University of Tehran Press

Online ISSN: 2345-475X

DESERT

Home page: https://jdesert.ut.ac.ir/

Assessing Land Sensitivity to Determine Areas Prone to Wind Erosion and Dust Production Using the ILSWE Model

Bahareh Jabalbarezi[1], Gholamreza Zehtabian[1], Hassan Khosravi[1*], Saeed Barkhori[2], Kazem Nosrati[3]

[1] Department of Arid and Mountainous Regions Reclamation, Faculty of Natural Resources, University of Tehran, Karaj, Iran E-mail: hakhosravi@ut.ac.ir

[2] Faculty of Natural Resources, Jiroft University, Jiroft, Kerman, Iran

[3] Department of Physical Geography, School of Earth Sciences, Shahid Beheshti University, Tehran, Iran

Article Info.

Article type:
Research Article

Article history:
Received: 17 Jun. 2023
Received in revised from: 10 Nov. 2023
Accepted: 21 Nov. 2023
Published online: 27 Dec. 2023

Keywords:
Land sensitivity,
Dust,
ILSWE model,
Jazmurian wetland,
Wind erosion.

ABSTRACT

Wind erosion plays an essential role in the production of sediment for dust storms and occurs when strong and continuous wind interacts with dry, fine-grained and loose soil. Identifying dust production centers is the first step in prioritizing different areas for executive operations to reduce dust and determine its control methods. Jazmurian area is one of the areas where the intensity and frequency of dust events have increased in recent years and caused a lot of damage. The purpose of this research is to determine the areas prone to dust production and sensitive to wind erosion using the ILSWE model in the Jazmurian wetland basin. This model is based on five effective factors of climate erosivity, soil erodibility, soil crust, vegetation cover, and surface roughness. Maps of temperature, precipitation, wind speed, percentage of sand, silt, clay, calcium carbonate, EVI and land use were used to calculate these factors. After calculating each factor, ILSWE index was calculated by multiplying them. Finally, sensitive areas were identified by classifying this index in Arc GIS software. The ILSWE classification map showed that 46.72% of the studied area is in very low sensitivity class, 16.56% in low class, 13.67% in medium class, 12.41% in severe class and 10.64% in class Very severe sensitive to wind erosion. Severe and very severe sensitivity class was considered as the center of dust generation. The results showed that the southern (wetland area and its surroundings), west, southwest, east and southeast areas of the Jazmurian wetland basin are prone to dust production and wind erosion. These areas are mostly located in areas without vegetation (barren areas), salt marshes and sand dunes; which shows the importance of vegetation in reducing producing dust. On the other hand, the topography, the presence of wind and the characteristics of the soil in these areas help to produce dust. In general, the results of this research showed that the ILSWE model has a suitable efficiency for determining areas prone to wind erosion and dust production.

Cite this article: Jabalbarezi, B., Zehtabian, GH., Khosravi, H., Barkhori, S., Nosrati, K. (2023). Assessing Land Sensitivity to Determine Areas Prone to Wind Erosion and Dust Production Using the ILSWE Model. DESERT, 28 (2), DOI: 10.22059/jdesert.2023.95534

Publisher: University of Tehran Press

1. Introduction

The phenomenon of dust is one of the atmospheric processes that occur because of strong winds blowing on erodible soil, which impress adverse environmental effects and consequences and is considered one of the most important environmental challenges recently (Boloorani *et al*., 2020).

Wind erosion plays an essential role in the production of sediment for dust storms and occurs when there is strong and continuous wind with dry, fine-grained and loose soil (Yigiterhan *et al*., 2018). Therefore, recognizing wind erosion as a dynamic and changing phenomenon in measuring soil erosion is very important (Kheirabadi *et al*., 2018).

Low rainfall, dryness and depletion wetlands and water catchments, not growing desert plants, and as a result, the intensity of the wind causes a 20-30% increase in dust in susceptible areas. Therefore, soil erosion is a widespread environmental problem that threatens the sustainability of the environment (Jiang *et al*., 2019).

Deaking with the dust phenomenon requires multilateral methods consisting of politics, ecosystem management, economics and capacity building; therefore, the true identification of dust centers is one of the first steps in the management and control of the dust phenomenon. On the other hand, the identification of dust production centers is the first step in prioritizing different areas for executive operations to reduce dust and determine its control methods (Hojjati *et al*., 2021).

Traditional measurement by field methods cannot be useful alone for monitoring dust centers due to limited temporal and spatial coverage (Rayegani *et al*., 2017). The most advanced field models are very complex to obtain the appropriate result, and when the goal is to determine dust centers on a regional and larger scale, practically doing this method faces many problems (Fenta *et al*., 2020).

On large scales, such as the regional scale, by using remote sensing and geographic information system and modeling factors effective in wind erosion and dust, susceptible centers are identified (Feuerstein *et al*., 2019).

Considering that wind erosion and dust are complex geomorphological processes that are affected by Several factors, modeling all the influencing factors makes it difficult to evaluate at regional and larger scales (Funk *et al*., 2006). Therefore, studies on this scale resort to a method of reducing complexity by maintaining the key factors affecting wind erosion.

So far, many studies have been done with different methods to determine dust centers on a large scale inside and outside the country. Among these research, we can mention the research by (Effati *et al*., 2019) The application of remote sensing to estimate the dust emission in Urmia lake area was investigated and a new framework was developed to determine the dust source areas and estimate the probability of dust occurrence based on the features of the land surface (soil moisture and vegetation), soil texture, wind speed and dust frequencies measured using remote sensing and satellite images were introduced.

(Rayegani *et al*., 2020) investigated the identification of sand and dust storm sources with the approach of remote sensing and ecological indicators. For this purpose, OLI Landsat 8 data were used during the years 2012 to 2014 to prepare maps of vegetation, soil moisture and sensitivity of land cover to wind erosion. These maps were combined with geology and roughness by multi-criteria evaluation method to obtain a map of potential sand source areas, and finally, based on a stratified random sampling plan and using the MCE (WLC) method, the locations prone to sand sources and dust were detected.

Feuerstein and Schepansk (2018) identified dust sources in a desert dust epicenter and implemented it with a dust diffusion model and concluded that the presented approach to describe dust sources can be applied in other Model studies implemented regionally, or even globally, and thus can help to obtain a more accurate picture of the dust source distribution and a more realistic estimate of the atmospheric dust load.

(Soleimani Sardo *et al.*, 2022) predicted the movement path of dust particles using HYSPLIT and WRF-chem models in the Jazmurian basin and their results showed that the management of the Jazmurian basin in times of drought or in conditions where the surface moisture of the soil is reduced It is very important and can be identified as the center of dust collection in the southeast of the country.

(Saeedifar *et al*., 2019) identified dust-prone areas and investigated its synspecies in the Jazmurian basin using the NMMB/BSC-Dust model in a three-year period (2014-2016). The results of their research showed that the central part of Jazmurian area; in which Jazmurian lagoon is located, it has the highest concentration of dust in these years.

One of the regional models that can be used on a large scale is the Land Susceptibility Index to Wind Erosion (ILSWE) developed by the European Soil Data Center (ESDAC). In recent years, this model has been used to determine sensitive areas to wind erosion and center of dust storm by (Fenta *et al*., 2020) in East Africa and (Borrelli *et al*., 2015 and 2016) respectively in 36 countries across the Mediterranean Sea and 34 European countries.

The vast extent of dry areas and the frequency of occurrence of dust phenomenon in Iran have caused the precise identification of dust centers to be one of the main goals of wind erosion research. Therefore, the main goal of this research is to determine the centers of wind erosion and dust in the Jazmurian basin using the ILSWE model.

Jazmurian basin is one of the areas where the intensity and frequency of dust occurrence have increased in recent years and caused a lot of damage. The dust arising from this region affects a large part of the south and southeast regions of Iran. The existence of areas without vegetation in this region and the recent droughts have caused the creation of internal centers of dust and intensified their activity (Soleimani Sardoo *et al*., 2022).

Therefore, accurate identification of the areas prone to wind erosion and dust in this area is necessary for future control actions and prioritization of dust control activities to reduce the damages caused by this phenomenon.

2. Materials and Methods

2.1. Study Area

Jazmorian wetland basin is one of the important wetlands of the country in the southeast of Iran; which is located between Makran and Shahsavaran mountains, that is, between Jabalbarez mountain range in the north and Beshagard mountain range in the south. Among the general public, the dominant vegetation of the region is known as "jaz" and its abundance and abundance is known as "termites". For this reason, this wetland is known as Jazmurian. This wetland is located between Kerman and Sistan and Baluchistan provinces with latitude coordinates of 26° 33´ to 29° 36´ North and longitude of 56° 16´ to 61° 26´ East and with an area of 69374 km^2 between the provinces of Kerman and Sistan and Baluchistan, which is approximately 300 kilometers long from east to west. It has spread from north to south to a width of 100 kilometers (Fig 1). The catchment area of this seasonal lake is 69,000 km^2 and its height is 300 meters above sea level. The total catchment area of the lake is 3,300 square kilometers when the water is full and 2,500 km^2 when the water is low. Bampur River in Sistan and Baluchistan and Halilroud River, which originates from the central highlands of Kerman province, are the main feeding channels of this Hamoon. The topographical physiography of this area includes mountainous and plain parts. Its northern and southern parts are mainly mountains and hills and its plain parts are located in the center. The average annual rainfall of this area is about 172 mm and the average temperature is 27.5°C. Therefore, the existence of Jazmurian wetland and its environmental effects on the neighboring provinces emphasize the importance of this area even more (Ahmadi *et al*., 2019).

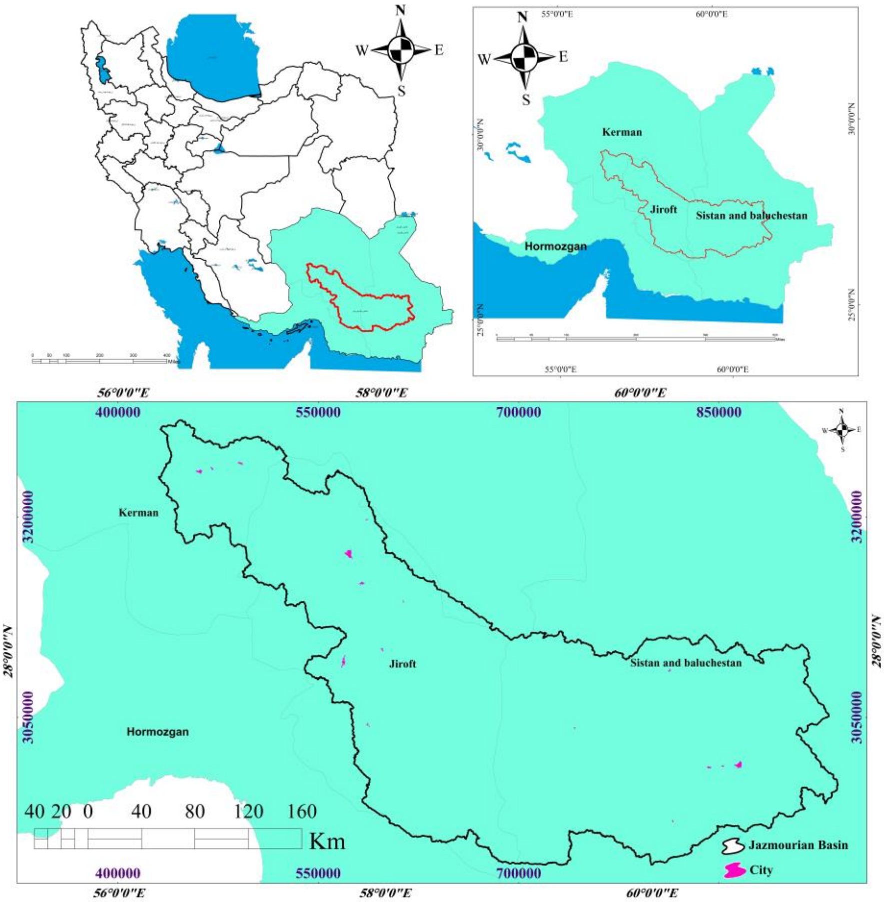

Fig. 1. Location of the study area in Iran

2.2. Methodology

In this research, the ILSWE model was used to determine areas prone to dust production.

The basis of this model is based on the concept that wind erosion occurs when there are three conditions including sufficient wind power, susceptible soil and lack of protection for the surface of the wind (Borrelli *et al*., 2016). This index is presented with the aim of reducing the complexity of wind erosion modeling at the regional scale (Borrelli *et al*., 2016).

The model consists of five factors: Climate Erosivity (CE), Soil Erodibility (SE), Soil Crust (SC), Vegetation Cover (VC) and Surface Roughness (SR). The overall process of this study is shown in Fig (2).

2.2.1. Climate Erosivity Factor (CE)

This factor shows the potential and aptitude of the climate of the studied area to produce conditions that lead to wind erosion (Fenta *et al*., 2020). In the present study, equation (1) developed by FAO (FAO. 1979); was used to calculate the climate erosivity factor.

$$CE = \frac{1}{100} \times \sum_{i=1}^{i=12} u_i^{\,3} \times \left(\frac{PET_i - P_i}{PET_i}\right) \times d_i \qquad (1)$$

In this equation; u_i is the average monthly wind speed (m/s) at a height of two meters in the month of i, PET_i is the potential for evaporation and transpiration in the month of i, P_i is the amount of precipitation in the month of i and d_i is the number of days in the month of i.

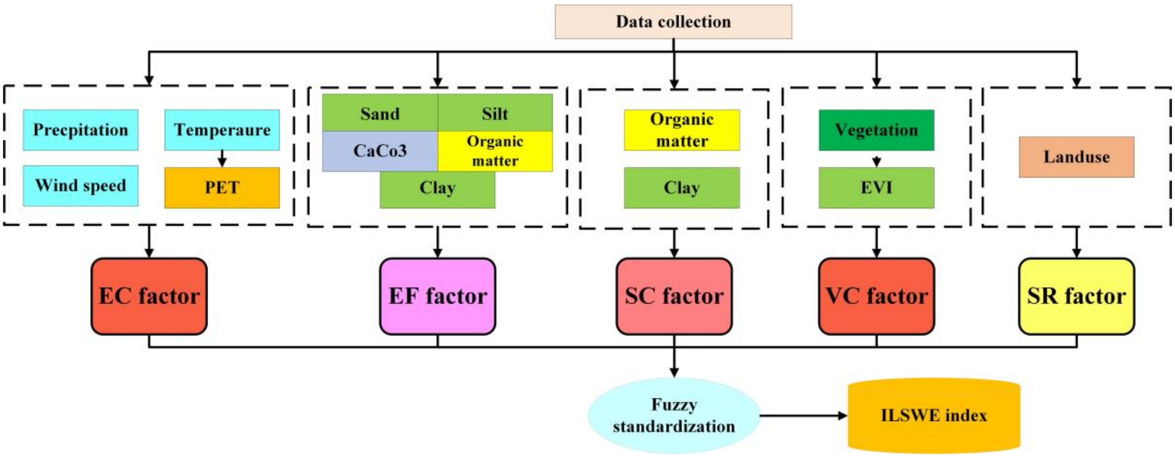

Fig. 2. The flowchart of the research methodology

To calculate this factor; monthly data of average wind speed, temperature and sum precipitation of 12 stations in the Jazmurian basin and its surrounding areas were collected for a period of 20 years (2000-2020). Then, using the Torrent-White method (Eq. 2) and temperature data, the monthly evaporation and transpiration potential of each station was calculated.

$$ETP = 16.2\left(\frac{10\ Ti}{I}\right)^{\alpha} \tag{2}$$

In this equation, T_i is the average monthly temperature, α is the coefficient obtained based on T_i and I is the number of the month. According to the latitude of the stations, the average hours of sunshine were calculated and then by multiplying it by the ratio of the number of days of each month to the total number of the year, a correction factor was obtained and using it, ETP_c was calculated.

Finally, for all three components used in the 12 months of the year, the monthly zoning map was prepared using the Inverse Distance Weighting (IDW) interpolation method in Arc GIS software and the CE factor was calculated using the Eq. 1.

2.2.2. Soil Erodibility Factor (SE)

The soil erodibility factor shows the level of soil resistance against wind power. In fact, this factor expresses the relationship between soil erosion by wind and soil characteristics (Fenta *et al.*, 2020).

Eq. 3 shows how to calculate SE using the multiple regression relationship presented by (Fryrear *et al.*, 1994) based on soil texture and chemical properties.

$$SE = \frac{29.09 + (0.31 \times SA) + (0.17 \times SI) + \left(0.33 \times \frac{SA}{CL}\right) - (2.59 \times OM) - (0.95 \times CaCO_3)}{100} \tag{3}$$

In this equation, SA is the percentage of sand, SI is the percentage of silt, CL is the percentage of clay, OM is the percentage of organic matter, and CaCO3 is the percentage of calcium carbonate of the soil.

In this research, the data of ISRIC Soil Grids database with a spatial resolution of 250 meters was used to calculate the percentage of sand, silt, clay, soil calcium carbonate and surface soil organic matter (0-5 cm) (Hengl *et al*., 2017).

The percentage of sand, silt and clay is available in this database; but the percentage of soil calcium carbonate and soil organic matter were calculated respectively using pH and soil organic carbon of ISRIC Soil Grids database, based on Eq. 4 and Eq. 5.

$$CaCO3 = (\frac{pH-2.378}{4.576})^{11.0023} \quad (4)$$

$$OM = OC \times 1.724 \quad (5)$$

Eq.4 is obtained based on the research of (Liu *et al*., 2002) and in it; the amount of calcium carbonate is obtained in percent.

In Eq.5, OC and OM are soil organic carbon and soil organic matter percentage respectively (Mirzashahi, 2016).

Finally, Soil Erodibility factor (SE) was calculated by Eq.3.

2.2.3. Soil Crust Factor (SC)

The SC factor is used to estimate the effect of soil crust on soil erodibility (Borrelli *et al*., 2015). In general, the relatively thin and integrated layer created on the soil surface and is more compact and mechanically stable than the its subsoil layer is called soil crust (Zobeck. 1991). The sensitivity of this layer to wind erosion is less than the underside soil layers (Fryrear *et al*., 2000).

In arid and semi-arid regions, where; wind erosion is more overcoming than water erosion, it performs an important role in soil protection (Zhang *et al*., 2004).

In this research, the SC factor was calculated using the Eq. 6 provided by (Fryrear *et al*., 1998).

$$SC = \frac{1}{1+(0.006\times CL^2)+(0.21\times OM^2)} \quad (6)$$

In this equation; CL is the clay percentage and OM is the soil organic matter percentage.

As mentioned above; the data of these two components were obtained from the ISRIC Soil Grids database with a spatial resolution of 250 m.

2.2.4. Vegetation Cover Factor (VC)

The effect of vegetation on wind erosion can be expressed using the percentage of the surface covered by plant material (Borrelli *et al*., 2016).

In the present study, the index of the fractional vegetation cover component (F_{cover}) obtained from the EVI vegetation cover index, was used to evaluate the VC factor.

The annual maximum map of the EVI was calculated by MODIS images in the years 2000 to 2020 for Jazmurian basin.

Then; F_{cover} was calculated by Eq.7

$$F_{cover} = \frac{EVI-EVI_S}{EVI_V-EVI_S} \quad (7)$$

In this equation; EVI is the annual maximum map obtained from the previous step, EVI_s is the index value in barren soil and EVI_v is the index value in dense vegetation.

After calculating F_{cover}, the VC factor was obtained by inverting F_{cover}. The reason for doing this is that; wherever the coverage is more, it is less susceptible to wind erosion.

2.2.5. Surface Roughness Factor (SR)

The surface roughness increases the friction of the earth's surface and it reduces the wind energy and wind speed near the land surface; consequently, surface roughness reduces wind erosion (Wever. 2012).

When land surface roughness data are not available, land use and land cover classes are very useful for estimating surface roughness length (Hansen. 1993).

In various studies, such as (Borrelli *et al.*, 2016); (Fenta *et al.*, 2020), which have been carried out on a regional scale, special tables have been used to determine the surface roughness factor based on land use and land cover.

In this study; the surface roughness factor was determined based on land use and land cover by using the table of (Floors *et al.*, 2018).

This table shows the average roughness length in different land use and land cover classes (table 1).

Table 1. Average roughness length in land use and cover classes (Floors *et al.*, 2018)

Row	land use and land cover	Z_0
1	Salty lands, vegetation without lands, moving sands, sand dunes, wetlands	0.01
2	Rangelands, poor natural grassland, marshy and swampy lands, aquifer area	0.02
3	Fallow lands, flaggy	0.05
4	Combination of irrigated and rainfed crops	0.10
5	Woodland and bushland, watery agriculture, rangeland with moderate to high canopy	0.20
6	Rangeland with low canopy, hand-planted forest	0.40
7	Garden lands, forest lands, rangeland with very high canopy	0.50
8	Rock outcrop	0.60
9	Fish breeding pond, salt lake, lake, dam and water reservoir	0.00
10	Urban regions	1.00

Land use and land cover map of Jazmurian basin was extracted from the land use map of Iran prepared by Natural Resources and Watershed Management Organization. Then, it was reviewed and corrected by using Google Earth Pro software.

2.3. Calculation of ILSWE

Equations (8) and (9) were used to fuzzy and standardize ILSWE index factors.

$$F = \frac{X_i - X_{min}}{X_{max} - X_{min}} \quad (8)$$

$$F = \frac{X_{max} - X_{min}}{X_{max} - X_{min}} \quad (9)$$

Equation (8) was used for climate erosivity factors and soil erodibility, which have a direct effect on wind erosion, and equation (7) was used for soil crust and vegetation factors, which have an inverse effect on wind erosion. It is worth mentioning that the surface roughness factor does not need fuzzification because this factor itself is between zero and one.

After calculating the five factors related to the ILSWE model, the fuzzy membership function of the factors was calculated. With this, the factors were places between zero (minimum sensitivity) and one (maximum sensitivity).

Then; ILSWE was calculated by using the Eq. 10.

$$ILSWE = CE \times EF \times SC \times VC \times SR \quad (10)$$

After calculating ILSWE, it was classified in Arc GIS software. Then, the Jazmurian wetland basin was classified into five sensitivity classes with Natural breaks (Jenks) method: very low, low, moderate, high and very high; in terms of sensitivity to wind erosion and dust.

In order to evaluate the accuracy of the ILSWE index in zoning the hazard of wind erosion, the map of dust source point in the study area was used.

The map of dust source point has been prepared by the Natural Resources and Watershed Management Organization and watershed. ILSWE map and dust source map were overlayed and evaluate the ILSWE accuracy.

3. Results

Fig (3) shows the fuzzy membership map of climate erosivity factor. According to the fuzzy membership map of climate erosivity (CE), the eastern and central regions have the highest potential for creating wind erosion by climate compared to other regions. The lowest amount of climate erosivity is related to the western areas of Jazmurian wetland; that is the highlands.

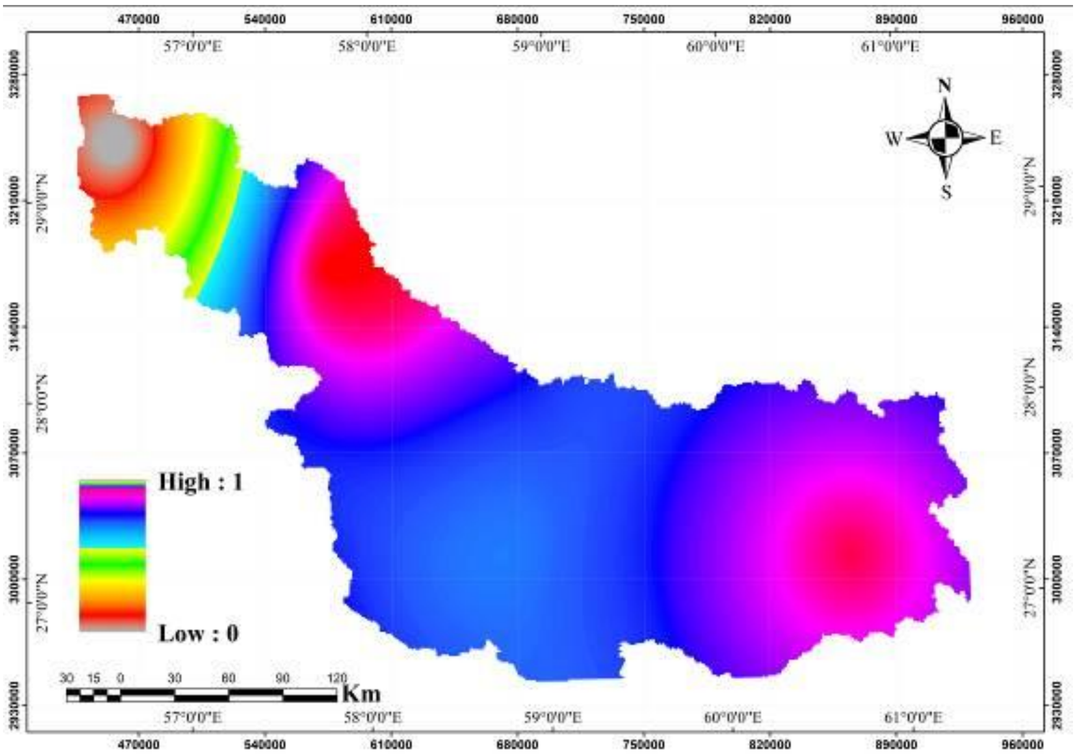

Fig. 3. Fuzzy membership map of climate erosivity factor (CE)

Fig (4) shows the fuzzy membership map of soil erodibility factor (SE). In general, according to the soil erodibility map, from the eastern to the western parts of the region, the soil erodibility increases relative to the wind. Of course, a decreasing trend for erodibility can be observed in the northern and southern parts of the Jazmurian basin where agricultural lands are located.

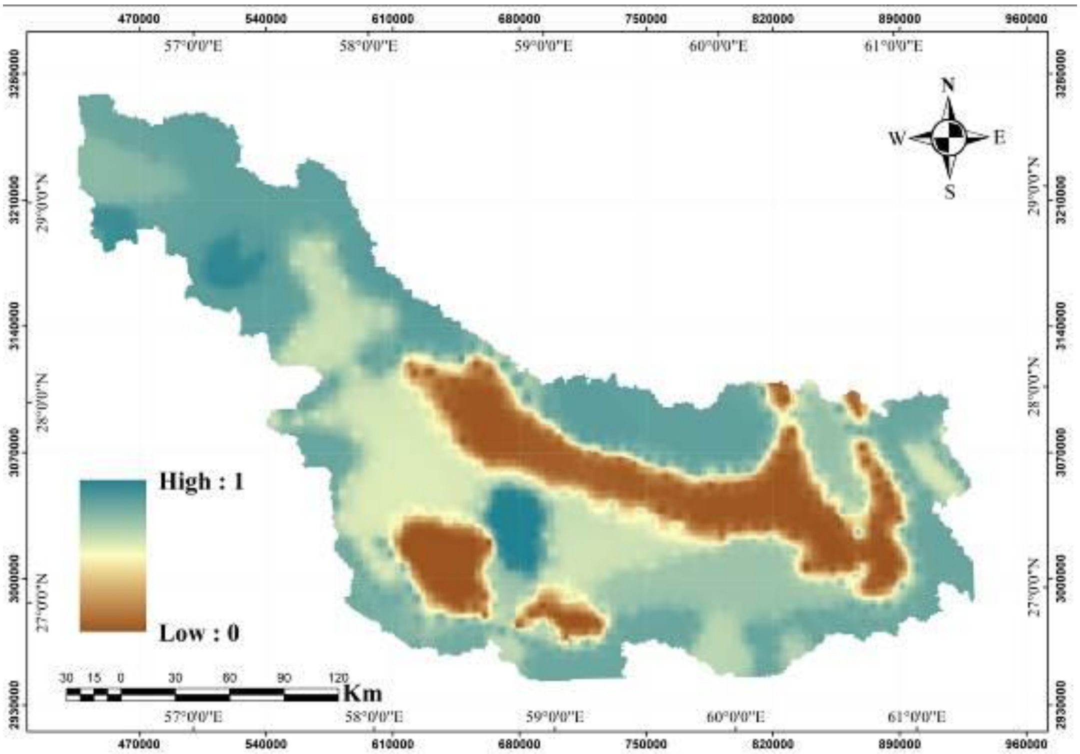

Fig. 4. Fuzzy membership map of soil erodibility factor (SE)

Fig (5) shows the fuzzy membership map of the soil crust factor (SC). According to this map, the eastern and southern parts have the most amount and the northern and western parts have the least amount of soil crust.

Fig (6) shows the fuzzy membership map of vegetation cover factor (VC). According to this map, the middle belt and the northern and western regions have the lowest probability of wind erosion due to the presence of vegetation, and other areas have the highest probability of wind erosion in terms of vegetation.

As mentioned before, land use map was used to calculate the surface roughness factor (SR). (Fig .7).

Fig (8) shows the fuzzy membership map of surface roughness factor (SR). According to this map, parts of the west, south, and east of the region are the most prone to wind erosion and dust in terms of surface roughness. Most of the central and northern regions of the wetland have the least ability to cause wind erosion and dust.

4.1. Calculation results of the ILSWE model

After preparing the fuzzy membership map of the five factors mentioned in the previous steps; the ILSWE model was calculated by Eq. 8.

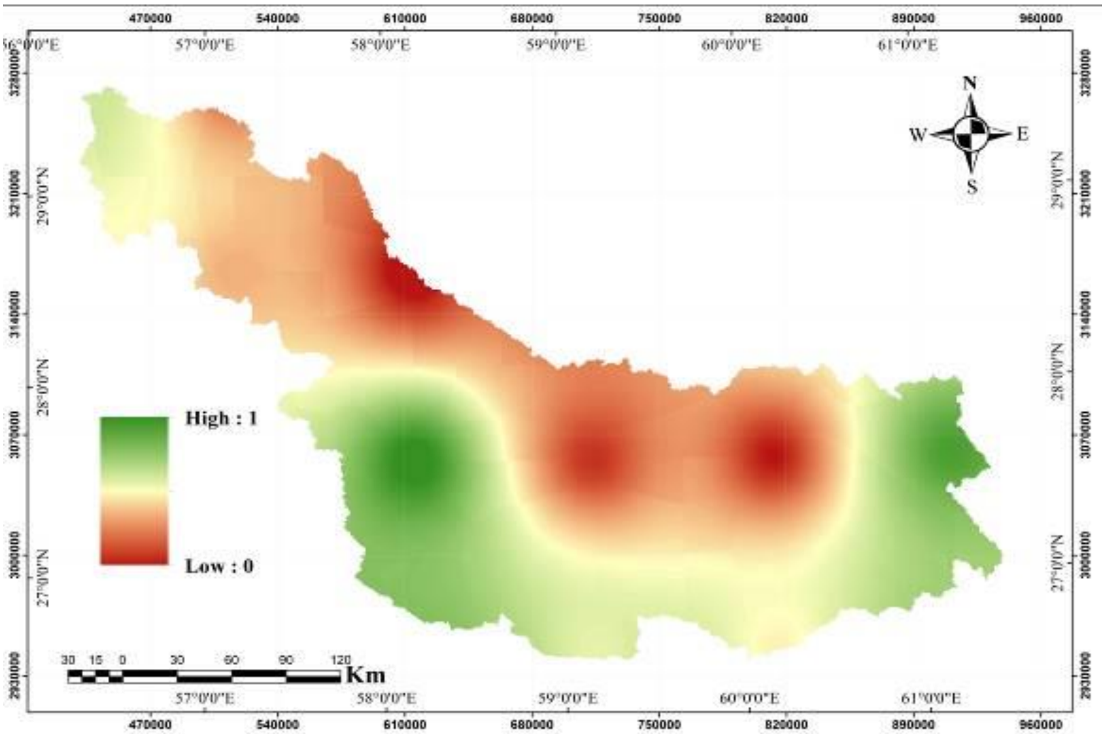

Fig. 5. Fuzzy membership map of soil cell factor (SC)

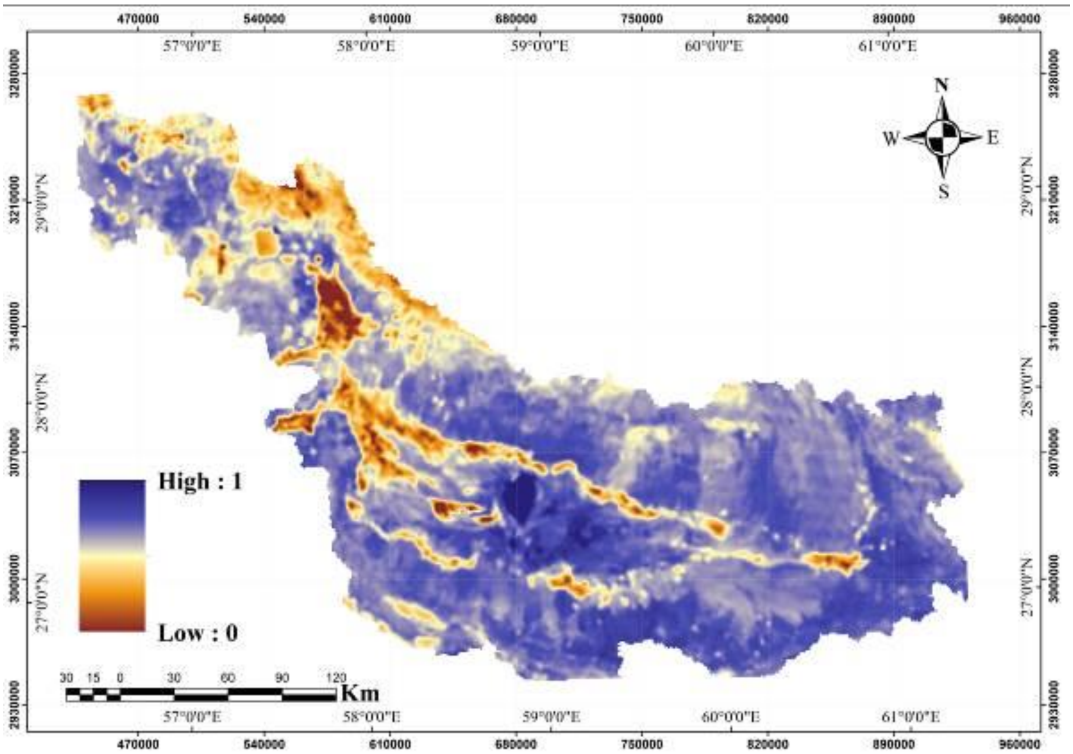

Fig. 6. Fuzzy membership map of vegetation cover factor (VC)

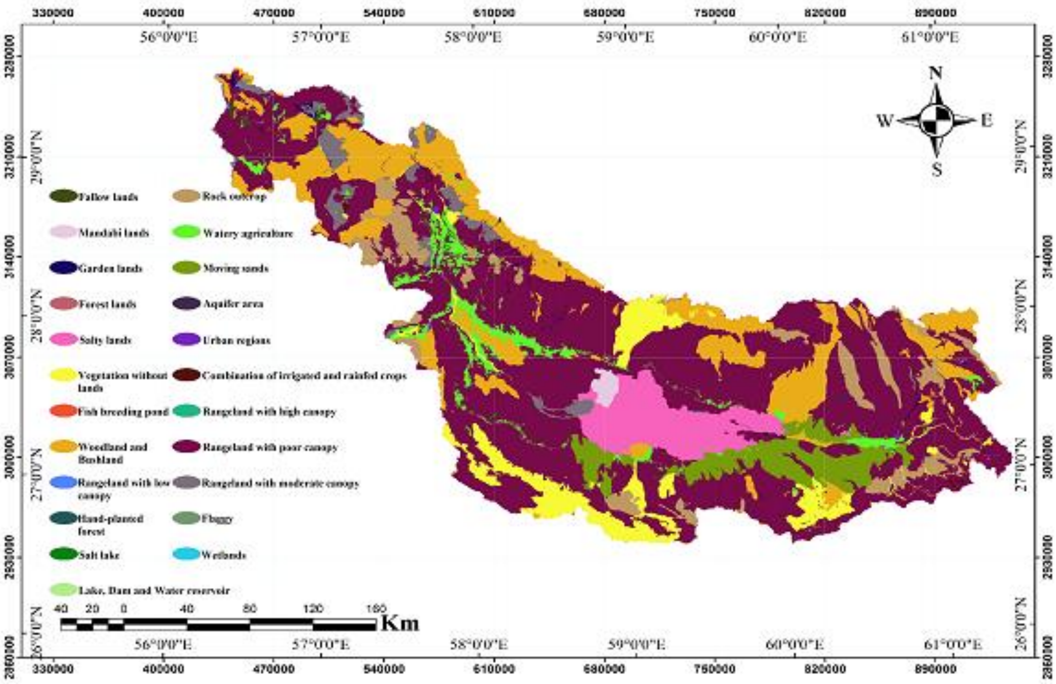

Fig. 7. Land use map used in Jazmurian wetland basin

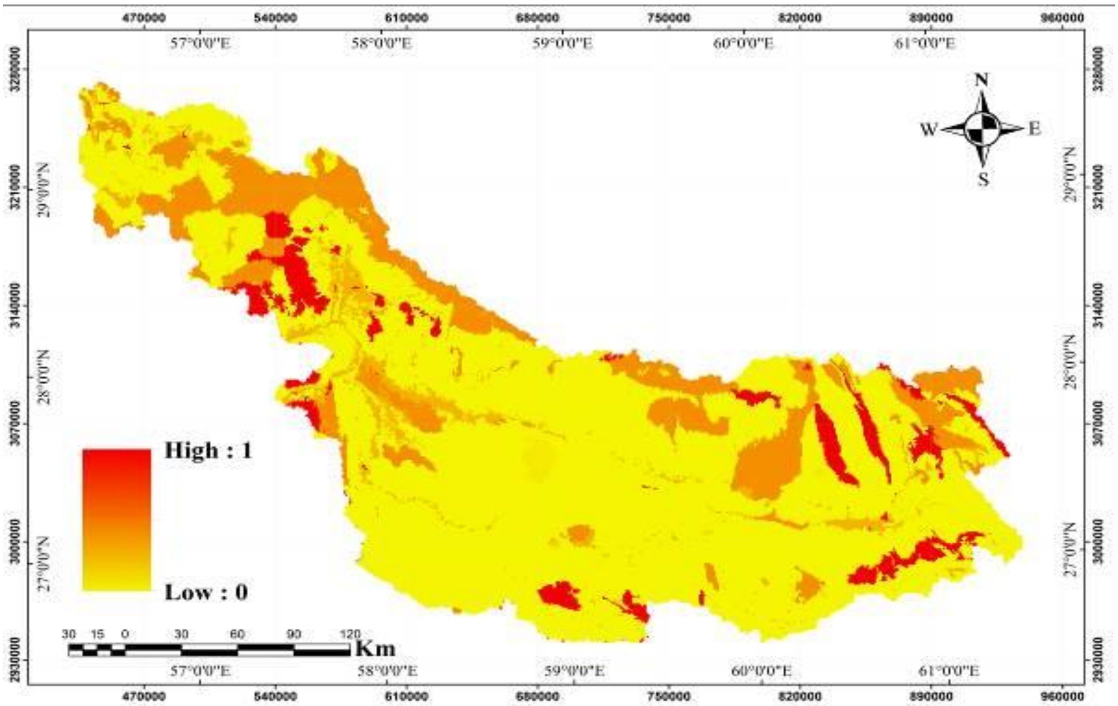

Fig. 8. Fuzzy membership map of surface roughness factor (SR)

Fig. 9 shows classified map of Jazmurian wetland basin to wind erosion and dust production provided in Arc GIS software It was classified into five classes from very low to very high sensitivity by using the natural break method. The very low, low, medium, high and very high sensitivity class cover 46.72%, 16.56%, 13.67%, 12.41% and 10.64% area of Jazmurian basin, respectively.

Most of the areas with very low and low sensitivity to wind erosion and dust production are located in the northern, northwestern, and northeastern parts of study area. While most of area with high and very high sensitivity are located in the southern, western, southwestern, eastern and southeastern parts of Jazmurian wetland. The central strip and small parts of the north and south of the region are in the medium sensitivity class to wind erosion and dust production.

Fig. 10 extracted from the ILSWE map (Fig. 9) shows regions prone to wind erosion and dust production in the Jazmurian wetland basin. Most of the regions prone to dust production are lands without vegetation, salty lands and sand dunes in the study area.

At the end, to evaluate the ILSWE index, the overlap of the final ILSWE map with the map of dust sources was used. The map of dust source in the study area is given in Figure 11. By comparing this figure with figures 9 and 10, it can be concluded that the ILSWE index has the property of high efficiency in zoning the hazard of wind erosion.

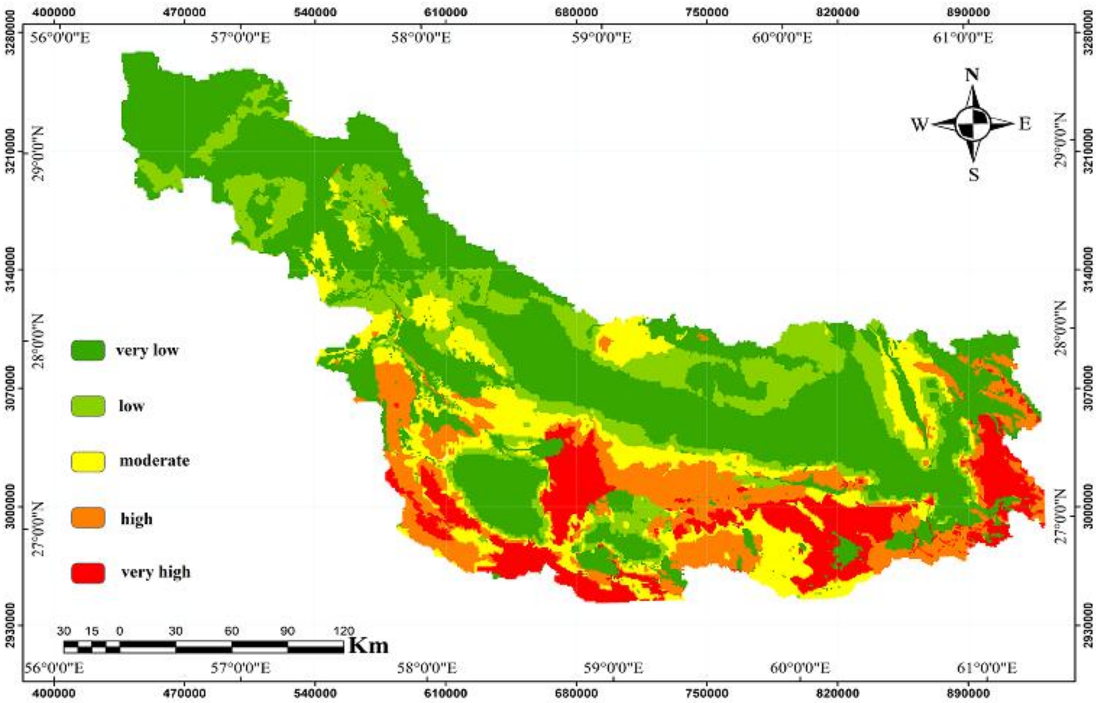

Fig. 9. Classified map of the ILSWE model in Jazmurian wetland basin

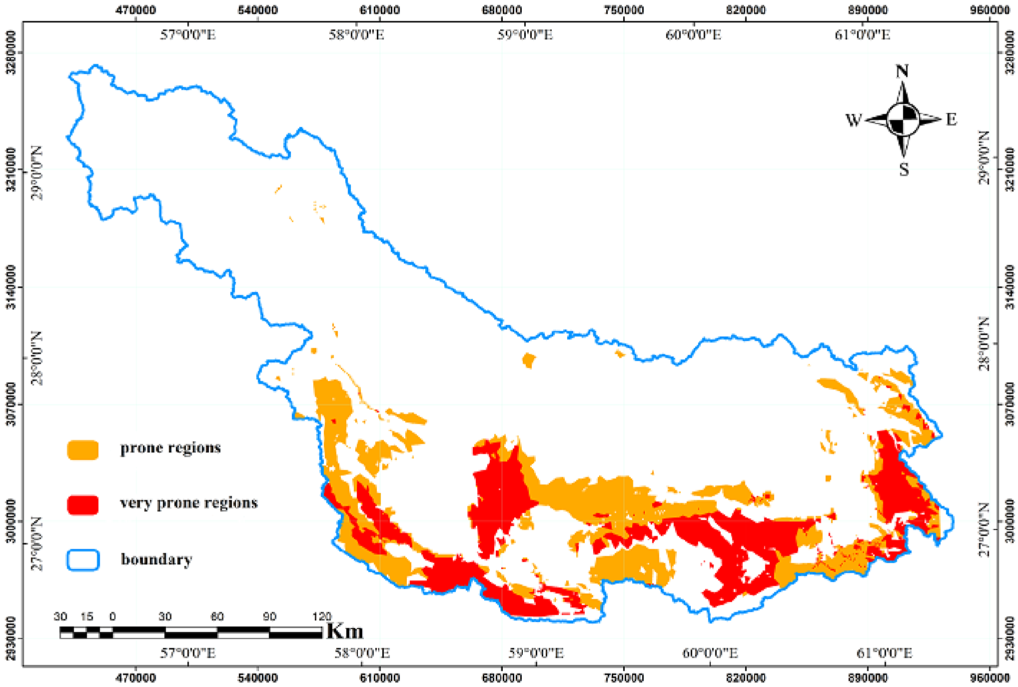

Fig. 10. Map of regions prone to wind erosion and dust production in the Jazmurian wetland basin

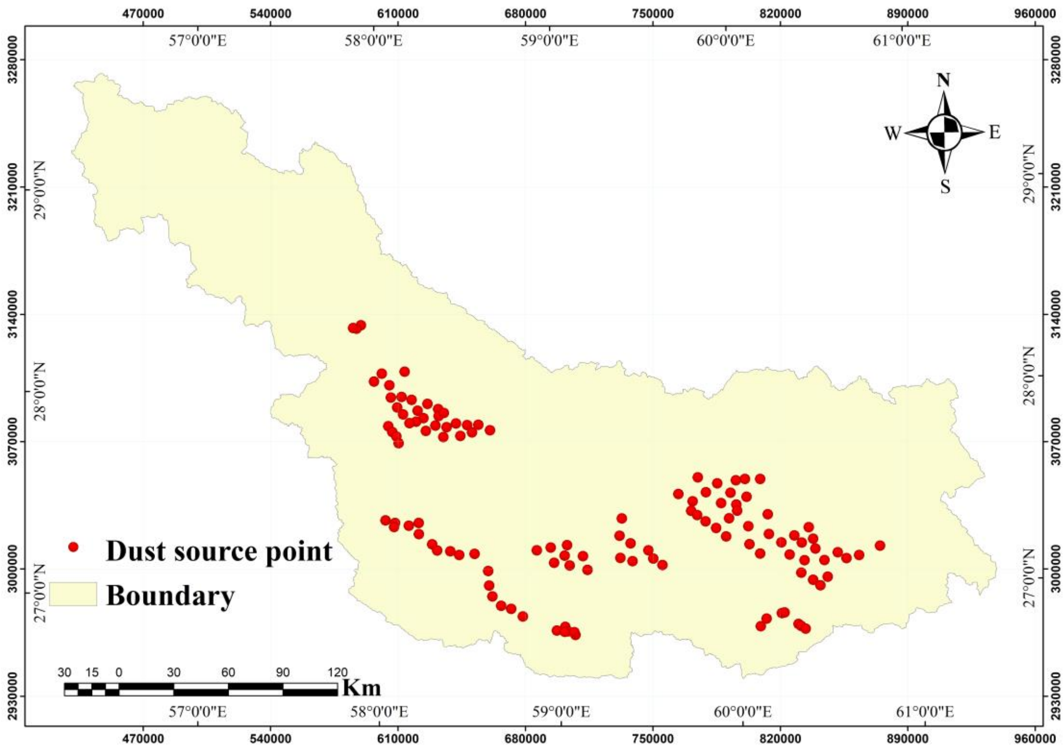

Fig. 11. Map of dust source point production in the Jazmurian wetland basin

4. Discussion

Combating the dust phenomenon requires multilateral methods consisting of politics, ecosystem management, economics and capacity building. Therefore, the correct identification of dust centers is one of the first steps in the management and control of the dust phenomenon. The aim of this research is to identify areas susceptible to dust production and wind erosion using the ILSWE index in the Jazmurian watershed.

This index is calculated based on five factors: climate erosivity factor, soil erodibility factor, Soil Crust Factor, vegetation cover factor, and surface roughness. The results of this research indicated that around 23% of study area located in the southern, central, and eastern regions of Jazmurian are susceptible to dust production and wind erosion. These areas are classified as high (12.41%) and very high (10.64%) land susceptibility to wind erosion

These areas are predominantly located in barren lands, highlighting the importance of vegetation cover in preventing dust generation. However, the topographic conditions, wind presence (the presence of 120-days winds in Sistan and Baluchestan), and soil characteristics in these regions also significantly contribute to the occurrence of dust and erosion (Soleimani Sardoo *et al*., 2022).

(Gholami *et al*., 2020) using six machine learning algorithms to evaluate and classify the hazard of wind erosion in the Jazmurian basin reached similar results to this research. Most of the areas identified by them as high-risk zones for dust production were also identified as susceptible areas in this study. This finding indicates that the index used in this research is effective in determining areas prone to dust production.

The results of this study demonstrated that the dry bed of Lake Jazmourian, barren lands without vegetation cover, and sandy dunes are the areas with the highest potential for dust production in the Jazmurian watershed. It appears that surface materials with fine particle size distribution are not considered as limiting factors for the dispersion of fine dust. Instead, wind and aridity seem to be more influential determining factors.

Lake Jazmourian and its surrounding areas are highly dependent on surface water supply from the mountains and the Halil River. Changes in land use practices and human activities have had a negative impact on vegetation in these dry landscapes. The reduction in river runoff due to the construction of dams in Jiroft and Bampour has significantly decreased seasonal inflows into the lake. The drying of a significant portion of the lake bed in recent decades has intensified the effects of dust dispersion in this region.

To evaluate the results of this research and assess the effectiveness of the ILSWE index, an overlap analysis was conducted with the map of active dust sources prepared by the Natural Resources and Watershed Management Organization of Iran. This overlap analysis demonstrated that the ILSWE index has a high accuracy in identifying areas with significant wind erosion.

Based on the results of this research and comparing them with previous studies, it can be concluded that the ILSWE index, as a suitable regional model, is effective in determining areas susceptible to dust production and erosion hotspots. Considering the limitations of time, extensive coverage, and cost in projects related to identifying dust and erosion hotspots in Iran, the ILSWE index can be utilized effectively. This finding is consistent with the results of studies conducted by (Borelli *et al*., 2016) and (Raeghani *et al*., 2017).

5. Conclusion

In general, the results of this research showed that barren lands, salt marshes, sand dunes and flowing sands play an important role in the production of dust in the Jazmurian wetland basin.

Therefore, it is possible to increase the soil surface coverage and stabilize the soil by using revitalization plans such as planting, seeding, and mulching, ultimately reducing the sensitivity of land to wind erosion and dust production.

To enhance the accuracy of the ILSWE index results, it is recommended to utilize ground data for measuring soil properties used in this index. By incorporating ground data related to soil characteristics such as sand, silt and clay percent, organic matter and etc., a higher level of accuracy can be achieved in identifying areas prone to wind erosion at a local scale. This approach can significantly improve the precision and assess ability of the index in a local context. Furthermore, regarding the calculation of the Surface roughness (SR) factor in the EF equation, which requires a scoring table for land use and land cover, it is necessary to anticipate and modify this table based on the specific conditions and characteristics of Iran.

Also, according to the results obtained from this research, it can be said that the ILSWE model is a suitable regional model for determining dust-sensitive areas. Therefore, considering the limitations of time, large area and cost, it can be used well in the plans to determine the centers of dust and wind erosion in Iran. Of course, it should be noted that more studies are needed for a better evaluation of this model in Iran.

References

Ahmadi, H., Y. Esmaeilpour, A. Moradi, H. Gholami, 2019. Assessment of land Sensitivity to Desertification Hazard Using System Dynamics Approach in the Jazmourian basin. J. of Water and Soil Conservation, 26(2); 211-224. DOI: 10.22069/jwsc.2019.15565.3076. (In Persian).

Boloorani, A.D., N.N. Samany, S. Mirzaei, H.A. Bahrami, S.K. Alavipanah, 2020. Remote Sensing and GIS for Dust Storm Studies in Iraq. Environmental Remote Sensing and GIS in Iraq, 333-375 pp.

Borrelli, P., P. Panagos, C. Ballabio, E. Lugato, M. Weynants, L. Montanarella, 2016. Towards a Pan-European assessment of land susceptibility to wind erosion. Land Degradation & Development, 27(4); 1093-1105.

Borrelli, P., P. Panagos, L. Montanarella, 2015. New insights into the geography and modelling of wind erosion in the European agricultural land. Application of a spatially explicit indicator of land susceptibility to wind erosion. Sustainability, 7(7); 8823-8836.

Effati, M., H.A. Bahrami, M. Gohardoust, E. Babaeian, M. Tuller, 2019. Application of Satellite Remote Sensing for Estimation of Dust Emission Probability in the Urmia Lake Basin in Iran. Soil Science Society of America Journal, 83(4); 993-1002.

FAO. 1979. A provisional methodology for soil degradation assessment. Food and Agriculture Organization, Rome, Italy.

Fenta, A.A., A. Tsunekawa, N. Haregeweyn, J. Poesen, M. Tsubo, P. Borrelli, T. Kawai, 2020. Land susceptibility to water and wind erosion risks in the East Africa region. Science of the Total Environment, 703; 135016-135036.

Feuerstein, S., K. Schepanski, 2019. Identification of Dust Sources in a Saharan Dust Hot Spot and Their Implementation in a Dust-Emission Model. Remote Sensing, 11(1); 1-24.

Floors, R., P. Enevoldsen, N. Davis, J. Arnqvist, E. Dellwik, 2018. From lidar scans to roughness maps for wind resource modelling in forested areas. Wind Energy Science, 3(1); 353-370.

Fryrear, D.W., J.D. Bilbro, A. Saleh, H. Schomberg, J.E. Stout, T.M. Zobeck, 2000. RWEQ: Improved wind erosion technology. Journal of Soil and Water Conservation, 55(2); 183-189 .

Fryrear, D.W., A. Saleh, J.D. Bilbro, H.M. Schomberg, J.E. Stout, T.M. Zobeck, 1998. Revised wind erosion equation (RWEQ). Wind erosion and water conservation research unit, USDA-ARS, Southern Plains area cropping systems research laboratory. Technical Bulletin, 1.

Funk, R., H.I. Reuter, 2006. Wind erosion. In: Boardman, J., Poesen, J. (Eds.), Soil erosion in Europe. Wiley, Chichester, UK, 563–582 pp.

Gholami, H., A. Mohamadifar, A., Sorooshian, J. D. Jansen, 2020. Machine-learning algorithms for predicting land susceptibility to dust emissions: The case of the Jazmurian Basin, Iran. Atmospheric Pollution Research, 11(8); 1303-1315.

Hansen, S.V. 1993. Surface roughness lengths. ARL Technical Report U. S. Army, White Sands Missile Range, NM 88002-5501, 51 pp.

Hengl, T., J.M. de Jesus, G.B. Heuvelink, M.R. Gonzalez, M. Kilibarda, A. Blagotic, W. Shangguan, M.N. Wright, X. Geng, B. BauerMarschallinger, M.A. Guevara, 2017. SoilGrids250m: Global gridded soil information based on machine learning. PLoS one 12(2); e0169748. https://doi.org/10.1371/journal.pone.01 69748.

Hojjati, K., Z. Abedi, B. Rayegani, M. Panahi, 2021. Assessing land sensitivity to determine areas prone to dust production (case study: Alborz province). Environmental Science and Technology Quarterly, 23(11); 151-164. (In Persian).

Jiang, Ch., H. Zhang, Zh. Zhang, D. Wang, 2019. Model-based assessment soil loss by wind and water erosion in China's Loess Plateau: Dynamic change, conservation effectiveness, and strategies for sustainable restoration, Global and Planetary Change, 172; 396-413.

Kheirabadi, H., M. M. Mahmoodabadi, V. Jalali, H. Naghavi, 2018. Sediment flux, wind erosion and net erosion influenced by soil bed length, wind velocity and aggregate size distribution, Geoderma, 326; 22-30.

Liu, S.Q., S.R. Zhang, J. Wu, X.Y. Pang, D.G. Yuan, 2002. The relationship between soil pH and calcium carbonate content. Soils, 5; 279-282.

Mirzashahi, K. 2016. Periodic survey of soil organic carbon in the plain of Khuzestan and providing promotion solutions. Promotional scientific journal of land management. 5 (1); 1-12. (In Persian).

Rayegani, B., S. Barati, H. Goshtasb, S. Gachpaz, J. Ramezani, H. Sarkheil, 2020. Sand and dust storm sources identification: A remote sensing approach. Ecological Indicators, 112; 106099-106113.

Rayegani, B., Z. Kheirandish, F. Kermani, M. Mohammdi Miyab, A. Torabinia, 2017. Identification of Active Dust Sources Using Remote Sensing Data and Air Flow Simulation (Case Study: Alborz Province). Desert Management, 4(8); 15-26. (In Persian).

Soleimani Sardoo, F., S. Karami, A.A. Motakan, 2022. Prediction of dust particle movement using HYSPLIT and WRF-Chem model in Jazmorian basin (Case study of dust 7 and 8 October 2018). Journal of Climate Research, 51; 1-13. (In Persian).

Wever, N. 2012. Quantifying trends in surface roughness and the effect on surface wind speed observations. Journal of Geophysical Research: Atmospheres, 117; 1-14.

Yigiterhan, O., B.Z. Alfoldy, M. Giamberini, J.C. Turner, E.S. Al-Ansari, M.A. Abdel-Moati, J.P. Obbard, 2018. Geochemical composition of Aeolian dust and surface deposits from the Qatar Peninsula, Chemical Geology, 476; 24-45.

Zhang, K., S. Li, W. Peng, B. Yu, 2004. Erodibility of agricultural soils on the Loess Plateau of China. Soil and Tillage Research, 76(2); 157-165.

Zobeck, T.M. 1991. Soil properties affecting wind erosion. Journal of Soil and Water Conservation, 46(2); 112-118.