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Critical centers of wind erosion and evaluation of measures taken to combat desertification (Case study in Jiroft and Anbarabad counties)

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ABSTRACT

Despite spending high expenses on combating desertification in our country, not much success has been achieved so far. The reason is the lack of evaluation or inappropriate evaluation of the projects done before and after the implementation of the projects. One of these plans is to control critical centers of wind erosion. Some of these critical centers of wind erosion are located 25 km east of Jiroft city in Kerman province. The importance and evaluation of the effect of each of the managerial, biomechanical and biological measures in stabilizing running sands and controlling wind erosion in this critical center has shown that the applied methods have had both positive and effective results. Since the sustainability of the applied methods depends on the observance of the principles based on sustainable development, it is very important to evaluate the measures taken. Finally, what has been done in the critical centers of Jiroft city is the joint and coordinated presence of all factors based on scientific, experimental and indigenous principles in the region, which has finally turned this project into an index project. One of the important features of this project is the use of non-living windbreaks instead of oil mulch and having a variety of species and compatible desert species. The results showed that among the evaluation methods, the best method for evaluating the measures taken in the critical centers of wind erosion are qualitative methods along with quantitative methods because most of the indicators in these areas are either digital or capable of being converted to quantitative indicators. Evaluations showed that the activities carried out changed the vegetation rate and improved it from 37% to 74%, which is a sign of the success of the executive parameters.

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1. Introduction

A large part of Iran suffers from acute climatic conditions, especially drought. In these areas, in addition to acute climatic conditions, successive droughts also increase the pressure on the environment and increase the phenomenon of desertification. According to the plan of detection of wind erosion centers, 170 critical wind erosion centers have been observed in 14 provinces. The Office of Sand Stabilization and Desertification is in charge of combating wind erosion and reducing the effects of desertification in the country, which approves and implements projects based on the proposal of desert provinces.

But the fact is that with the limited facilities of the country, in terms of credit, it is not possible to fight against wind erosion and prevent the movement of running sands, and it may not be necessary to control them in places where the running sands do not cause damage. Studies conducted in the desert areas of Iran show that the best stage to combat wind erosion is in the harvest stage. In addition to less costs, combating wind erosion during the harvest phase will be more successful than the other two areas. However, in some areas, due to the damage caused by the sedimentation area, it is necessary to carry out executive operations in the sedimentation area as well. Therefore, in the national plan of the Office of Sand Stabilization

and Desertification, the critical centers of wind erosion were identified and the damage caused by it was estimated, as well as prioritizing the critical centers. The plan to review and evaluate the critical centers of wind erosion was put on the agenda almost several years after the initial preparation of this plan. This plan is based on the method of origin of sand dunes in Iran (Ekhtesasi and Ahmadi). The first problem in evaluating the plan is to determine the questions that need to be answered, that is, what problems for resolving which the plan is prepared or decisions of plan implementation are being made. Decision makers must try to find a solution or find a solution or answer. By defining the issues and problems under study and designing the method of questions and problems, better experts will achieve the overall goal of evaluation. From a managerial point of view, the perspective of efficiency or problem solving is the best way to examine a system. The responsibility of management sector is to identify inefficiencies and eliminate them (Charles Vest Cherman, 1900). In previous research, researchers have identified areas of harvesting D, transport T, and sedimentation S in sand dunes, and by using economic and social indicators, the part of these areas that cause damage to biological and economic facilities is determined and they are named as wind erosion centers. These critical centers are classified into high H1, medium H2 and low intensities H3 according to the desired indicators. According to the above plan, in the country, 28.20219475 hectares of lands are affected by wind erosion, of which 5.145118470 hectares are part of the harvest area, 8.991529 hectares are part of the transport area and the remaining 15.4777475 hectares are part of the sedimentation area. Among the positive management measures, we can mention the reclamation of vegetation through the cultivation of compatible species. However, it should be noted that a plant species is introduced as a compatible species after various stages and tests and it is possible to recommend its cultivation in specific regional conditions (Khalkhali, 1996). So far, extensive executive measures have been taken in the provinces and desert areas to try to prevent the growing development of critical centers. Several projects have been implemented in Kerman province, including the desertification project, we can mention the implementation of these projects in the cities of Jiroft and Kahnooj, has been started since 1997through the implementation of seedling, seeding and cutting projects with drought and salinity-resistant species such as Atriplex, Gaz and Acacia and … . Jery et al. (1990) in a study entitled “Natural methods of establishing native plants in critical areas” reported that generally mechanical and chemical methods to improve such lands are not appropriate and sufficient and they often cause more complex disturbances than the previous process, so they suggested using natural systems. Examples of general issues and goals are: protection, rehabilitation, development, exploitation, economic, social, environmental and cultural (Abdullah-Pour, 2011). According to the views of the executive bodies related to natural resources, a number of national plans have been prepared for many years, especially in the last decade. Now, after a decade of preparation, formulation and implementation of these plans, as well as spending costs and capital excessive investment, the need to review the effectiveness of these projects and evaluation in the process of implementation and planning of various natural resource projects is felt. Among these projects are critical centers of wind erosion that are located in different parts of the country and a lot of costs has been spent on them. Among these critical centers, as mentioned in the previous articles, we can mention the critical centers of wind erosion in Jiroft and Kahnooj regions, due to the high costs that have been spent on them so far. But so far in these areas, a proper evaluation of the measures taken has not been done. The measures taken in the critical centers of wind erosion have been studied by Shariati and Taliban Fard’s (2010).

It has caused a qualitative change in the plant species of these areas also, in the research conducted by Akhlaghi (2011) and Golbabaei et al. (2008), quantitative methods were used to evaluate natural resource projects, which showed that the lack of public participation has caused the failure of natural resource projects. Therefore, the present study was conducted to evaluate the ecological effects, evaluate and examine the weaknesses of previous projects and provide solutions for the implementation of future projects.

2. Material and Methods

In order to investigate the issue, while referring to the files and documents available in the Department of Natural Resources and Watershed Management of Jiroft and Anbarabad, the identification and implementation plans of the region were studied and the executive methods in dealing with this phenomenon were explored. And the effect of the measures was evaluated qualitatively and quantitatively in comparison with the previous situation.

2.1. Location of the region

Executive plan of wind erosion critical centers of Jiroft and Anbarabad counties with an area of 190421 hectares are located in the range of 25 to 205 km east of Jiroft city in the range of longitude of 57° 51′ to 58° 49′ and latitude of 26° 51′ to 30° 34′. The average rainfall in the region is 180 mm. The highest monthly rainfall is related to March at 35 mm. The average annual temperature is 27.4, the average minimum annual temperature is 11.1, the average maximum annual temperature is 27.7, the absolute minimum annual is 2.6 in December and the absolute maximum annual is 47.8 ℃ in July. The study area included executive areas with an area of 190421 hectares and comparison and evaluation with the situation before the implementation was performed as a control.

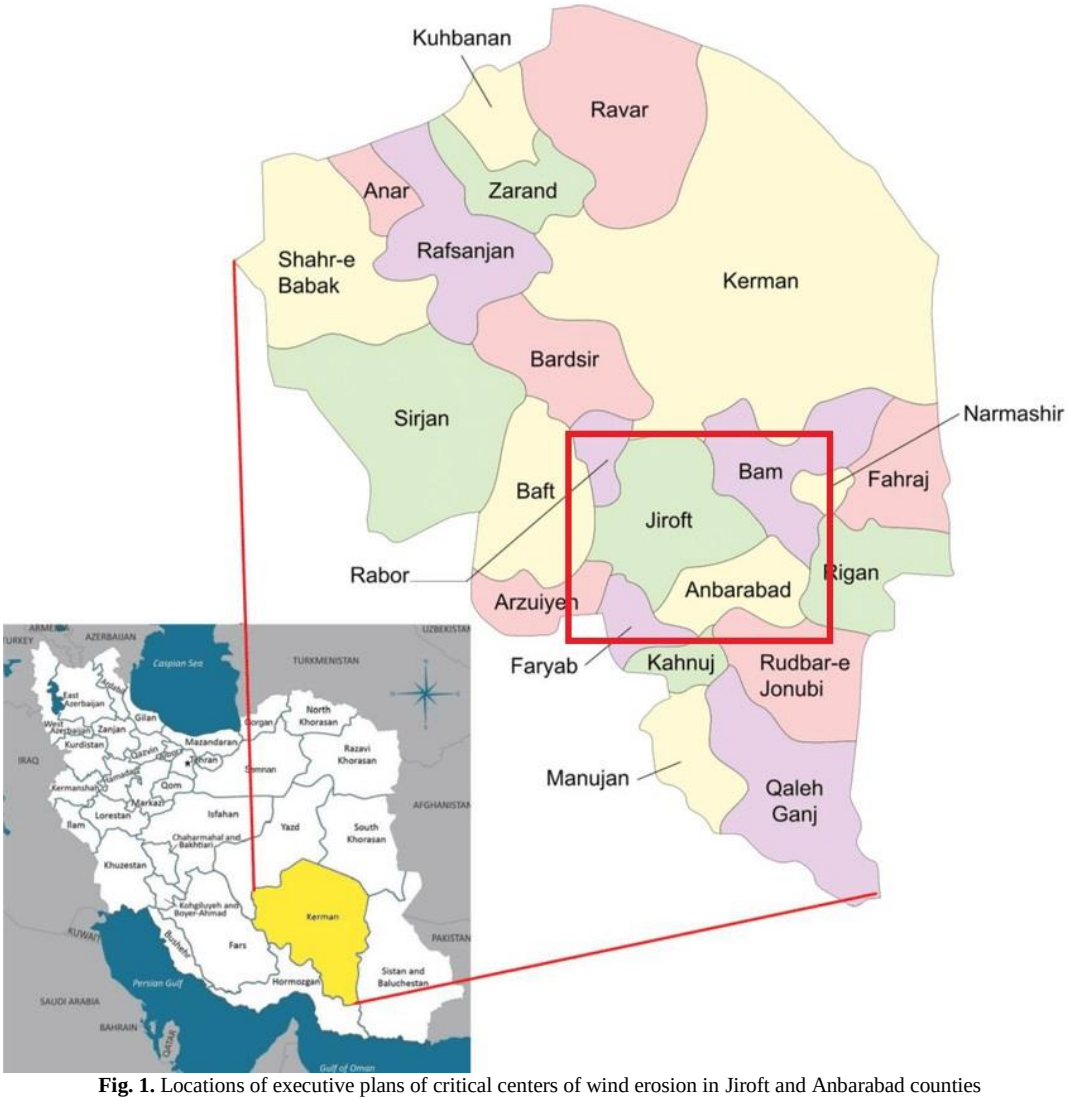

Fig. 1. Locations of executive plans of critical centers of wind erosion in Jiroft and Anbarabad counties

Table 1. The level and location of the critical center along with the affected biological and economic resources in Anbarabad city

County	Critical center	areas in the center	Geographical coordinates				Critical Center Area (hectares)				Biological and economic resources affected	The extent of damage to biological and economic resources (Thousand Rials)
			Longitude		Latitude		H1 (high intensity)	H2 (moderate intensity)	H3 (low intensity)	total		
			From	to	From	to						
Jiroft and Kahnooj	Jazmorian	Rudbar, Boeing, Kopri, Zahkloot, Chahdasht, Chah Hassan, Miandaran, Peng, Chah Shahi, Tavakolabad, Abbas Abad, Chah Dadali, Kohan Cheragh, Chah Ahmad	57°56′	54°58′	27°43′	28°06′	131103	-	-	131103	Residential areas, agricultural lands and main and secondary roads	173530952
	Takol Hasan	Takel Hassan, Harouni village, Lashkar engines (12)	58°02′	58°02′	30°19′	30°34′	9151	-	-	9151	Residential areas, agricultural lands and main and secondary roads	13276060
	Chah Dadkhoda	Dadkhoda well and pumps and adjacent agricultural lands	58°00′	58°35′	27°10′	27°23′	42124	-	-	42124	Residential areas, agricultural lands and main and secondary roads	82042380
	Ramshk Road	Ramshk Road	58°36′	58°49′	51°26′	27°07′	-	-	6909	6909	The main way	250838
	Total	-	-	-	-	-	182378	-	6909	1892887	-	269100230

* According to the latest land divisions, Jazmourian and Takol Hasan centers have been allocated to Rudbar city and Chah Dadkhoda and Remshak road centers have been allocated to Qaleh Ganj city.

Table 2. The level and location of the critical center along with the affected biological and economic resources in Anbarabad city

County	Critical center	areas in the center	Geographical coordinates				Critical Center Area (hectares)				Biological and economic resources affected H1 (high intensity) From	The extent of damage to biological and economic resources Thousand) (Rials H2 (moderate intensity) to
			Longitude		Latitude		H1 (high intensity) From	H2 (moderate intensity) to	Longitude From	Latitude to		
			From	to	From	to						
Anbar Abad	Meysam Abad	Jihad Abad, Meysam Abad, Chehel Mani, Shahid Salari Town, Khatun Abad Farm, Ahmad Abad Farm	51°57′	55°57′	28°17′	28°20′	-	1134	-	1134	Residential areas and agricultural lands, transportation routes and pastures	962631

2.2. Investigation of the vegetation status of the region in the years 1996 to 2020

There is no scientific and accurate evaluation and estimation of the amount and type of vegetation in the pastures of Jiroft and Anbarabad counties, but the rangeland audit file and card in 1986 confirms the existence of Ashnian, Salsola, Ajwa, Estabargh and Kor species. In addition, images from the years 1986 to 2013, which were taken from these pastures after the occurrence of problems caused by the movement of quicksand, show a lack of vegetation of less than 2%. In order to evaluate the vegetation and also the success rate of the executive operations predicted in the previous plans, by dividing the area into two types of geomorphology, first according to the proposed planning map, the location of each executive plan in the two types is identified and then each of these operations was reviewed thus, three areas (executive plans) were examined for additional studies:

A) Exclosure area with seeding operations

B) Planting area

C) Protected area

Then, sampling sites were determined in each of the executive programs, thus trying to have a completely homogeneous sampling site and characteristics related to each area. The size of sampling plots was determined according to the type and method of vegetation distribution by the minimum surface method. To study vegetation, plots of 100 square meters (10×10) and one square meter (1 × 1) were used randomly in each area. Thus, sampling was performed in ten plots in each area. Vegetation characteristics such as vegetation percentage and dry forage production (cutting and weighing method), determining the vegetation status using the four-factor method (traditional method of the US Forest Service), determining the tendency using the scoring method and considering the signs Regression was measured in plants

2.3. Review of executive measures in the region

The actions performed in the design logic are divided into three categories, which are managerial actions, biomechanical actions and biological actions.

2.3.1. Managerial measures

These measures include two types of activities, which are: a- Physical removal of the main causes of destruction b- Restricting the area.

2.3.2. Biomechanical measures

The above measures are based on creating a moan in the main area of winds in the region in order to establish suitable plant species. In the area, by creating several rows of non-living windbreaks, it has made possible the establishment of seeds and seedlings in regeneration operations in the protected area. Under the protection of these mechanical barriers, the mechanical seeding operation has also been successful and with the emergence of plant species, the width of the non-living windbreak and the surface cover have stabilized the quicksand.

2.3.3. Biological measures

Rehabilitation or biological operations including broad seeding and planting seedlings with suitable desert species. Studies have shown that a variety of species have been used in seeding and seedling operations, which has ultimately shown positive results.

3. Results and discussion

After reviewing the data in terms of having the necessary conditions to perform statistical tests, analysis of variance was used to compare the characteristics of plant communities, and Duncan's multiple range test to group the means.

3.1. Quantitative results of vegetation study

The results of reviewing and comparing the vegetation status and the predicted executive plans at the beginning and end of the project in two types of geomorphology have been presented in Tables 3 and 4.

Table 3. Vegetation status before the project implementation

No.	Name of the foreseen executive operation	Factors under study	Average score of ten plots				Total score	Vegetation status	Tendency	production (kg/ha)	(%)Vegetation
			Coverage	composition	Soil protection	Plant vigor					
1	Exclosure with broad seeding		9	10	8	7	34	Moderate	Positive	36	35
2	Seedling		3.6	2.5	1	3.5	1.6	Very week	Positive	17	16
3	Protected area		1	1	0.3	2.2	5.5	Very week	Positive	4	10

Table 4. Vegetation status at the time after project implementation

No.	Name of the foreseen executive operation	Factors under study	Average score of ten plots				Total score	Vegetation status	Tendency	production (kg/ha)	(%)Vegetation
			Coverage	composition	Soil protection	Plant vigor					
1	Exclosure with broad seeding		9	10	8	9	36	Moderate	Positive	41	39
2	Seedling		5.6	3.5	1	7.5	17.6	Moderate	Positive	23	21
3	Protected area		5	4	2.3	4.3	15.6	Moderate	Positive	7	13

3.2. Qualitative results of the project

Due to the coordination and alignment of managerial, biomechanical and biological measures, the following results have been obtained:

A. Quantitative increase of vegetation over five years from less than 37% to 74% and increase in quality of plant species.

B. Complete control and stabilization of running sands.

C. Increasing life expectancy, work, effort, agriculture and animal husbandry within the scope of the project.

D. Practicing collaborative work with the cooperation of administrative, disciplinary and judicial bodies and rescuing the region from sandstorms.

E. Significant effect of exclosure on revitalization and resuscitation and approaching the climax of the region.

4. Conclusion

What has turned Jiroft and Kahnooj counties into a critical center of wind erosion, is one of the important aspects of the issue. The geomorphological condition and the sensitivity of the region to wind erosion as well

as excessive grazing caused the above region to become a completely poor pasture. Decreasing the income of the people of the region on the one hand and the impossibility of agriculture and light livestock on the other hand have changed the livelihood system and made them turn to heavy livestock breeding along with illegal trade. Although vegetation loss and desertification are generally slow and slow and their effects are very rapid and dangerous, however, due to the sensitivity of natural and inherent conditions of this region to erosion and at the same time excessive livestock pressure on pastures, desertification effects have occurred in a short period of time, but using the role of vegetation in the projects, erosion has reached its minimum level. Soil management operations are more focused on improving plant growing conditions and improving soil structure to increase resistance (Stanlengz, 1975). The construction of a fence in areas where there is a risk of moving quicksand is a very effective and necessary action. Vegetation creation sometimes plays the main role of inhibiting wind erosion. Therefore, a set of managerial, biomechanical and biological measures in the above region has led to the establishment of a sustainable ecosystem in the region. Today, erosion and especially wind erosion is recognized as one of the effective factors in the extension of desert areas. Classification of the importance and evaluation of the effect of each of the managerial, biomechanical and biological measures in stabilizing running sand and controlling wind erosion in these critical centers has shown that the applied methods have had both positive and negative results. Since the sustainability of the applied methods depends on the observance of the principles based on sustainable development, the evaluation of the measures taken will show that each of the methods used alone has the desired dimensions for sustainable development, whether in terms of species diversity or adaptation and will also bring about the influence of local communities as well as the participation of the executive, judicial and disciplinary bodies. Finally, what has been done in the critical centers of Jiroft and Anbarabad region is the joint and coordinated presence of the above factors based on scientific, experimental principles and indigenous knowledge in the region, which has finally turned this project into an index project. There are many indicators studied in wind erosion centers. Most of these indicators are quantitative and have the statistical analyzability, and in the case of quality indicators that should be converted into quantitative indicators, and that the conversion of some qualities into quantity is complex, but some of the qualities that are convertible into quantity must be converted and measured in numbers. Among the above indicators, we can mention wind speed, wind erosion threshold speed, sand displacement rate and other indicators that quantitative nature of these indicators causes quantitative and environmental methods to be used in evaluating these plans. The results obtained were not consistent with ethical research, (C, 2011) and were not consistent with the results obtained by Shariati and Taleghani (2010) research. Studies show that the elimination of the main causes of destruction, exclosure and restoration of vegetation in the region has been a prerequisite and effective management measures in the region. Undoubtedly, the non-implementation of any of the above cases would have overshadowed the effect of the next measures and the implementation of the plan would have failed. Elimination of factors of destruction, exclosure and restoration of vegetation, which was possible only with the effective cooperation and interaction of the executive, judicial, law enforcement and security agencies, is considered a positive aspect of the project. Experiences of this assistance and cooperation can be considered as useful findings and transferable experiences. The role of exclosure in this project in creating and restoring vegetation is obvious. The absence of hand-planted plant species as a plant type and on the other hand the emergence of native species in the above area reveals the impact and role of exclosure on restoration operations. Destruction of vegetation that took place in the region until 1983 and caused the movement of running sands in the implementation stages put priorities before the project implementers, such as the implementation of biomechanical and mechanical operations in the form of windbreaks Non-live and live plants were able to significantly reduce the effect of wind erosion in parts of the region and also make it possible for the seeds and seedlings to be established in regenerative operations in the windbreak protection zone. Therefore, the role

of positive biological actions and, secondly, their importance are evaluated. And the fact is that the introduction of relatively fast-growing species such as hawthorn and atriplex as shrub or wood species is a necessity of the project, which especially in the first years of the project has played a complementary role in the reconstruction of the region, such that the results of this study are in complete contradiction with the results of Shariati and Taliban Fard (2010) and indicate the positive results of the project. The effect of resuscitation operations has been effective in both reducing wind speed and creating microclimatic conditions. But in the following years, the implementation of the evaluation plan, the impact of these measures has a lesser position. This means that considering the obstacles created and the establishment of native and plant species under the shelter of a light pasture-controlled grazing management, a sustainable ecosystem can be achieved in the region so that the results obtained were in agreement with the results obtained by Jerry et al. (1990).

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