Desertification assessment of the territory of Atyrau region

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Abstract. The article assesses the dynamics of desertification based on changes in the area of moving sands in the territories of the villages Issatay, Zineden, Maykomgen, Miyaly Zhaskairat over the past 17 years based on the processed data of remote sensing satellite images. It should be noted that the research area is located almost on the border of the semi-desert and desert zones, which within Kazakhstan occupy 57.7% of the territory. Ecosystems of these arid territories are very vulnerable to impacts, especially in modern conditions of climate change, reduction of water resources and active anthropogenic development. It should be noted that land degradation has a serious socio-economic impact on the standard of living and health of the population, especially on socially vulnerable sections of the rural population.

1. Introduction

Desertification of the territory is one of the most important environmental problems of the Atyrau region. The project assessed the environment and the socio-economic situation in the settlements - the villages of Issatay, Zineden, Maykomgen, Miyaly and Zhaskayrat, located in areas prone to desertification.

The studied area is located in Issatay, Zhylyo, Kyzylkoga and districts of Atyrau region in settlements Issatay, Zineden, Maykomgen, Miyaly and Zhaskayrat. The area of each of the sections is 225 km², except for the Isatay 400 km² section.

2. Research methods

The main process contributing to the degradation of the natural systems of the study area is deflation (wind erosion), the natural causes of its manifestation and development are the wide distribution of sand, arid climate, especially the wind regime and immoderate anthropogenic load. The study and assessment of the dynamics of aeolian processes of sand massifs, whose ecosystems are extremely unstable to changes in natural and increasing anthropogenic factors, is relevant for this region. Due to the fact that reserves of fresh underground waters, deposits of building materials are often confined to sand massifs, they are a good year-round forage base for cattle grazing, a territory of distribution of rare species of flora and fauna, the sustainable development and environmental status of sand desert territories is very relevant [1].

The main methodological approach was the use of statistical spatial analysis of the results of processing satellite images of Landsat TM / ETM + and OLI for the period from 2000 to 2016. When assessing the degree of desertification of the studied territories of settlements, the percentage of the territory affected by the deflation process and the intensity of the manifestation of the process on the
basis of a comparative analysis of deviations from the average values for the study period (2000-2016) were taken into account [2].

3. Results and discussion
The study area is located in the Caspian lowland, in the desert zone on brown soils, most of which are occupied by saline and saline soils. The terrain is flat. The climate is sharply continental: short, not very snowy, but rather cold winters and hot long summers. Summer temperatures can exceed 32.9 °C, while winter temperatures can drop to 10 °C. Daily temperature fluctuations are significant. The average annual maximum and minimum temperatures are 14.5 °C and 3.9 °C, respectively. The annual precipitation is 176 mm (the lowest in winter), of which approximately 17% is snow. Monthly average number of days with a dust storm are presented in Table 1 [3].

Table 1. Average number of days with a dust storm.

| Station       | I  | II | III | IV | V  | VI | VII | VIII | IX  | X  | XI | XII |
|---------------|----|----|-----|----|----|----|-----|------|-----|----|----|-----|
| Makhambet     | 0.1| 0.3| 0.8 | 1.8| 0.7| 1.6| 1.2 | 1.0  | 1.1 | 0.2| -  | 9.9 |
| Atyrau        | 0.4| 0.7| 1.6 | 3.9| 2.4| 3.3| 3.0 | 3.3  | 3.3 | 1.8| 0.3| 0.1 | 24.1|
| Peshnoy       | -  | -  | 0.4 | 0.3| 0.2| 0.1| 0.2 | 0.1  | 0.03| -  | -  | 1.6 |
| Ganushi no    | 0.1| 0.3| 1.2 | 4.2| 3.0| 4.3| 3.0 | 2.1  | 2.9 | 1.1| 0.3| 0.5 | 23.1|

The distinguished dominant classes, in accordance with their ecological state, the presence or absence of vegetation cover, and the degree of moisture, reflect the degree of their degradation and susceptibility to desertification processes. The “bare areas” class, which includes loose sand and areas without vegetation (vegetation is absent in 80-100% of the territory), are defined as territories with manifestations of a strong degree of desertification. This class mainly occupies sandy areas with a predominance of areas of transplantable sand.

The “rare vegetation” class, which includes areas with grass and shrub vegetation coverage of less than 15% and areas of mixed grass, shrub and wood vegetation of less than 25%, are defined as territories with an average degree of desertification. This class mainly occupies the territory of semi-fixed and weakly fixed sand. The “pasture / meadow” class includes areas with a permanent grass cover of more than 25% of the territory, as well as areas with mixed grass-shrub-woody vegetation. They are defined as territories with manifestations of a weak degree of desertification or the absence of desertification. This class includes the territory of low terraces and floodplains of rivers, moist areas [4].

Thus, when assessing the degree of desertification of the studied territories of settlements, the percentage of the territory affected by the deflation process and the intensity of the manifestation of the process based on a comparative analysis of deviations from average values for the studied period (2000 - 2016) were taken into account [5].

The analysis of the area dynamics by the degree of desertification for each of the sites, a comparative analysis of all sites, as well as the average values for the studied period, are carried out. The analysis of average values of the degree of desertification showed that the largest area of a strong degree of desertification is characteristic of the territory near the village of Maykomgen and Issatay, they are 7.6 times larger than in the Miyaly section and 22 times higher than in the Zhaskayrat section (table 2).

This analysis is also confirmed by the dynamics of changes in areas with a strong degree of desertification in all areas of the study (figure 1). It should be noted that for all areas there remains a certain synchronization of changes in area, which indicates the influence of factors with regional impact.
Table 2. Average values of areas according to the degree of desertification, %.

| Name of territory | The average value of the areas by the degree of desertification 2000-2016, % | Strong grade | Medium grade | Weak or absent |
|-------------------|-----------------------------------------------------------------------------|--------------|--------------|---------------|
| Issatay           | 20.5                                                                        | 33.4         | 46.1         |                |
| Miyaly            | 3.6                                                                         | 21.8         | 74.6         |                |
| Zhaskayrat        | 1.23                                                                        | 11.24        | 87.53        |                |
| Maykomgen         | 27.68                                                                       | 46.22        | 26.1         |                |

Figure 1. Dynamics of areas of severe desertification in all areas.

Analysis of changes in areas by the degree of desertification near the village of Issatay revealed an inverse relationship between areas with medium and weak (or absent) desertification (figure 2). Moreover, from 2011 to 2015 there was a noticeable transition of lands from medium desert to slightly desert or desert. The process of deterioration began earlier in 2007 and peaked in 2014-2015. Since 2007, the growth of areas with a strong degree of desertification began, which reached a maximum in 2015. At the same time, since 2016, there has been a trend towards improving conditions and restoring vegetation to the level of 2014 [6]. Thus, the trend of changes in areas indicates the impact on them of short-term changes in exposure. The reason can be both a change in the water content of ecosystems and anthropogenic impact in the form of a change in pasture load (figure 1).

The analysis of the area dynamics by the degree of desertification in the villages of Miyaly, Zhaskayrat and Maykomgen as a whole also reflects the features indicated for the Issatay. First of all, this is the strengthening of degradation processes from 2007-2015. The difference is the large areas of territories with a low degree of desertification, which occupy from 74 to 87% of the territory near the villages of Miyaly and Zhaskayrat.

Thus, the assessment of the degree of desertification, based on the processed remote sensing data on changes in the areas of moving sands and the degradation of vegetation in areas near the villages of Issatay, Zineden, Maykomgen, Miyaly and Zhaskairat over the past 19 years, indicate the impact on desertification processes of both natural and and man-made factors [7].

A strong degree of desertification, characteristic of a third of the plot near the village. Issatay and Maykomgen. Synchronization of changes in areas of strong, medium and weak degrees of
desertification - for all four territories located in the Caspian lowland, indicates the influence of regional factors.

Determination of the desertification target based on changes in the area of moving sands according to remote sensing data over the past 19 years in the territories of the villages Issatay, Zineden, Maykomgen, Miyaly and Zhaskairat.

The determination of the desertification target is based on a study of the trends in the changes in the area of moving sands over the past 19 in the territories near the villages of Isatai, Zineden, Maykomgen, Miyaly and Zhaskairat.

To assess the impact of anthropogenic factors on the dynamics of desertification, an analysis of the population. A study of the dynamics of the population of villages over the past 19 years according to the Rural Territory Monitoring Program of the Ministry of Agriculture of the Republic of Kazakhstan showed an increase of 13.9% in the village of Issatay, by 42% in the village of Zenidin, by 21.2 in the village of Miyaly, by 10.7 in the village of Zhaskayrat, by 43.1% in the village of Maykomgen (figure 2).

Also, an analysis of the dynamics of the livestock stock located in the private farm within the studied settlements according to the Rural Monitoring Program of the Ministry of Agriculture of the Republic of Kazakhstan was carried out. Over the past 9 years, there have been slight changes in the numbers of cattle, camels and horses. At the same time, the number of small cattle, which has the greatest impact on pasture degradation, is generally decreasing, in particular in the villages of Maykomgen (a decrease of 13,185 animals) and Zhaskayrat (a decrease of 7277), a sharp decrease in the number of cattle is observed. In addition, its number in the village Issatay has grown over the past 9 years by 1300 goals. These two factors possibly determine the growth of desertification areas in this locality.

![Figure 2](image_url)  
**Figure 2.** Population dynamics of Issatay, Zineden, Maykomgen, Miyaly and Zhaskayrat villages.

Thus, the natural factors that determine the regional parameters of the desertification process as a whole have a greater effect on the degradation of the natural complexes of the studied areas. Anthropogenic factors related to the strong overload of sand pastures, as well as the degradation of
woody vegetation due to deforestation, had a smaller effect on the increase in areas with moderate and severe desertification.

![Graphs showing livestock by species in the context of settlements](image)

*Figure 3. Dynamics of livestock by species in the context of settlements.*

In accordance with the above, an increase in the rate of desertification directly on a direct basis does not depend on a decrease in the load on sand pastures, the introduction of methods of pasture rotation and transhumance livestock breeding. To restore territories with a high degree of desertification within the boundaries of moving sands, it will also be necessary to use methods of mechanical protection and phytomelioration [8].

4. Conclusion

Studies have shown that the degree of desertification of territories depends on many factors, ranging from climate change problems, soil lithology, the quality and stability of the soil and vegetation cover to a number of anthropogenic causes. The multifactorial nature of the process assessment requires detailed studies with many indicators. In addition, Kazakhstan has not yet adopted a single methodology for assessing desertification, a methodology for monitoring desertification. At the present stage of the state of the problem, only at the stage of development and possible further adoption is the methodology for monitoring desertification based on remote sensing data.

However, taking into account the importance of carrying out sand containment works to create a favorable environmental situation in the region, it is recommended to use the indicator of the area of special forest plantations in the following areas as Issatay village, Maykomgen village, Taysoigan village, Kobyakovo-Zaburny canal, Kulsary city as a target indicator.

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