good computing features.

The Multi-Layer Perceptron (MLP) model is the most general network for predicting air pollution. It can solve nonlinear and very complex problems through the network topology. In this study, 20% of data were used in the training phase and 80% data in the test phase. The results obtained from the models were evaluated with indicators. The Root Mean Square Error (RMSE), Coefficient of determination (R^2), Normalized mean square error (NMSE), Fractional bias (FB), and the Index of agreement (IOA) indicators were used to determine the performance of the models. The Root Mean Square Error (RMSE), summarizes the difference between the observed and predicted concentration and shows the actual error model. Therefore, in an optimal model, the Root Mean Square Error (RMSE), should be close to zero.

The Coefficient of determination (R^2), indicates how much of the changes in the data observed by the model have been reproduced. The high Coefficient of determination (R^2) is a sign of desirability. A very small amount of the Normalized mean square error (NMSE), index indicates the implementation of the model in space and time, which is closer to zero, indicating the optimal model. Fractional bias (FB) indicates the low and high values of the predictions. If Fractional bias (FB), is equal to zero, it indicates that the forecast was very accurate. The Index of agreement (IOA) is a useful measure of model performance and has been proposed as an alternative to R and R^2 . This index is considered as the standard for measuring the mean square error.

Discussion and Results

In this study, to predict air pollutants in Kermanshah city and optimization effective variables in forecasting were used from the multi-layer perceptron model and Feature Selection (FS) technique. Results showed that relative humidity and temperature with VIF values of more than 10 and tolerance values below 0.2 exceeded the recommended value. After eliminating the both mentioned variables, the multi-collinearity test was repeated and results indicate that all variables were obtained within the recommended limit. The different subset of variables was developed using FS method by added one by one the variables constitute most to least correlation between input variables and dependent variable. For each pollutant, seven models were evaluated, but for O_3 pollutant, eight models were calculated due to the effect of pollutant NO_2 . The results of multilayer perceptron neural network analysis show that, MODEL 1 with $FB= 0.0170$, $IOA= 0.967$, $NMSE= 0.100$ and the highest $R^2= 0.7341$ was suitable for same-day predicting of CO. To predict one-day advance of CO, MODEL 2 and MODEL

5 have the highest R^2 values, but IOA statistics in MODEL 2 is more than MODEL 5, and the values of FB and NMSE in MODEL 2 is lower than that of MODEL 5. So, MODEL 2 is more suitable for one-day advance of CO pollutants.

In predicting the PM₁₀ pollutant, the MODEL 4 has a maximum value of IOA= 0.960 and FB= 0.00151 with one of the lower value than other models in same day predicting of PM₁₀, and the MODEL 4 has the lowest amount of NMSE= 0.487 and RMSE= 0.0718 in one-day advance predicting of PM₁₀. So, MODEL 4 is selected for prediction of PM₁₀ pollutant as the optimal model. The prediction results of SO₂ pollutant indicate that the MODEL 3 has the lowest FB= -0.00302 and NMSE= 0.135 and the highest IOA= 0.943 and R^2 = 0.6118, respectively. Therefore, this MODEL is perfect for same-day prediction of SO₂ concentration.

Based on the result MODEL 6 with lowest values of NMSE= 0.105, FB= -0.0048, and the highest IOA= 0.972 is suitable MODEL for predicting one-day advance of SO₂.

In predicting NO₂ the MODEL 2 and MODEL 3 represents the highest performance compared to other models in same-day and one-day advance in prediction of NO₂ pollutant. Comparing the two models mentioned for NO₂ shows that both models have the same conditions in minimum and maximum values of the statistics, so considering the RMSE of the test phase, which is less in model 2 than model 6, indicate that model 2 it is a more appropriate model in predicting NO₂. The prediction results of the O₃ pollutant indicate that the MODEL 7 in the same day forecasting and the MODEL 5 in one-day forecasting in terms of the IOA index have the same value, and the indexes NMSE= 0.00120 and FB= 0.00137 in the MODEL 5 have the minimum values and in model 7, the value of R^2 = 0.711 is highest, so the input composition of MODEL 5 is considered as the optimal model.

Advantages of the Forward Selection (FS) technique include improving model accuracy, reducing computational time in model construction, facilitating data visualization and model understanding, and reducing excessive risk. The main idea of this technique is to evaluate the most useful subset of variables for a given learning algorithm, and the best subset of features is determined by the performance of the model. So, selecting the optimal model using FS technique has provided the possibility of saving time and reducing calculations cost, and by determining the final optimal model for each contaminant and selecting the most effective quantities in forecasting, it is possible to predict with more accuracy and less error.

Conclusion

Air pollution is a concern in many societies today, so choosing the best model for predicting pollutants in the atmosphere and using effective methods to determine the most important effective quantities is beneficial. Based on the results obtained, the final optimal model of model 2 with 6 independent variables is optimal for CO pollutant, and model 4 with 4 meteorological quantities is optimal for PM₁₀ contamination. For pollutants SO₂ model 6 with 2 independent variables and for pollutants NO₂ model 2 with 6 variables were selected as optimal and model 5 with 4 effective quantities is optimal for pollutant O₃. In general, the results of this study show that use of multi-collinearity test and forward select technique to eliminate linear relations and create a subset of effective variables is satisfactory. The results of this study showed that for the prediction of any pollutants, no need to use all seven variables from the output of the multi-collinearity test. The optimal number of independent variables for the prediction of each pollutant was obtained differently. Therefore, we can conclude that the selection of effective independent variables by FS method will reduce the analysis cost and time, as well as increase the accuracy of the pollutant predictions.

Keywords: air pollution, FS technique, Kermanshah, multi-collinearity, multi-layer perceptron network.

The Scenario base Calculation of Ecohydrological Water Needs for Sustainable Development of Water Resources (Case Study: Kaji Salt Wetland of Nehbandan)

Mohammad Hossein Sayadi^{1,2}, Elham Yousefi^{3*}, Elham Chamanehpour⁴

1. Associate Professor, Department of Environment, Faculty of Natural Resources and Environment, University of Birjand, Birjand, Iran (Email: mh_sayadi@birjand.ac.ir)
2. Associate Professor, Department of Environment, Faculty of Natural Resources and Environment, University of Ardakan, Ardakan, Iran
3. Assistant Professor, Department of Environment, Faculty of Natural Resources and Environment, University of Birjand, Birjand, Iran
4. Ph.D. Student in Environmental Sciences, Faculty of Natural Resources and Environment, University of Birjand, Birjand, Iran (Email: elham.chamanehpour@gmail.com)

Received: October 24, 2019

Accepted: February 8, 2020

Expanded Abstract

Introduction

Wetlands are actually the kidneys of the earth that lead to the environmental balance of the earth. Wetland is a unique environmental system with diverse performance and high biodiversity. Wetlands cover approximately 5 to 8 percent of the earth's surface (7-10 million km²) and must be preserved in order to maintain their important functions as natural habitats and their role in the global carbon cycle. Wetlands have high primary productivity among all ecosystems and provide many ecological services, including environmental treatment, modification in the atmosphere and water cycle, wave intensity reduction and disasters resulting from them. However, a large proportion of wetlands in the transition zone from marine-river ecosystems lies in terrestrial ecosystems, making them a sensitive and fragile ecosystem. Due to changes in natural environments, over-exploitation of wetlands and irrational use of their resources, the structure of wetland ecosystems has been destroyed and the boundaries of wetlands are gradually shrinking, which leads to damage or their ecological performance is lost. Therefore, it is necessary to revive wetland systems through efficient engineering technologies and logical management approaches. In order to provide a scientific basis for protection and restoration, it is necessary to examine the ecological water requirement of the wetland. According to studies, the ecological water requirement is equal to the amount of water that maintains the balance of the wetland ecosystem and guarantees its main functions. The main methods of calculation for the ecological water needs of wetlands include hydrological, ecological and eco-hydrological methods. The eco-hydrological method is a combination of hydrological and ecological methods and considers all the required rules of ecological water of wetlands and combines the advantages of these two methods. Today, remote sensing is an alternative to terrestrial measured data. Studies have shown that remote sensing data provide many benefits, including high time resolution, spatial distribution, and data access for monitoring and evaluating ecosystem time patterns. Therefore, they are a powerful tool for monitoring wetlands. Researchers are trying to balance the ecological needs of the wetland with the rational allocation of water resources. Achieving this balance can ensure the natural flow of water in order to improve the overall ecological performance of the wetland system, with the aim of restoring its function and rebuilding its ecosystem.

Materials and Methods

In studies of calculating the water requirement of wetlands, the functions of the study wetland should be identified first and the index should be determined for each function. The indicators should be determined in such a way that in addition to maintaining the main functions of the wetland, its functions are also maintained. Due to the characteristics of Nehbandan wetland, including water with salinity and high salts, lack of aquatic animals, lack of endangered species related to wetland water, as well as special socio-economic and cultural factors related to wetlands such as special traditional ceremonies. This wetland does not have a special production, socio-economic and cultural function and its most important functions are from the point of view of physicochemical, biological and ecosystem services.

* Corresponding Author:

E-mail: e_yusefi_31@birjand.ac.ir

After identifying these functions, an indicator was selected for each of them to calculate the amount of water required of the wetland. Maintaining the area of the main spot of the wetland in minimum and maximum amount as a physicochemical index, maintaining the area of the main spot of the wetland in medium size as an ecosystem services index and preserving plant and animal species related to the wetland were selected as biological indicators.

The MNDWI index was used to identify the water area of the wetland. After determining the boundaries of the wetland, in a process using the detection of the wetland underwater surface and depth measurement with satellite images, the volume of water at different levels was calculated according to the shape of the wetland bed and water depth. The water balance formula was used to calculate the hydrological needs of the wetland. The average amount of precipitation in the region was calculated using the monthly data of TRMM satellite, the amount of evapotranspiration was calculated using Modis satellite data and the amount of runoff was calculated using Terra climate data. After calculating the hydrological water requirement, three species of tamarix aphylla, haloxylon aphyllum and phragmites australis were selected as plant indicators and anas platyrhynchos were selected as animal indicators and the ecological water needs of the wetland were calculated.

After calculating the indicators, the amount of water demand of Nehbandan wetland is examined during 6 scenarios so that while identifying the condition of the wetland in different scenarios, it is planned to achieve the ideal situation. These scenarios include the following:

1. Determining the hydrological water requirement of the wetland according to the average size of the wetland's main spot or normal condition
2. Determining the hydrological water requirement of the lowest size of the wetland's main spot or drought condition
3. Determining the hydrological water requirement of the wetland according to the highest size of the wetland's main spot or wet year condition
4. Real scenario of wetland's vegetation water requirement
5. Ideal scenario of wetland's vegetation water requirement
6. Determining the wetland's water needs of animal species index

Discussion of Results

In this study, in order to preserve and revive the Nehbandan wetland, its hydrochloric water requirement was calculated in 6 different scenarios. The wetland water balance was used to calculate the hydrological water needs of the wetland and the species of Haloxylon aphyllum, Phragmites australis, Tamarix aphylla and Anas platyrhynchos were used to calculate the ecological water needs of the wetland. The hydrological water balance of the wetland was estimated through the following equation:

$$\frac{\Delta S}{\Delta T} = \text{input} - \text{output} = P + Qi + Gi - ET - Qo - Go$$

$$\frac{\Delta S}{\Delta T} = \text{input} - \text{output} = 1.3333 + 12.2 + 0 - 13.785 - 0 - 0 = -0.452$$

In this equation, ΔS shows the water changes of the wetland in the period ΔT . P is the direct input from rainfall, Qi is the direct input from runoff and surface rivers, Gi is the amount of wetland feeding through groundwater, ET is the amount of evapotranspiration, Qo is the amount of direct output from the wetland and Go is the amount of discharge through groundwater. The results showed that currently the water balance of the wetland is negative and the outflows of the wetland are 0.452 million cubic meters more than its inputs.

Using the MNDWI index, the highest area of the wetland was calculated in May 2016 and amounted to 20 km², the average limit of the wetland in May 2017 was 8.8 km² and the minimum limit of the wetland was 6 km² in November 2018. Therefore, due to the depth of the wetland in different years, which varied between 10 and 30 cm, the volume of water in these three areas was calculated.

Therefore, in order to maintain the main spot of the wetland in the cold months of the year, 0.65 million cubic meters of water is needed for minimum extent, which is 1.32 million cubic meters in average extent and 6 million cubic meters in maximum extent.

According to the calculations, the amount of wetland water required in real scenario of plant water need is 0.1026 million cubic meters, that this amount in ideal scenario of plant water need is 0.12345 million cubic meters.

Also, the water needs of the wetland in order to preserve the important animal species is 0.0003479 million cubic meters. Hydrological wetland water requirement according to the low, average and high spot level of wetland are 13.3, 13.97 and 18.65, respectively.

In the section of biological indicators, *Phragmites australis* was introduced as the most abundant wetland species to calculate the plant water requirement. Since, there is no real amount of evapotranspiration of this plant, alternative methods can be used to calculate the amount of evapotranspiration of *Phragmites australis*. In this study, Thornth Waite method was used.

Also, since ducks are one of the most important species observed in aquatic environments, mallard were used in this study. Liu et al. (2018) also introduced rare ducks such as mallard as a suitable species using as an indicator to calculate the water needs of wetlands. Therefore, using these two species as a biological indicator to calculate the ecological water needs of the wetland is very useful, especially in the study wetland, which has a very low species diversity.

In the discussion of calculating the hydrological water requirement of the wetland, using the water balance equation can be an effective approach to control the volume of water withdrawn from the wetlands, because this equation considers all inputs and outputs of the wetland.

Therefore, by maintaining the volume of water in the wetland, its ecological status can also be maintained. On the other hand, by reducing the output of the wetland, its condition can be restored and improved.

As mentioned, the most important factor in calculating the water balance is the amount of evapotranspiration, which in order to manage the wetland, especially in arid and semi-arid areas, the correct calculation of this parameter is very important. In this study, the value of this parameter was estimated by using satellite data and Penman-Monteith algorithm.

uttolomondo et al. (2016) also used plant evapotranspiration data using Penman Mantis method to calculate this parameter. They also concluded that the most important factor in the amount of wetland water balance is the evapotranspiration parameter. During the study, it was observed that the MNDWI index is one of the best indicators for separating water zones from land because it is able to show canals and waterways better than other indicators such as AWEI. So, it shows the border of the blue zone very accurately

Conclusions

According to the obtained results, in order to provide the average level of water stain in the cold months of the year (the time of the presence of the wetland), Nehbandan saltwater wetland, with a water volume of 13.97 million cubic meters per year, needs water, which 12.2 million cubic meters are supplied via surface runoff. Therefore, there is a shortage of 1.77 million cubic meters, which must be met by reducing the area's groundwater abstraction by about 20 percent. Also, in order to maintain and develop the vegetation of the region in an ideal condition, the annual need for water is equal to 0.12 million cubic meters. This is equivalent to 0.000348 million cubic meters per year for the protection of waterfowl in the region. Therefore, by providing the water needs of ecosystem services in order to preserve fine dust, the ecosystem related to the wetland, including plant and animal species of the region, is also preserved. The results in the scenario of ecosystem services show that in the current situation, water balance of wetland is negative and considering that the area of the wetland is one of the wind erosion centers of the province, so the most important ecosystem services of Kaji wetland is to deal with dust.

Due to the hot and dry climate of the region as well as the recent droughts, there is a concern that with the drying up of the region's wetland, it will become a center of dust. Salt and mineral in the lagoon also exacerbate this concern. Therefore, it is necessary to maintain and rehabilitate it, and determining the water needs of wetlands can restore their ecological conditions and play an important role in improving their environmental performance.

Keywords: ecological and hydrological water needs, ecosystem services, remote sensing, water balance.