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A BRIEF HISTORY OF THE STUDY OF SALT SOILS IN CENTRAL ASIA

Chembarisov Elmir Ismailovich[1], Khozhamuratova Roza Tazhimuratovna[2], Balliev Ajiniyaz Ibragimovich[3], Reimova Gulzhamal Batyrbaevna[4]

[1]Doctor of Geographical Sciences, Professor, Research Institute of Irrigation and Water Problems
[2]Doctor of Geography (DSc), Associate Professor, Karakalpak State University named after Berdakh
[3]Doctoral Candidate (PhD), Research Institute of Irrigation and Water Problems
[4]Doctoral Candidate (PhD), Research Institute of Irrigation and Water Problems

ABSTRACT

The article considers the results of some authors who studied various characteristics of saline soils in Central Asia, as well as their methodological approaches used in assessing these characteristics.

KEY WORDS: ***Central Asia, saline soils, toxic and non-toxic salts.***

INTRODUCTION

Saline soils are an essential component of natural and anthropogenic landscapes in arid areas. Salinity is one of the main genetic features of arid soils, as well as a property that limits their fertility.

Numerous studies have established that salinity and salt regime of soils in the Aral Sea basin is a very dynamic process in time and space and depends on climatic, hydrological, geomorphological, hydrogeological and irrigation and economic conditions. The study of the whole set of factors that determine the migration of salts and soil salinization, the centuries-old practical experience in combating salinization and the achievement of reclamation science makes it possible to develop scientifically based systems of hydrotechnical and agrotechnical measures to combat salinization on developed lands and to predict changes in the water-salt regime and balance, that may occur when new lands are irrigated to prevent their salinization [1-13].

Therefore, it is important not only to analyze the existing studies on saline soils, but also to study the methodological approaches used by the authors in conducting these studies [12-14].

GENERAL CONTENT OF THE ANALYTICAL REVIEW

A significant contribution to the study of various aspects of saline soils, apparently, belongs to V.A. Kovda, who is the author of the two-volume book “Origin and regime of saline soils”, known among specialists, published by the publishing house of the Academy of Sciences of Russia in Moscow-Leningrad in 1946-1947. [1].

Volume I discusses very useful and necessary aspects of saline soils by chapters: 1) origin, movement and accumulation of salts, 2) salt balance of soils and territories, 3) modern centers of salt accumulation in the soils of the USSR and neighboring countries, 4) factors of soil mineralization waters, 5) the main patterns of salt accumulation in groundwater, 6) salt accumulation in soil solutions and their salt regime, 7) salt accumulation in soils and soils, 8) secondary salinization of soils during irrigation, 9) water regime of saline soils, 10) salt regime of soils irrigated areas.

In his 1st volume, V.A. Kovda writes that most scientists (V.M. Goldshmit) believe that CL (chlorine) and S (sulfur) were part of the primary solution of salts in ocean waters, even at the time of its formation. The possibility of bringing in a large amount of CL, S and B (boron) from volcanic gases and volcanic sources is not excluded, but even after the magma cools and turns into a massive crystalline rock, it continues to be a source of CL, S and B Na (sodium) for a long time, Mg (magnesium) and K (potassium) were already mainly products of weathering and chemical denudation of massive crystalline rocks that make up the continents.

Throughout the geological history of the earth's crust, a cycle of easily soluble salts has flowed between the earth and the ocean, and the balance of this process has generally been in favor of the ocean. However, along with this circulation of salts between the ocean and the continents, salt differentials took place in accordance with their solubility, which led to the predominant accumulation of sulfates and carbonates on land and chlorides in the ocean.

For the territory of the USSR and neighboring countries, V.A. Kovda identified the following provinces of salt accumulation: a) the province of chloride salt accumulation, b) the province of sulfate-chloride accumulation, c) the province of chloride-sulphate accumulation, d) the province of sulfate-soda accumulation.

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B.V. Fedorov in 1950 wrote the book "How to deal with soil salinization in irrigated areas", Ed. Academy of Sciences of the Uzbek SSR, 66 p. [2]. He wrote that one of the most harmful salts is table salt (Na CL), Glauber's salt is less harmful than table salt, gypsum and lime are themselves harmless to plants. Huge reserves of salts are contained in ancient rocks that lie at one or another depth from the surface of the earth. He also noted that special soils that have undergone profound changes are called solonetsous: they pass water very poorly, and when dried, they become excessively compacted; these soils are difficult to cultivate, and when they are plowed, very strong lumps are formed.

L.P. Rozov (1956) in his textbook "Reclamation Soil Science" (M.: Selkhozgiz, 1956) refers NaCL, MgCL2 to harmful salts; CaCL2; Na2SO4; MgSO4; Na2CO, and NaHCO; to harmless -Ca SO4; MgCO3; CaCO3; Mg (HCO3)2 and Ca (HCO3)2[3].

S.A. Vladychensky (1964) in the textbook "Agricultural soil reclamation" (Moscow: Moscow State University, 1964) gives the following example of the ratio of the toxicity of various sodium salts, if we take the toxicity of sodium sulfate (Na2SO4) as a unit (1) [4] :

Salts:	**$Na_2 CO_3$**	**NaCL**	**Na HCO_3,**	**Na_2SO_4**
Degree of toxicity:	10	3	3	1

P.A. Pankov in his textbook “Reclamation Soil Science” (Tashkent: Ukituvchi, 1974, 415s.) notes that the main chemical elements involved in the salinization of soils, surface, ground and soil waters of land include Ca; Mg; Na; TO; ABOUT; CL Sulfur(S), carbon(C), nitrogen(N), boron(B), etc. [5].

M.A. Pankov notes that groundwater plays a significant role in the accumulation of salts in soils. He gives the following soil salinity gradation (Table 1).

таблица 1

	Density, rest %	**Chlorine (CL),%**
Non-salted	<0,3	<0,01
Slightly salted	0,3-1	<0,04
Medium saline	0,3-1	0,04-0,1
Heavily saline	1-2	0,1-0,3
Salt marshes	3	>0,3

In the 2nd part of the textbook, he describes the soil-reclamation characteristics of saline soils of various geographical regions of Central Asia, including the Amudarya delta, highlighting the soils of the modern (Aral) delta, the soils of the Khorezm and Tashauz oases, the soils of the Kunyadarya plain, the soils of the Akchadarya delta.

This textbook provides interesting data on the entry of salts into the Amudarya delta along the Amudarya River in the 1950s: with an average annual river runoff of 48 million m3 and an average mineralization of 0.47 g/l, it was 18.9 million tons of salts, of which harmful salts 7.48 million ton

He also gives an example of the calculation of salts, in deposits of young alluvium saturated with water with a content of 0.017% salts. At the same time, 1 liter of fresh manure (porosity 50%, bulk density 1.4) will contain 1400 g of solids and 500 g of water. If there are 0.47 g / l of salts in the water, their total content will be 0.2335 g, or 0.017% of the dry matter weight.

M.A. Pankov writes that near the canals, groundwater is desalinated and belongs to the chloride-sulfate type, and in the depressions between the canals, where the outflow of saline solution occurs, highly mineralized groundwater of the sulfate-chloride and chloride types is formed.

T.P. Glukhova studied soil processes during irrigation with mineralized waters (Tashkent: FAN, 1977, 127c), while noting that the chemical composition of mineralized waters determines the nature of the course of soil processes and the leaching of certain salts. In her opinion, according to the degree of toxicity for cotton, irrigation waters of different chemistry are arranged in this order: a) soda; b) soda-sulfate; c) sodium chloride d) sodium chloride sulfate; e) sulfate magnesium-sodium; f) sulfate-sodium, g) sulfate-magnesium [6].

A.R. Rasulov in 1969 studied in detail the saline soils of the Karshi steppe, the ways of their development and increase of fertility (author's abstract of the thesis for the degree of doctor of agricultural sciences, Tashkent: TSI, 1969, 51 p.). He writes that the main The source of water-soluble salts in the soils of the Karshi steppe is the weathering products of marine and continental sediments. The salinity of the rocks determines the increased mineralization of the waters of the Guzardarya River [7].

He notes that the salinization of soils and waters depends on the geological structure and composition of rocks in the feeding area, the general course of the formation of geomorphological elements, the conditions for the formation and regime of the runoff of surface and groundwater, and other factors. The following figures given by A.M. Rasulov in 1974 are of interest. Of the total area of dry lands of the Kashkadarya region (430,100 ha, including fallows and planted), saline lands accounted for 238,000 ha or 55.4%. Of these, 55.0% were weakly and moderately saline lands, 0.4% were highly saline and saline lands. In 1967, 321,709 hectares, or 74.8%, were saline lands. 70.9% turned out to be weakly and moderately saline, 3.9% - strongly saline and salonchaks. Thus, as a result of the development of unprepared lands for reclamation and an increase in the irrigated area from 47,000 to 164,000 hectares over a 20-year period, the area of saline

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lands in these massifs will require planning, flushing, construction of a collector-drainage network and the correct irrigation regime.

M.M. Krylov in 1977 was able to re-publish his monograph "Fundamentals of reclamation hydrogeology of Uzbekistan" (Tashkent: Publishing House "Fan" of the Uz SSR, 1977, 247 pp.), which outlines the main provisions of reclamation hydrogeology, a branch of hydrogeology that originated and took shape in Uzbekistan in connection with the development of irrigated agriculture. Along with various regions of Uzbekistan, he cites the main features of the hydrogeological and reclamation zoning of the lower reaches of the Amu Darya [7]:

1) the extreme difficulty of the general underground flow due to the weak slopes of the surface of the deltas, in connection with this, GW are consumed practically by evaporation, 2) a positive salt balance characterizing the delta as a whole as a region of constant salt accumulation, 3) relatively well expressed localization of underground flow in thick sandy deposits ancient channels of the Amudarya 4) the subordination of the groundwater regime, and, consequently, the dynamics of their balance to the regime of surface runoff and irrigation.

O.K. Kamilov studied in detail various aspects of the amelioration of saline soils in Uzbekistan using the example of irrigated areas of the Hungry Steppe ("Melioration of saline soils of Uzbekistan" Tashkent: FAN, 1985, 230 p.) [8]. In one of the sections of the monograph, considering the dynamics of salts in the aeration zone and groundwater, using the example of an experimental site, he cites the following data: in 1966, the salt reserve in t/ha in the 0-1 q layer was equal to 80.9 in terms of dry residue; chlorine - 6.5, sulfates (SO4) - 40.11 t / ha, and in 1975. The stock of salts also in the layer 0-1 m in terms of dry residue was 45.4 t / ha, chlorine (CL) - 3, 5; and sulfates (SO4) -23.1 t/ha.

V.M. Borovsky considered in great detail the formation of saline soils and halogeochemical provinces of Kazakhstan ("Formation of saline soils halogeochemical provinces of Kazakhstan", Alma-Ata: "Nauka", 1982, 254 p.) [9]. Summarizing various classifications of saline soils, he writes that N.I. Bazilevich and E.I. Pankova (1968) developed a classification of soils according to the degree of salinity, based on accounting for toxic ions, this construction is based on the idea of separating ions into toxic (all salts Na and Mg) and non-toxic (Ca salts). For an approximate determination of the amount of toxic salts (S), N.I. Bazilevich and E.I. Pankov proposed the following empirical formula: S% \u003d 0.066 (mg-eq Na + mg-eq Mg). They proposed the following classification according to the degree of salinity, taking into account the "total effect" of toxic ions (Table 2).

Table 2

Degree of salinity	"Total effect" of toxic ions (CO3; HCO3; CL; SO4) expressed in mEq CL
Non-salted	<0,3
Slightly salted	0,3-1,0(1,5)
Medium saline	1,0(1,5)-3,0(3,5)
Heavily saline	3,0(3,5)-7,0(7,5)
Very salty	>7,0(7,5)

M.A. Yakubov and co-authors in 1989 developed recommendations on the assessment and the possibility of using mineralized collector-drainage water for irrigation in the Jizzakh region (Tashkent: Uzgiprovodkhoz, 1989, 53p.) [10].

He writes: on lands where drainage water is used for irrigation of agricultural crops, sampling must be carried out annually, in the summer-autumn period. It is imperative to carry out control by taking water samples for chemical analysis from collectors and water pumped out from vertical drainage wells.

Salt sampling scale is 1:25000 (2....3 points per 100 ha). According to the scale, the area of elementary plots when compiling cartograms for salinity should be 30 .... 50 ha.

Yu.I. Shirokova in the early 2000s published an article "The problem of salinization and ways to improve the control of salinity in irrigated lands" [11]. She writes that in international practice, to assess the salinity of soils and water, the method of determining the electrical conductivity of saturated extracts is successfully used, which primarily lies in the fact that, in comparison with a water extract, it reflects the effect on the plant of all soluble salts present in the liquid phase (Table 3). This method was previously known in the CIS, but was not used, due to the preference for direct methods of chemical analysis of water extracts at a soil:water ratio of -1:5.

Таблица 3
Классификация принятая ФАО(USDA) для оценки степени засоленности почв

Degree of salinity	Electrical conductivity values of Ece soil extracts in ds/m and ms/cm at t=25^0C	
Non-salted	0-2	very sensitive crops
sparsely populated	2-4	sensitive crops
Medium saline	4-8	slightly sensitive crops
Heavily Salted	8-16	slightly salt tolerant
Very salty	>16	salt tolerant

E.I. Chembarisov and B.A. Bakhritdinov in 1981 wrote a brochure "Salts in soils and waters" published in the Uzbek language by the publishing house "FAN", Tashkent: 1981, 38 s [12].

Referring to L.P. Rozov (1936), they provide information about most of the salts found in soils and waters:

1) NaCL-table salt,

2) Na2SO4 - Glauber's salt (Glauber's salt and gypsum actually contain water molecules (Na2SO41OH2O; CSO42H2O);

3) Na2CO3-soda is normal, linen;

4) NaHCO3-bicarbonate soda, drinking;

5) MgCL2 - magnesium chloride;

6) Mg SO4 - bitter salt;

7) MgCO3-magnesium carbonate or magnesite;

8) Mg (HCO3) 2-magnesium bicarbonate;

9) Ca CL2-calcium chloride;

10) Ca CO3-carbonate or limestone, chalk;

11) Ca SO4 - gypsum;

12) Ca (HCO) 2 - calcium bicarbonate.

They also write that as a result of experimental studies, it was found that a more complete amount of soluble salts passes into water when preparing water extracts with a weight ratio between soil and water of 1: 5, three-minute shaking and filtering immediately after shaking (Arinushkina, 1970. - 487 s [14]).

According to the number of components to be determined, a full extract and a reduced one are distinguished. When conducting a complete analysis of the bytes, the dry residue and the content of all the main ions (Ca3-2; HCO3-; CL-; SO4-2; Ca + 2; Mg + 2; Na +; K +) are determined. In this case, the dry residue and the content of ions are usually expressed as % per 100 g of air-dry soil. In the reduced extract analysis, only Ca3-2 is determined; HCO3-; CL-; SO4-2 and dry residue. In areas with garden or sulfate salinity, the content of Na + is also determined. The ions in the solution are bound in salt according to the method proposed by Kurnakov. This operation is carried out in mg-equivalent form. The order of combination of ions in salt is as follows:

1) first, the hydrocarbonate ion (HCO3-) is associated with the content of calcium (Ca), then magnesium (Mg) and finally with sodium (Na). In ionic form, this can be expressed as: HCO3-→Ca; Mg; Na;

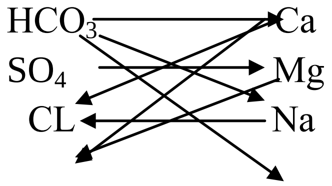
2) further, the calcium residue is associated with the sulfate ion (SO4)4 chlorine (CL): Ca → SO4; CL;

3) similarly, the residue SO4 → Mg; Na;

4) residue Mg → CL;

5) Na → CL residue.

The described order of connection of ions can be expressed in the form of the following scheme:



The above information will help specialists to more correctly assess the salinity of their land fund, as well as develop measures to reduce the salt content in the soils and waters of the fields used.

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