On the question of salt management of the Amudariya river delta (Aral Sea basin, Karakalpakstan)

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Abstract
This report deals with the investigations of salinization of the South Aral region soil till 10 meters underground in 15.000 sq. Km. On the basis of analysis three causes of salinization were determined: dust-salt migration; salt migration of underground salts, owing to irrigation; and salinization of agricultural plants by salt water from the Amudaria river. This report investigates the influences of each of these factors on soil salinization; maps the salinization of the soil in this region till 10 meters underground; provides a mathematical model of salinization of this region's soil; and provides a recommendation for preservation of the soil from salinization is given.

Keywords
Karakalpakstan, salinity, soils, salinization, Aral Sea

Introduction

One of the ecological pecularities of Karakalpakstan is the salinity of the soil. Over the last several years, the salinity of the soil has increased and it has had a very negative impact on the environment. The salinity of the soil affects the aggression of ground water and as a result the ground water destroys the foundations of buildings, construction work and underground communications. The soil cover dies and crop capacity is reduced because of the salinity of the soil.

Currently in Karakalpakstan the main question is the desalinization of the soil and the softening of the negative influences that the salinity of the soil has had on the environment of the region.

To solve the problem of salinity and to soften the negative impact on the economy of Republic it is necessary first of all to determine the main factors causing the salinity and to devise methods for diagnosing the changes in the soil's salinity in the region.

One of the known reasons for the salinity of the soil of the Karakalpakstan area is dust storms, which blow salt from the bottom of the Aral Sea to the surrounding area and beyond.. The second reason for salinity is the mineral content of the water that comes from the Amu-Darya River and is used for irrigation purposes. A study showed that a third factor is the migration of salt from the deeper soil layers to the surface through irrigation.

Methods

To estimate the impact of the above mentioned factors on the soil's salinization, a special geological investigation was carried out in agricultural fields in the northern part of Karakalpakstan. During that investigation, a special boring machine was used. Holes were bored into the soil 11.7 metres deep. Soil samples were taken from each borehole and the water table was measured. Holes were bored on 15,000 sq. km of agricultural fields.

The lab tests of the soil samples showed that the soil composition was mainly clay, loamy soil, sandy loam, fine-grained clay and dusty sand of alluvial form.

The lab tests for the salinity of the soil samples showed that the salt can be classified as the sulphate type and the chlorine type. Based on these analyses a map was made of the soils' salinization at the depth of 11.7 m.

To estimate the salt concentration in the soil based on the above mentioned three factors it was necessary to calculate the salt content on the territory of the 15,000 sq/ km. The calculations were done on the samples from each borehole and the deepest soil layer was 10 metres.

Results and Discussion

The analysis showed that the concentration of salt in the soil depends on the depth of the soil layer. For example, for the soil of 0-0.3 m depth the salt concentration is 5.66 ton/hectar to 777.2 ton/hectar. The average figure for the 44 boreholes was 747 ton/hectar. Based on the data of the salinity of different soil layers, 2 maps were made of the northern part of Karakalpakstan for soil at the 0-0.3 m to 0-10 m depth.

Note: Fugeres1 and 2 should be placed there

On map #1 you can see that the maximum salinity is in the areas with active irrigation. The results of the investigation showed that the Chimbay Region and Kegeily Region have the highest concentration of salt. The region with the least concentration of salt is Muynak. The given information is taken from the map of salt concentration for 0-0.3 m depth. On the map for 0-10 m depth the salt concentration has the characteristic of equal distribution. At the same time the least salt concentration is marked around the hill called Kushanatau.

The results of the comparative tests show that one of the factors of soil salinization is the migration of salt from the deeper soil layers to the surface through irrigation. The amount of salt blown by the wind and water was also estimated.

Table 1

	Salinity components	Amount of salt per million tons for 15,000 sq. km	Amount of salt per thousand tons per hectar
1	Natural salt sources (data for 1994)		
	for 0-0.3 m depth	160	0.107
	for 0-10 m depth	1120	0.747
2	Salt which comes through irrigation (depending on the water volume – about 4-8 cu. km per year)		
	mineralization of water is about 1.5 gram/litre	6-12	0.004-0.008
	mineralization of water is about 3 gram/litre	12-24	0.008-0.016
3	Dust and salt migration from the bottom of the Aral Sea. Kosnazarov and Razakov (1991)	0.225-0.450	0.00015-0.0003

The results of the analysis given in Table 1 show that the Natural Salt sources are the main sources of salt. At the same time the soil salinization may increase through irrigation and as a result, migration of salt from the deeper soil layers to the surface may occur. The figures of salt amounts which come from mineralized water from the river are quite impressive; 6 to 24 million tons a year.

The smallest contributor to total salinization is the migration of salt from the bottom of the Aral Sea through wind, but this factor will become dominant over the next few years.

The following mathematical formula is given to predict soil salinization:

$$S = \int_v \int_t [W(v, t) + U(v, t) + D(v, t) - Y(v, t)]\, dtdv \quad (1)$$

Where W(v, t) is a function showing the salinization of the soil through the use of mineralized water
U(v, t) is a function of salt migration from the deeper soil layers to the surface
D(v, t) is a function of salt migration from the bottom of the Aral Sea
Y(v, t) is a function of the desalinization of the soil
v - is space, and t - is time
The type of W(v, t), U(v, t), D(v, t) and Y(v, t) may be determined by tests.

Calculating the salt concentration by using a given formula may give us an opportunity to determine the salinization of the soil. To estimate the salinity of soil it is advisable to introduce the concept of Ecological Reserve. Ecological Reserve can be calculated by using the following formula:

$$R = S(\lim) - S \quad (2)$$

Where S is the amount of salt calculated using formula #1
and S(lim) is a limit in the amount of salt in the soil

Conclusions

- The results of the comparative tests show that one of the factors of soil salinization is the migration of salt from the deeper soil layers to the surface through irrigation.
- The results of the investigation show that the salinization of the Amudariya river delta is a result of inefficient water usage.
- The results of the investigation show that the salinization of the Amudariya delta occurs due to the irrigation of the Amudariya delta using saline water from the Amudariya river.

- **References**

(ii) Aimbetov I..K., Seitniyazov Sh. (1994). Engineering and geological estimation of salting of the North part of Karakalpakstan. Magazine *"Vestnik", #2, Karakalpak branch. Academy of Science of Uzbekistan*, Nukus pp 16-20.
[i] Kosnazarov K. and Razakov R. (1991). Process of salinization and dust migration in the Aral Region. Karakalpakstan, Nukus, pp. 38-42.