AUCTORES
Globalize your Research

Biotechnology and Bioprocessing

Open Access

Research Article

Desirability Assessment with the Aid of Satellite Imagery and Chorographic Data in the Areas with Agricultural Land use in Esfahan; Geo-Spatial Analysis and Fuzzy Approach Nexus

Meysam Saeedi *

Graduate Faculty of Environment, University of Tehran, Iran.

***Corresponding Author:** Meysam Saeedi, Graduate Faculty of Environment, University of Tehran, Iran.

Received date: May 10, 2023; **Accepted date:** May 22, 2023; **Published date:** June 02, 2023

Citation: Meysam Saeedi, (2023), Desirability Assessment with the Aid of Satellite Imagery and Chorographic Data in the Areas with Agricultural Land use in Esfahan; Geo-Spatial Analysis and Fuzzy Approach Nexus. *J, Biotechnology and Bioprocessing* 4(3); DOI: 10.31579/2766-2314/092

Abstract

Background: Aflatoxin is one of the most problematic fungal-produced toxins as it is responsible for massive global agricultural losses and is deleterious to both human and animal health. Contamination of crops by certain strains of Aspergillus fungi accumulate aflatoxin in both post- and pre-harvest conditions.

Methods: In this report, we tested the aflatoxin-degradation efficiency of an endogenously expressed enzyme in harvested maize kernels. In post-harvest conditions, equivalent loads of A. flavus were used to infect harvested maize kernels previously engineered to express an aflatoxin-degrading enzyme from the Honey mushroom fungus.

Results: No measurable, or significantly reduced, levels of aflatoxin were detected in all the enzyme-expressing harvested kernels initially and then 3 days post –harvest the transgenic kernels amassed aflatoxin.

Conclusions: This is the first report of an enzyme degradation of aflatoxin in a crop in harvested kernels. This demonstrates the potential of this strategy to aid in the mitigation of aflatoxin in post-harvest conditions.

Key Words: climate change; fuzzy approach; geographical information systems; geo-spatial analysis; sustainable agriculture

Introduction

Over exploitation of natural resources, over population, lack of biodiversity, environmental pollution, and climate change are among the most important socio-ecological issues related to natural resource management. The sustainable use of limited natural resources in the world in order to maximize the amount of food production is one of the major challenges in achieving the sustainable development goals of the United Nations [1]. Natural resource management, especially water resources, is of the utmost importance and is one of the solutions to achieve sustainable development goals [2]. According to the global partnership in the field of water resources, integrated water resources management (IWRM) deals with the process of promotion, management, and development of water and soil resources to ensure economic and social well-being as well as the sustainability of ecosystems and water resources for the future generations [3]. Over-population rate and extravagant use of water and soil resources underlie environmental, social, and economic issues [4], such as the extraordinary rise in soil erosion and subsequently land use changes [3], water shortages in agriculture, soil salinity, and food crisis in many parts of the world. These issues have made sustainable development encounter huge challenges [4]. According to the FAO 2020, 37.1% of the land use on the planet was used for the agricultural activities in 2017 [5]. According to these cases, the optimum exploitation of water and soil resources is among the necessities for improving environmental situation and facilitating sustainable agriculture [4]. On the other hand, climate change has caused some disasters such as drought, flooding, and irregular rainfall patterns. From 2008 to 2018, drought, flooding, and other natural disasters have imposed detrimental impacts on developing countries by causing financial losses amounting up to 108 million dollars. In developing countries and in the agricultural sector, drought and flooding have caused damages to 18% and 19% of agricultural products, respectively [6]. Environmental conditions play a crucial role in the quality of agricultural products [7]. Furthermore, one of the important consequences of flooding can be its negative impacts on farmlands. Destruction of the water drainage system [8], declination of efficiency and the economic justification of crop cultivation [9], the deposition of waste materials in the soil, the reduction of product quality, and the increase in soil density due to the agricultural machinery movements, are among the impacts of flooding on farmlands. Also, the saturation of soil with water, leads to intensifying microbial activities and subsequently causes a drop in the amount of soil elements such as oxygen, nitrogen, manganese, iron, and sulfur, remarkable changes in the food chain, and a fall in the amount of crops in the long term [8]. Hence, rational exploitation of water and soil resources for attaining sustainable agriculture necessitate the spatial analysis of the factors affecting farmlands such as precipitation, flooding risk, soil erosion, accessibility to water resources and finally the classification of the areas with agricultural land use. The main purpose of this research was to classifying different areas with agricultural land use soil resources in the area in line with sustainable agriculture,

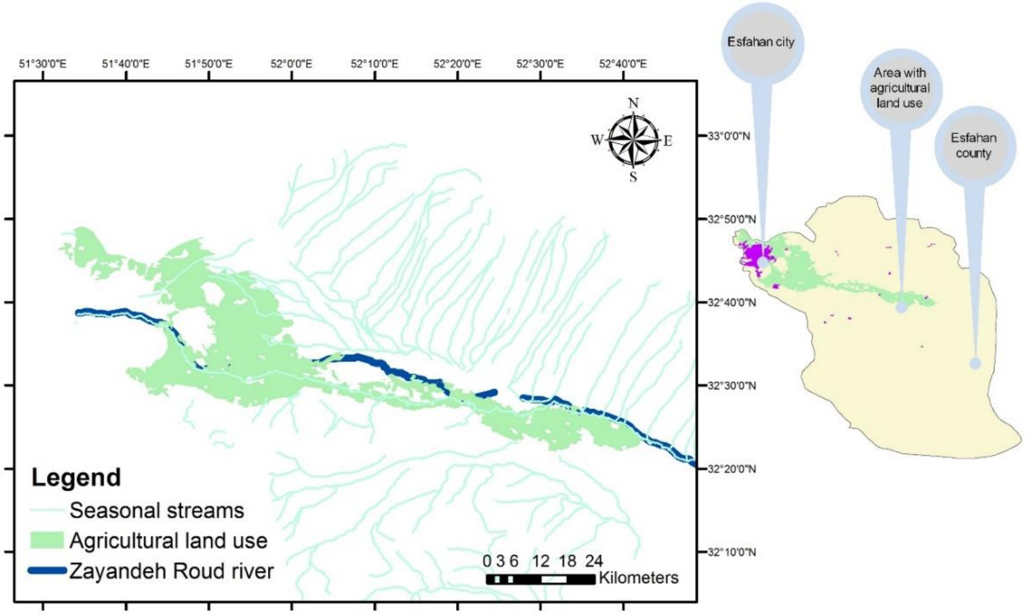

Figure 1: Case study

and adapting the cultivation type with the potential of the farmlands. To this aim, spatial analysis of the factors affecting the cultivation such as precipitation, flooding risk, soil erosion, and accessibility to water resources was performed. The case study includes areas with agricultural land use in the northern, eastern, and southeastern of Esfahan city, as well as the central and eastern parts of Esfahan county. Figure 1 depicts the study area. The longitude and latitude of the study area are in the range of 51° 31'-52° 43' E and 32° 22'-32° 49' N, respectively, and the total area of the studied area is 1296.9 square kilometers. Zayandeh Rood river flows in some parts of the study area from west to right to supply water demands. On the other hand, the presence of seasonal water flows to some extent has facilitated agricultural activities in this area. According to the soil classification map of the study area, the soil erosion has been classified qualitatively as very low, low, medium, and high. In 88.4% of the study area, the amount of soil erosion is very low, 10.6 percentage low, 0.02% medium, and 0.08% is estimated high. According to the flooding map of the Esfahan county, 21.8% of the study area is on the verge of flooding, and these areas mainly located in the eastern parts of the study area. Extracted data from satellite images shows that the average precipitation in the area from 2011 to 2021 was equal to 179 millimeters.

II. Materials and Methods

In spatial analysis of the factors influencing the cultivation conditions for categorizing study area, four criteria namely precipitation, soil erosion, accessibility to water resources, and flooding risk were considered. Average precipitation in different parts of the study area measured, extracting annual precipitation distribution from satellite images pertaining to the 2011-2021 period [10]. The data first converted from the tif to NetCDF format by ArcMap software, and then output converted to shape using the Raster to Point feature and finally to a table using the Point to Table feature. Subsequently, precipitation average for each point was calculated. Next, the outcome was converted into points using the Table to Shape feature, and a field under the title of average rainfall was added to its attribute table. Finally, the spatial distribution of the average precipitation during the 2011-2021 period was obtained using the Kriging method. In the Kriging method, two adjacent points were used to produce the spatial distribution, and the Spherical Semivariogram model was also selected. The spatial distribution of the average rainfall from 2011-2021 is illustrated in Figure 2. The soil erosion assessment in different parts of area was performed using Iran Chorography Organization maps. First map with shape format converted into a raster layer using the shape to raster feature, then using the Extract by Mask feature, the raster layer related to soil erosion distribution in different parts of the study area produced. Figure 3 shows the soil erosion distribution in different parts of the study area. Accessibility to water resources evaluated, considering two sub-criteria of proximity to the river and proximity to seasonal streams. To this aim, Euclidean distance used to create raster layers of accessibility to water resources. Figure 4 and Figure 5 demonstrate the Euclidean distance from the Zayandeh Roud river and the Euclidean distance from the seasonal streams, respectively. In addition, flooding risk assessment also performed with the Iran Chorography Organization maps. For this purpose, first map with shape format converted into a raster layer using the Shape to Raster feature, after that, applying the Extract by Mask feature, the raster layer related to the risk levels of flooding in different parts of the study area was produced. Then the outcome layer was merged with the raster layer of the study area using the Mosaic To New Raster feature. Figure 6 shows the spatial distribution of flooding risk in different parts of the study area. In order to consider the criteria of precipitation,

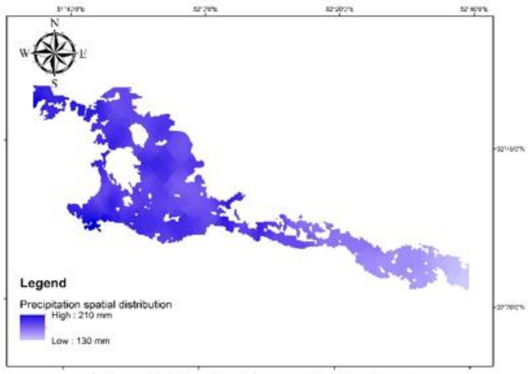

Figure.2. Precipitation spatial distribution

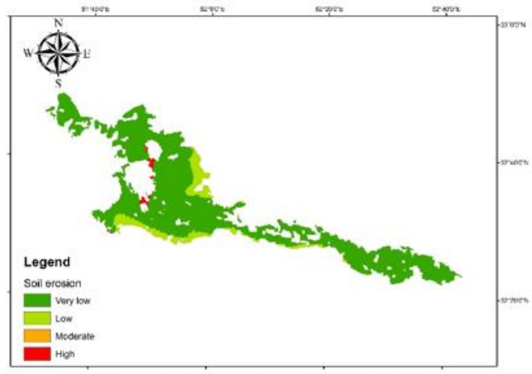

Figure.3. Soil erosion spatial distribution

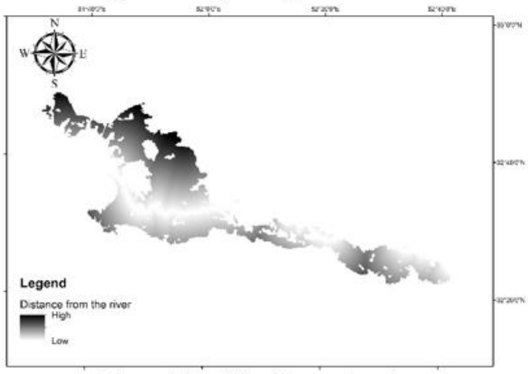

Figure.4. Euclidian distance from river

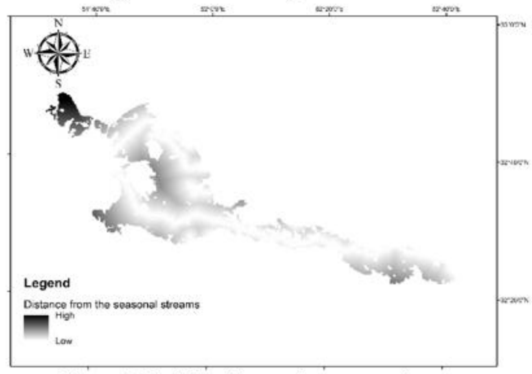

Figure.5. Euclidian distance from seasonal streams

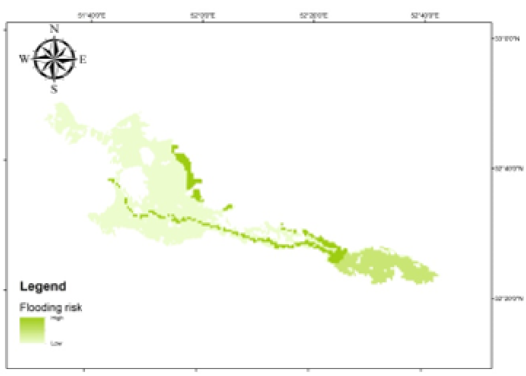

Figure. 6. Flooding risk spatial distribution

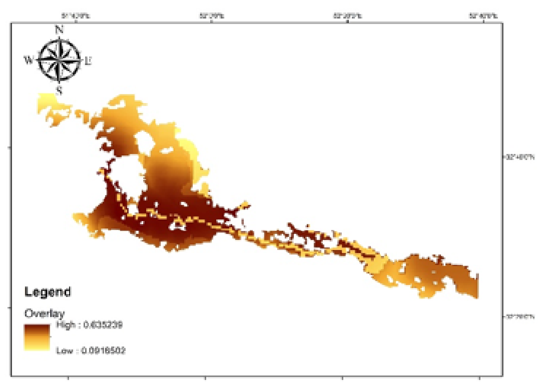

Figure.7. Overlay layer

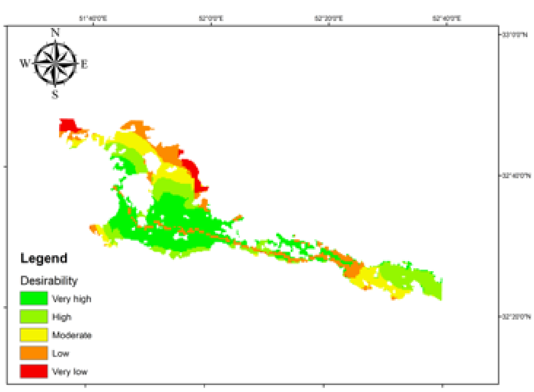

Figure.8. Desirability of farmlands in different parts of the study area

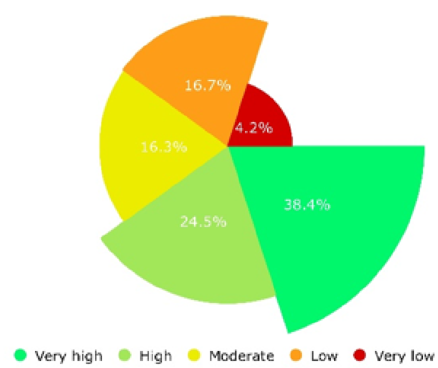

Figure.9. Desirability percentage of different categories in the case study

Soil erosion, accessibility to water sources, and the flooding risk the fuzzy method utilized in decision making process. First, the fuzzy functions of the raster layers generated using the Fuzzy Membership feature, and then these layers were placed on each other using the Fuzzy Overlay feature. The GAMMA function applied to place the layers on top of each other and the gamma value was chosen to be 0.5. The type of Fuzzy membership type considered for the raster layers of precipitation, soil erosion, Euclidean distance from the river, Euclidean distance from the seasonal streams, and flooding risk were Large with coefficient of one, Small with one, Small with three, Small with five, and Small with two, respectively.

Results

Figure 7 illustrates the overlay layer. For classifying different parts of the study area, the output raster layer was categorized into 5 classes with equal intervals using the Reclassify feature. Figure 8 depicts the classified area from the point of view of the desirability for agricultural activities. Applying the Raster to Polygon function, the output raster layer resulting from placing the layers on top of each other was converted into a Polygon, and then the Area column was added to its attribute table. At the end, the area of different categories calculated and its results were presented in Figure 9. As shown in Figure 9, 4.2% of the farm lands has very low, 16.7% low, 16.3% moderate, 24.5% high, and 38.4% very high desirability for agricultural activities.

Conclusion

Extravagant use of water and soil resources triggers adverse effects on economic, society, and environment, also sustainable development has encountered big challenges in many parts of the planet. Furthermore, climate change impacts on the planet such as flooding and drought have intensified economical losses in agriculture sector and imposed adverse effects on the ecological environment. In this research, the fuzzy approach was applied in order to provide good vision in decision making process regarding water and soil resource allocation in line with sustainable agriculture goals. Considering the criteria of precipitation, soil erosion, accessibility to water resources, and flood risk, the area with agricultural land use in Esfahan county was classified to identify desirability of farmlands in different parts of the study area. According to the spatial analysis obtained from implementing the fuzzy approach, the marginal areas of the Zayandeh Roud river have the most desirability, whereas the northern and eastern parts of the study area have very low and low desirability, respectively.

References

1. R. Singh, S. Patel, A. Tiwari, and G. Singh, "Assessment of flood recession farming for livelihood provision, food security and environmental sustainability in the Ganga River Basin," Current Research in Environmental Sustainability, vol. 3, pp. 100038, March 2021.
2. S. Apostolaki, P. Koundouri, and N. Pittis, "Using a systemic approach to address the requirement for Integrated Water Resource Management within theWater Framework Directive," Science of the Total Environment, vol. 679, pp. 70, May 2019.
3. S. Mhaske, K. Pathak, S. Dash, D. Nayak, "Assessment and management of soil erosion in the hilltop mining dominated catchment using GIS integrated RUSLE model," Journal of Environmental Management, vol. 294, pp. 112987, June 2021.
4. Y. Zhang, Y. Li, J. Sun, G. Huang, "Optimizing water resources allocation and soil salinity control for supporting agricultural and environmental sustainable development in Central Asia," Science of the Total Environment, vol. 707, pp. 135281, Nov 2019.
5. P. Bucki, K. Regdos, P. Siwek, I. Domagała-´Swiątkiewicz, P. Kaszycki, "Impact of soil management practices on yield quality, weed infestation and soil microbiota abundance in organic zucchini production," Scientia Horticulturae, vol. 281, pp. 109989, Feb 2021.
6. M. Venkatappa, N. Sasaki, P. Han, I. Abe, "Impacts of droughts and floods on croplands and crop production in Southeast Asia – An application of Google Earth Engine," Science of the Total Environment, vol. 795, pp. 148829, 2021.
7. S. Kheybari, M. Javdanmehr, M. Rezaie, J. Rezaei, "Corn cultivation location selection for bioethanol production: An application of BWM and extended PROMETHEE," Energy, vol. 228: pp. 120593, Apr 2021.
8. Shah, S. Shah, V. Shah, "Impact of flooding on the soil microbiota," Environmental Challenges, vol. 4, pp. 100134, May 2021.
9. P. Sharma, J. Humphreys, N. Holden, "Environmental impacts of alternative agricultural uses of poorly drained farm land in Ireland," Science of the Total Environment, vol. 637-638, pp. 120-131, May 2018.

DOI: **10.31579/2766-2314/92**