# The Potential of Bayesian Belief Networks in Estimating and Evaluating Wind Erosion Rates (Case Study: Ilam Dhlran-Plain)

**Ali Mohammadian Behbahani[a*], Abdalhossein Boali[b]**

[a] *Assistant Professor in Desert Regions Management Department, University of Agriculture and Natural Recourses Sciences of Gorgan*
[b] *PhD Student in Desert Regions Management Department, University of Agriculture and Natural Recourses Sciences of Gorgan*

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## 1. Introduction

Wind erosion is one of the important aspects of land degradation in arid and semi-arid areas. Countries in arid and semiarid belt of the world, including Iran, have always been associated with this phenomenon. In some studies, wind erosion index of IMDPA model is used to evaluate the wind erosion. Wind erosion assessment models use different scores to determine the erosion rate in a given class. However, due to the spatial and temporal complexities and the multiplicity of factors affecting the ecological conditions of the region, it is impossible to fully rely on the results and use them for targeting, prioritizing the areas and providing suitable solutions for management. But Bayesian Belief Networks (BBN) are based on probabilistic approaches which show the uncertainty in the evaluation of phenomena in terms of probability. These Networks are essentially developed as tools for analyzing decision-making strategies under uncertainty. Accordingly, the purpose of this study is to estimate the rate of wind erosion based on the IMDPA model, and to assess the potential of the BBN as a relatively new and probable means for estimating the wind erosion, and finally, to evaluate the management scenarios for controlling wind erosion in Dehloran plain in Ilam province.

## 2. Materials and Methods

The wind erosion criterion of IMDPA model was used in this study. Three indicators were used to weight the wind erosion criterion. The "percent vegetation cover" and " emergence of erosion facies" indicators were valued based on existing maps and field visits. Data were collected from Dehloran synoptic station for a period of 30 years in order to evaluate the DSI index which stands for the number of the days with dust storm. The final score of wind erosion in each area was obtained based on the geometric mean. The information layer for each wind erosion criteria was prepared based on the weights given in the GIS environment and the final map of the wind erosion criterion

*. Corresponding author: Ali Mohammadian Behbahani Email: behbahani1383@yahoo.com Tel: +989162073200

was prepared. In order to begin the process of modeling the networks of Bayesian beliefs with regard to the purpose of the study and by a review of the resources and assisting experts, suitable variables were selected for modeling the BBN. In the next step, the relationships between the variables should be determined using the impact graph. The impact diagram shows the relationships and effects of the variables on each other and on the output node of the model (the amount of wind erosion). Finally, in order to create a model and formulate the conditional probability tables of model variables, the impact diagram was transformed into a BBN model using the Netica software.

## 3. Results and Discussion

After evaluating and scoring indices to measure wind erosion and calculating the geometric mean of work units, the emergence of erosion facies index indicates the lowest, and the dust storm index shows the highest weight with the greatest impact on the severity of wind erosion in the area. Based on the weights given to each standard wind erosion indices at the work unit level, the facies of sediment source, abandoned lands and fine-grained ridge plains have the most roles in the wind erosion of the area. Using the final model of Bayesian's belief network, the causal relationships between the variables affecting the rate of wind erosion were shown. The target variable in this model is wind erosion. Based on the results, geological variables, land management, topography of the area, soil texture, rainfall and frequency of wind speed at speeds of more than 6 m/s were considered as key variables of the model. In order to run the model, information about each of the key variables was taken from the area at the unit level and fed to the model. Finally, the model was designed to estimate the amount of wind erosion in each unit. Based on the output of the model, the probability of wind erosion in each unit was used to zone the probability of wind erosion in the study area. The overall sensitivity analysis of the model also indicates that the wind erosion rate of the area has the most sensitivity to the wind velocity and speed, the frequency of wind speeds of more than 6 m/s and the protection of the earth's surface. On the other hand, the least sensitivity is to variables like soil texture, geology and topography. A high correlation between the results of the two models was found. There was a suitable and significant correlation coefficient at the level of $\alpha = 0/05$ between the high probabilities of the BBN and wind erosion criterion of the IMDPA model.

## 4. Conclusion

It was shown that the BBN presents the probability of different wind erosion rates for each unit in the study area. In the BBN, the uncertainty of the evaluation results is expressed in terms of probability and managers are to choose and implement timely and appropriate management decisions to reduce the risk of wind erosion in the region. The designed model in this study can be implemented in all regions. However, depending on the conditions of each region, the number of variables in the model can be increased or reduced. In the model of Bayesian belief network, the data presented in this study show that land management and vegetation density are factors that affect the amount of wind erosion and, with regard to the environmental constraints of the area, they can be partially rectified. But other factors such as land form and soil texture cannot be changed due to the size of the area and economical instability.

**Keywords**: Sensitivity analysis, wind erosion, IMDPA, Bayesian belief networks (BBN)

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