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Economic Assessment of Environmental Damages Caused by Drying up of Hamoon Wetland in Sistan Zone

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ABSTRACT: Sistan is characterized by questionnaire was designed in order to gather detailed information about valued features of the Hamoon wetland, and 248 questionnaires were filled. Both male and female respondents were in three age groups (25<, 25-45, 45>).The data was descriptively analyzed with SPSS and Excel spread sheet in order to analyze the empirical parts of the second and third questions. The obtained results indicated that in best situation, the Hamoon wetland scenario may provide job opportunity for 40.8 % of Sistan households, out of which nearly 8.6% of job opportunities are involved in bird catching, whereas 4.1% are busyin reed harvesting and mat weaving. After each sandstorm, approximately 972 houses are covered by severe sandstorm. Assuming that the residents excavate and repair their houses only once a year after this severe windy season in October, the cost of excavation and reparation is estimated 10,692,000,000 Rials per year, mainly due to sandstorms exerted on people and dryness of the Hamoon wetland. The total estimated cost of excavation and reparation of the villages once per year would be 37,048,0000 Rials. The region lacks appropriate infrastructure and development potentials and its unemployment rate is higher than 21%.

Key words: Hamoon Wetland (HW), Economic Assessment (EA), Damages, Health, Sistan

INTRODUCTION

Sistan is a densely populated enclave in the most scarcely populated area in SE of Iran. It is known for its severe socio-economic conditions such as poverty, unemployment, immigration to other neighboring regions, high levels of illegal activities and health problems and loss of natural resources. The water resources are scarce in the region. The main water resource is the Hirmand River that flows from Afghanistan into Iran and finally runs into Hamoon Lake. However, during the last decade, its inflows into Iran have decreased significantly. High rates of evaporation and inefficient water usages have also reduced the sescarce resources. This condition was regarded in this case study of Hamoon. The valuable features of the Hamoon wetland, categorized as regulation functions, attributes, goods and human direct and indirect uses, were defined based on the gathered empirical data. It was concluded that the Hamoon wetland is able to provide many valuable features for the Sistan community and it also contributes to the socio-economic development of the region (1-5). Various categories of socio-economic criteria influenced by the Hamoon wetland were employment, economic value of fishing, reed harvesting and bird hunting, food supplying and their direct influence on the microclimate of the region, severity of sandstorms, health, and finally, provision of recreational opportunities in the region. The present research was aimed to integrate the hydrological features of the wetland with its associated ecological, socio-economic situations. The hydrological situation in the Hamoon wetland influences its ecosystem and results in changes in availability and quality of its valued features. In addition, the hydrological situation may directly influence the socio-economy of the region, regardless of its features. The first section of the paper introduces different stages of water availability in Hamoon wetland, which may be resulted under different levels of water resource availability and various water allocation strategies. The participants were asked to clarify different water availability situations they have experienced in the wetland and to describe the levels of water availability have influenced their socio-economic well-being in the past. In this regard, three types of water availability situations were defined: wet year, semi- wet year, and dry year. Next, the ecologists were asked to set ecological thresholds in water availability levels. If they are met, certain features of the wetland may exist in certain levels.

Based on these ecological thresholds 6, three availability situations were classified into more detailed water availability situations: 4 types of plausible wet years, 10 types of plausible semi-wet years, and 3 types of plausible dry years. These valuable features of the wetland and the scores of the socio-economic criteria may change under each of these situations. In order to assess the socio-economic criteria under such cases, required data were extracted from 248 questionnaires. The region lacks appropriate infrastructure and development potentials and its unemployment rate is higher than 21% compared with the national high. Since this region stretches along the border of Iran and Afghanistan border and mostly because of its lack of job opportunities, many households have been involved in illegal activities including drug dealing and smuggling. Moreover, there is a critical water crisis in the region. The water resources are limited, whereas the demand for water is quite high.These factors have resulted in a large-scale immigration from the region. If it continues during the next years, it will have several negative effects on the Iranian national security.

Fig. 1. Location of Sistan region in Iran on the borders with Afghanistan.

However, due to various factors involved in the region, the investment on some projects which will eventually result in the socio-economic development ofthe region. It can prevent people from immigrating to other regions. A practical conceptual framework, derived from a number of existing frameworks, was used to study the valued features of the wetland in four separate categories: regulation functions, commodities, attribute, and direct and indirect uses of human resources.

The latter category (i.e. the human direct and indirect uses) is different from other categories, because it is considered to be a feature of the wetland to the limit of sustainable uses. Beyond that limit, it is known as a feature of the human community.

MATERIAL AND METHODS

In order to define the contribution of the Hamoon wetland, these main research questions were posed: a) How can one define the socio-economic criteria that facilitate the socio-economic development of Sistan? b) How can one define the socio-economic criteria with which the Hamoon wetland may contribute, in case that provided water is allocated to it? and c) How can oneassess the contribution of the Hamoon wetland to the socio-economic criteria? To answer the first research question, a participatory approach was chosen and an actor analysis was performed. Two classifications of actors were distinguished: the non-organized interests who benefit from the governmental institutions that are responsible for the socio-economic development. The Sistan and Baluchistan Regional Water Company (SBRW), the regional representative of the Iranian Ministry of Energy, is the official problem solver in the international water resource management (IWRM) project, and is considered as one of these governmental institutions. Considering the aim of the research, the non-organized interests were further divided into households involved in Hamoon- related activities and the ones involved in non-Hamoon related activities. Households engaged in Hamoon related activities are involved in a combination of fishing, animal husbandry on Hamoon pastures, field cultivation near the wetland, bird hunting, mat-making, and reed harvesting. Households involved in non-Hamoon related activities either live in villages or are involved in a combination of field cultivation, animal husbandry, horticulture, greenhouses and aquaculture or live in cities which are involved in commercial activities (mall), services, education, and industries. Among these actors, unemployment and severe sandstorms are the main socio-economic problems of the region.

Many other problems such as lack of access to sufficient food, insecurity, or adverse health situation are considered to be largely related to unemployment and sandstorms. Regarding the second and third questions, little data was readily available. Therefore, since it was necessary to gather empirical data, different data generating materials were designed throughout the research.

At first, data was generated from field observations, interviews with some authorities, and group- oriented discussions with the participants involved in Hamoon-related activities. Next, a questionnaire was designed in order to gather detailed information about valuable features of the wetland and different Hamoon- related activities and their subsistence uses. Local students were taught and supervised to conduct the interviews. The households, both those involved in Hamoon-related activities and the ones involved in non-Hamoon-related activities were interviewed.

Finally, the questionnaires were filled up. The respondents from both genders were defined in three age groups (25<, 25-45, 45>).The data were analyzed with SPSS and Excel spread sheet answer the empirical parts of the second and third questions.

RESULTS and DISCUSSION

A. Job provision (JB)

In its best situation, the Hamoon wetland may provide 18,524 households (40.8% of the Sistan households) in Sistan with their full income (Table 1). Out of these job opportunities, about 8.6 % is in form of fishing, 2.8% catching, and 4.4 % reed harvesting and mat weaving. More than 25% of these job opportunities are provided in animal pastures of the wetland and from field cultivation beside the Hamoon wetland. On the other hand, in its worst-case scenario, the number of households provided by the wetland may make 100% of their income (less than 1032), and in some cases, it is near zero (less than 2.3 % of the Sistan households). In an mild case scenario, the number of households that the Hamoon wetland may provide income is 9,430 households, i.e. , 20.8 % of Sistan total households out of which 4.6 %, 1%, 3%, and 12% are respectively involved in fishing activities, bird catching, reed harvesting, animal husbandry on wetland and field cultivation near the wetland.

Table 1: Various job opportunities in Hamoon wetland in different situation.

Job Opportunity	Good Situation	Average Situation	Bad Situation
Fishing	8.6	4.6	-
Husbandary	25	12.2	-
Reed harvesting	4.4	3	-
Bird catching	2.8	1	-
Total	40.8	20.8	0

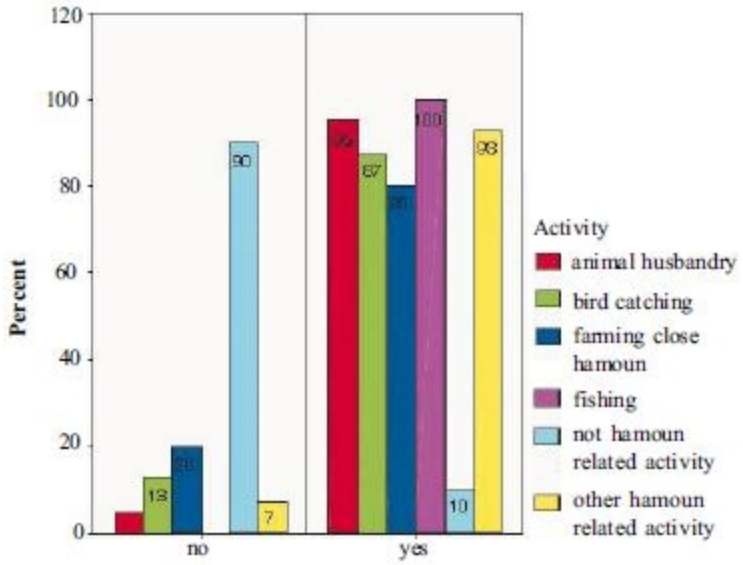

Fig. 2. Percentage of the households involved in different activities that assign or do not assign religious or cultural values to the Hamoon wetland.

The Fig. 2 shows that percentage of the households involved in different activities that are/ are not assigned to the religious or cultural values of the wetland. From these figures, it is apparent that most of the households who live close to the wetland and are involved in Hamoon- related activities assign cultural values to it, but less than half of the households active in non-Hamoon based activities assign such values just to the wetland itself.

B. Profitability of Hamoon wetland Fishing

In the best case scenario (considering an optimal case in which the maximum amount of catching fish is caught by the regional fishermen), 30,000 ton/ year fish is caught from the Hamoon implying an economic value of nearly 37,500 million Rials (Table 2). In contrast, in the worst case scenario (considering a worst case in which the least rate of fish is caught by the fishermen in the region), less than 900 ton/ year fish is caught which implies an economic value of less than 1125milion Rials. This situation happens during dry years. In a mold- case scenario, nearly 12500 tons/ year fish is caught from the Hamoon implying an economic value of 15,625 million Rials. This situation happens with the advent of wet years.

Table 2: Contribution of Hamoon Wetland in provision of income (million rials).

Source	Good situation	Average situation	Bad situation
Fishing	37500	15625	1125
Bird catching	4800	880	60
Reed harvesting	525	328.1	183.7

C. Bird Catching

In the study area, bird catching is an activity in which many people are involved. In the best circumstances, almost 2,400,000 birds/ year are caught from the Hamoon which implies an economic value of 4800 million Rials (Table 2). In the starting season of the year, fewer than 30,000 birds/ year are caught which implies an economic value of less than 60 million Rials and the values of the hunted birds are 440 and 880 million Rials, respectively. In an average- case scenario, nearly 440,000 tons/ year are caught from the Hamoon implying a value of nearly 880 million Rials. This situation happens under wet years.

D. Reed Harvesting

About 1200000m^2/ year reeds are harvested which implies an economic value of 525 million Rials when there is enough rainfall. In contrast, in the worsts cenario (considering the worst case in which the regional reed harvesters harvest the minimum amount), less than 420,000 m^2/ year reeds are harvested from the Hamoon implying an economic value of less than 183.7 million Rials (Table 2). In an average case scenario, 750000 m^2/ year reeds are harvested from the Hamoon that implies an economic value of 328.1 million Rials. This situation happens under wet cases.

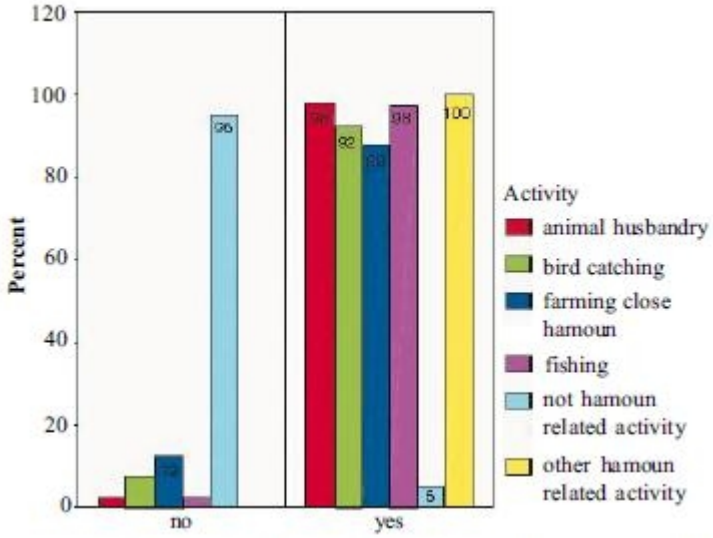

Fig. 3. Percentage of the households involved in different activities that use reeds from the Hamoon wetland.

Fig. 3 represents the percentages of the households involved in different activities such as harvesting reeds from the wetland, construction purposes, household utilities, handicrafts, and the like. As it seems, nearly all of the households involved in the Hamoon related activities use the reeds of the Hamoon wetland for one or more purposes, but only 5% of the households involved in non-Hamoon basedactivities have used the reeds of the wetland before the recent drought.

E. Contribution of the Hamoon wetland in providing food

During the seasons when the bird and fish population of the Hamoon wetland are in very good conditions, almost 100 % of the meat consumption of 12,676 households of the area population) is produced in the area. In this situation, 97.5% of the households in the region believed that the their capability rate of producing meat from different sources is sufficient for them. In an adverse situation, less than 20% of the meat demand can be met. In an average situation, when the bird and fish populations of the Hamoon wetland are in moderate conditions, they are able to provide 100% of the meat consumption for 5874 households in the region (12.9% of the Sistan population). In this situation, 40.6% of the residents in Sistan region believed that the amount of meat they are capable to get from different sources is sufficient for them.

F. Socio- economic Values of the Hamoon Wetland

The severity of sandstorms scores was low and very low in all types of wet years and high and very high in all types of dry years in the semi- wet year, yet it depends on the condition of vegetation coverage and the fishing rate of the Hamoon-e Saberi. The devastating effects of severe sandstorms are in their highest rate in the Miankangi division and the lowest rate belonged to Shahrakinarui and Markazi divisions. Posht-e-ab and Shib-e-ab divisions are between them. As a result of these severe sandstorms, nearly 37,048,000Rials damage is caused in the region. These severe sandstorms happened frequently during the year. Since people do not have enough money to excavate or repair their houses, they either leave them and immigrate to other regions or continue living under the worst living conditions. The people under consideration pointed out that the numbers of health problems, caused by malnutrition, which they have faced are more in situations where the wetland is not providing enough food to the region. They also believed that the numbers of sandstorm- related diseases such as respiratory, eye and skin problems are more in situations where the severity of the sandstorms is very high. This needs more professional research to understand whether the diseases with which people are faced are really related to the sandstorms or they are also influenced by other factors unknown to the non-medical people. In this research, the contribution of the Hamoon wetland to the socio-economic development of Sistan under different water availability situations in the wetland was studied. The results indicated that the wetland usually contributes to the socio-economic development of the region. It is made by providing, among many other things, job opportunities, and food. Therefore, it could reduce the need of households to get involved in illegal activities and to prevent them from leaving the region. Therefore, it would finally increase the safety of the region and the whole nation. The results showed the percentages of income that different households in Sistan obtain from the Hamoon wetland through different combinations of activities when the Hamoon wetland is full of water and when it is nearly or completely dry.

This Fig. 4 presents the percentages of households, involved in different activities, who used the Hamoon wetland as a means of transportation before the recent drought. As shown in this figure, most of the households living near the Hamoon wetland have used the wetland as a means of transportation. In contrast, only 10% of the households involved in non-Hamoon related activities used the Hamoon wetland as a source of transportation. The results reveal a horrifying truth about the security of the region during the seasons when the Hamoon wetland is dry. In this research, the households whose main income is gained by performing non-Hamoon related activities (e.g. field cultivation and stock farming far from the Hamoon wetland administrative and commercial jobs in the cities) did not harm that much from the Hamoon wetland. The main harm is experienced by the households that earn main part of their income from a Hamoon-related activity. When the wetland is dry, for example, the fishermen households earn an average 88.5% of their income from other sources, whereas it was previously earned from the Hamoon wetland. For bird catcher households, number is even higher. They obtain an average of 97.2% of their income, which they obtained previously from the wetland, through other resources. However, those who live in villages do not have any financial resources and social power and are mostly uneducated. This explains the rise in emigration, hostility, smuggling and other illegal activities taking place in the region. Moreover, this study concluded that besides creating job opportunities and food for the Sistan community, which would result in a safer Sistan, the Hamoon wetland has the potentials to contribute to the economic situation of the region by the annual fish catching, bird catching and reed harvesting which it provides to the region. Likewise, the wetland will stabilize the micro climate of the region and will reduces the severity of the sandstorms and consequently, it will reduce the social and economic damages of these sandstorms to the region.

According to the local people, it will at least support the health situation of the households and livestock in the region and finally it will create recreational opportunities. It is worth to mention that other demand sectors may also contribute to these socio-economic criteria, but there is something unique about the nature of the contribution provided by the Hamoon wetland. The job opportunities generated by the wetland are those which create income to the households who are experiencing the lowest socio-economic conditions. It provides jobs to the people who are unemployed. For example, it provides job to a bird catcher household that does not possess anything besides a gun and his expertise in hunting bird. Therefore, providing job opportunity n bird catching for someone who does not have many income alternatives for generation, is more valuable than a job opportunity created by fish ponds for a farmer who already, is cultivating land, even in a small scale.

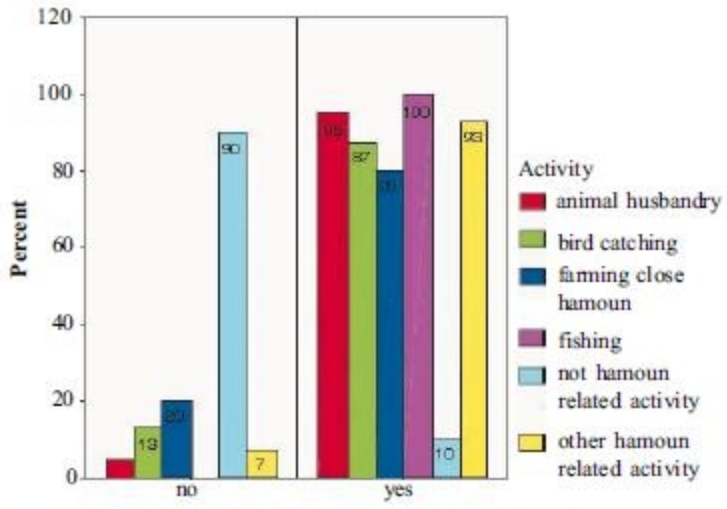

Fig. 4. Percentage of the households involved in different activities that used the Hamoon wetland as a means of transportation before the recent drought.

Therefore, the nature of the contribution to socio-economic development provided by the Hamoon wetland would reduce the difference between the socio-economic welfare of different categories because it increases the overall socio-economic situation of the region by helping the poorest to be self-sufficient. It will also allow a larger percentage of the population to experience the same better socio-economic condition, rather than just increasing the overall socio-economic condition. This goal is achieved by increasing the socio-economic conditions of the ones who are already experiencing higher socio- economic situations and in turn, increases the gap between the social and economic welfare of the population. To conclude, the Hamoon wetland contributes to the socio-economic development of the region; therefore, it is at least as important as the other demand sectors to be considered for water allocation. According to the findings of this study, it is recommended to collect more detail information from local people involved in Hamoon such as their traditional practices in managing the wetland resources as well as functioning its structure.

The households who are involved in Hamoon-related activities have very rich information about the Hamoon wetland and its values. This can help policy- makers to apply policies which can prevent immigration from Sistan. It is also recommended that government invest on educating people in Hamoon wetland area.

The education of these people will aim to inform them about the necessity of sustainable use of wetland's resources and the fact that this sustainable practices will eventually benefit them and their future generation. The authorities should note that when the people are hungry or poor, the education alone does not work. Therefore, at the same time, that they are told not to over-exploit the wetland's resources, it should provide them with additional food so as to support them use the wetland resources in a sustainable way.

G. Effects of Severe Sandstorms on the Region

Severe sandstorms have had devastating effects on the Sistan region. After these sandstorms, many houses in the villages are covered with sand.

Many agricultural lands and consequently, cultivation are destroyed resulting many health problems. The results of the survey about these devastating effects of the sandstorms on the habitats of local people and the agricultural lands of the farmers are presented in this part.

H. Effects of Sandstorm on Habitation of the Local People

The results of the survey showed that different divisions of Sistan region face different levels of sandstorm severity. Since the wind direction in Sistan is gradually changing from North to North-West and from the south to the West towards Kandahar, in Afghanistan, Miankangi is the division of the Sistan region which suffers most. According to the inhabitants of this region, on average of 80% of the houses in the villages are covered by sand after each sandstorm. The results also showed that after any severe sandstorm, the average cost of excavation and reparation per house is 11000000 Rials (2014). 38 out of 40 respondents living in Miankangi division stated that after each sandstorm, 80% of the houses of are covered by sand. These respondents live in different villages all over the Ghorghori rural district. Some of these villages are Gamshad, Kandukeh Molaali, and Golbache. Therefore, it is assumed that this situation is true for all villages located in Ghroghori rural district with 3152 households. In other words, after each sandstorm nearly 2396 houses are covered by sand. Due to the fact that 133 severe sandstorms generally happen in a year, especially when the Hamoon wetland is dry, so the average cost of excavation and reparation house will be about 11000000 Rials. Assuming that the people excavate and repair their houses only once a year in October, the cost of excavation and reparation exerted on the people and the government is estimated 26,356,000,000 Rials per year. Also, 110 respondents out of 117 living in the Poshtab division referred to this problem. These respondents live in villages in the North-West and West parts of Poshtab division, mostlyin Bozi and Adimi rural districts. Some of these villages are Gazanguri, Golzar, Halim khan, Mil nader and Mohammadabad-e lorghebagh. Therefore, it
is assumed that this situation is true for one third of the villages located in Bazi and Adimi rural districts. This means, after each sandstorm, nearly 972 houses are covered by sand after each severe sandstorm. Assuming that the people excavatere pair their houses only once a year in October, the cost of excavation and reparation on the people and the government in a year is estimated some 10,692,000, 000 Rials per year. The total cost will be 37,048,000,000 Rials/ year. This means that the quality of life will decrease more over the years and people will leave their villages and go to other parts of the region. Note that sandstorms with such devastating effects happen on average 133 times per year when the Hamoon wetland is dry; therefore, if the aim is to keep the quality of life of people in the villages constant, the excavation and reparation should take place more than once per year; therefore, the cost of it will be many times more than the estimated 37,048,000,000 Rials.

I. Effects of Sandstorms on Agricultural Land in the Region

The results of the survey show that when the wetland is dry, an average 18%of the cultivations/ year near the Hamoon wetland is destroyed because of the severe sandstorms. It implies a great deal of loss to the local farmers mainly due to loss of crops and additional production costs for upgrading thelands to acceptable levels for cultivation after the sandstorm.

J. Contribution of Hamoon Wetland to Health Condition of Households and Livestock in Sistan

The people in the survey believed that Hamoon wetland had a positive effect on the health condition of their household and their live stock. Therefore, health situation of these people and their livestock is another category of socio-economic criteria which needs to be scored under different water availability situations in the wetland. Health situation is influenced by many factors and requires professional expertise to define what factors will worsen or ameliorate it and to what extent. In this part, therefore, the effect of some factors, namely climate, food and sandstorms (that are themselves influenced to same extent by the wetland) on the health situation of households and livestock will be explained. However, more professional research is needed to prove the relationship between climate, food and sandstorm and their effects on the health situation in the region and to quantify health related criteria.

K. Effect of Climate on Health Condition

All the respondents, either near or far from the Hamoon wetland, believed that the increase in temperature and in the amount of dust and dirt in the air, which is partly because of the dried wetland, have negatively affected the health situation of their households as well as that of their livestock. Nearly all of them believed that the decrease in humidity has had the same effect.

L. Effect of Food on Health Condition

Many households obtain their meat and dairy products directly or indirectly from the wetland. If the wetland is dry, these households cannot obtain sufficient meat and dairy products, either because there is nothing to catch or because the market prices of meat and dairy products are rising beyond their purchasing power.

That malnutrition will result in diseases. Also, many animal husbandry whose livestock normally graze on the Hamoon pastures, believed that in situations when the Hamoon wetland is dry, they have to obtain fodder from the market. They believed in this situation their livestock are not as healthy as when they graze on the Hamoon pastures. They supported their statement with two reasons. First, they believed the fodder they could buy from the market was not of good quality and included sand in it and was not digestible for the livestock. Second, they believed that the fact that in this situation, their livestock had to be kept in small stables, in which they cannot move freely, so it would worsen the health situation of the livestock.

M. Effects of Sandstorms on Health Condition

The results of the survey showed that 13.7% of the members of a household were suffering from respiratory diseases, 11.4% from eye diseases and 3.4% from skin diseases. They believed that these diseases are due to sandstorms that have occurred during the recent droughts (1998-2005). They also mentioned that before the drought, they did not have such severe diseases. Whether that is true or not, it needs professional medical expertise which is beyond the limits of this paper. The results showed that the average percentage of members of a household suffering from respiratory, skin and eye diseases due to sandstorms are higher in parts of the region that are closer to the wetland, namely Miankangi, Poshtab and Shibab divisions. These percentages are lower in parts more far from the wetland, namely Shahraki-narui and Markazi.

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