Main regularities in changing the saline composition of the subsoil water in connection with degradation of the irrigated lands

Shukhrat Odilovich Muradov

Karshi Economic Engineering Institute, Uzbekistan
m.oikos@rambler.ru

Abstract: On base of the statistical analysis of perennial hydro chemical data and analysis metamorphization of chemical composition of subsoil water (SW) in the south of Uzbekistan (1960 - 2009 years) are revealed main regularities. It is given forecast of the changes of the chemical composition of subsoil waters in connection with degradation of the soil. For the first time, there was a motivated possibility of the appearance of sodium salination in the south Uzbekistan.

[Shukhrat Odilovich Muradov. **Main regularities in changing the saline composition of the subsoil water in connection with degradation of the irrigated lands.** *Researcher* 2012;4(10):47-52]. (ISSN: 1553-9865). http://www.sciencepub.net/researcher. 8

Keywords: arid; subsoil waters; irrigation; salination and desalination of the soil; metamorphization; hydro chemistry; hypothetical; the regression; the approximation.

1. Introduction: In spite of the general enough studied the problems salination and desalination of the soil in conditions of the irrigation [26], [14], [1], [18], [8], [16], particularities and mechanisms of salts from subsoil waters it is not studied far enough because of labour contents and imperfection of the methods of the study of these processes [18]. The irrigated husbandry and water farming construction - powerful anthropogenic factor, powerfully changing dynamic balance of the condition hydro geochemical ambiences [21].

Studying some problems of the changes of the saline composition of subsoil waters has been denoted by some scientists with their own works D.M.Kath (1982), K.E. Pitiyeva (1978), N.N.Verigin, S.V.Vasiliev, N.P. Kuranov, V.S.Sarkisyan, D.F.Shuligin (1979), S.A. Nerozin, R.T. Rahmatov (1980), I.P.Aydarov (1985), R.K.Ikramov (2000), G.A.Panov (2004), N.N.Parfenova (2007), V.A.Kovda (2008) and others.

It is necessary to know the chemical composition of subsoil and surface water and its changes in the existing and design conditions of the irrigated regions for estimation the type salination at present, as well as for scheduling the forecast of the changes in salination as a result of intensive development of the irrigated lands. In the work by J.Tikseront (1958) was noted that in arid areas rotation of salts it is necessary to study in the same way, either as rotation of water. On perennial experienced data by J.Ahmedova, K.Mirzajonova, S.Azimbayeva and S.Isaeva (2009), even under weak salination of the soil productivity pat falls on 15-20%, under average - on 30-35%, but under strong on 70-80%. On weak salted grounds the ruin of plants does not exceed -5%, on average salted- 10-20%, on strong salted - exceeds 30% [7]. The most harmful when using for irrigation are salts sodium. The weak oppression of the plants begins at contents of fraudulent sodium in amount till 10-15% from the capacity of the absorption of the ground, containing it till 20-35% causes very strong oppression of the plants. At estimation of meliorative conditions of the lands is taken into consideration also the presence of fair - and complicated soluble salts (the gypsum and carbonate) [13].

As M.P.Tolstoy and V.A.Malygin note that the degree of harmfulness of the salts sodium it is possible to express the following attitude: Na_2SO_4 : NaCl : Na_2CO_3 = 1:3:10. The following limiting rates are taken under the well permeable grounds for salts sodium (in mg/l): for Na_2CO_3 = 1000, for NaCl=2000, for Na_2SO_4 =5000 (1976). Comparing the salts on degree of their toxicity V.A.KOVDA (1946) offers the necessary estimation: if it is conditionally considered that toxicity of the soda (Na_2CO_3) is 10 bals, then the toxicity of the chloride sodium (NaCl) -7 bals, sulphate sodium (Na_2SO_4) and magnesium (Mg SO_4) -5-3 bals, but sulphate calcium ($CaSO_4$) and calcium carbonate ($Saco_3$)-approximately 1bal. (from the book of E.N.Chembarisova, B.A.Bahritdinova, 1989, p. 222) And hereinafter he notes (2008) that the weak oppression of the cultural plants begins, when contents of fraudulent sodium form 10-15% from the capacity of the absorption of the ground. If contents of fraudulent sodium increase till 20-25%, oppression of the plants increases (p.75). Toxic for plants is as well as the other salts: $MgCl_2$, $CaCl_2$, $NaHCO_3$. The contents of salts Na_2CO_3 in amount already 300 mg/l are harmful for plants, at that time, as such contents of the gypsum ($Caso_4$ $2H_2O$) are harmless. The essential source of the forming the soda except processes of weathering is fraudulent chemical, physico-chemical

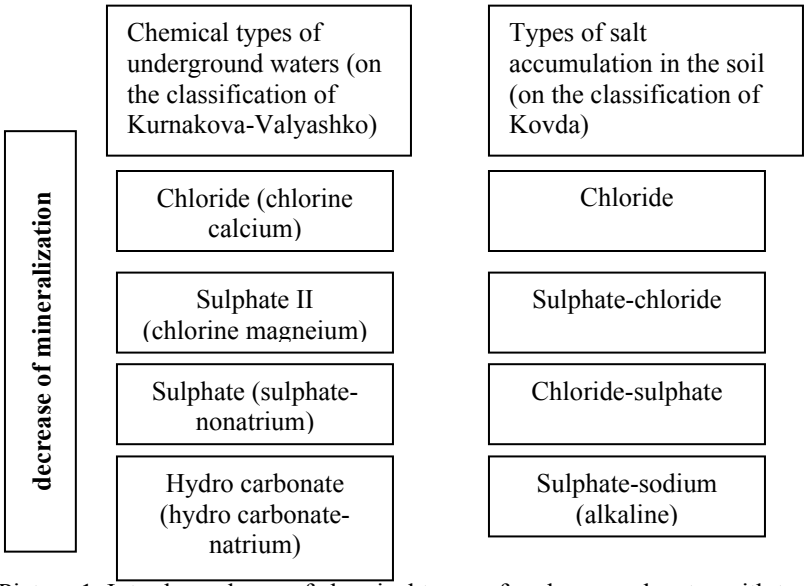
and biochemical reactions in underground water, ground and lake [16].

Even thereof short enumeration is seen that forming the salination of the soil and toxic for plants are salts, defining the composition of the main chemical types of underground waters.

Consequently, salination of the soil it is necessary to consider in close-fitting interdependence with process of the change of the chemical composition (the metamorphization) of the subsoil and, partly, the surface water. At ascent of the subsoil waters, secondary salination of the velocity of desalination the most high moreover desalination exists regardless of quality requiring watering[24]. The discovery of this interdependence it is particularly necessary to correct forecasting of tendencies of saline process in the ground under long usage of the irrigated lands.

2. Methods and the object of the research

As E.I. Pankova and others noted (2008) that in the base of the categorizations of ground on chemical composition of salination the principles of the estimation lie, offered by V.A.Kovda with coauthority (1960), which is used in many countries of the world (Picture 1).



Picture 1. Interdependence of chemical types of underground water with types of salination of soils

3. Methods and object of the study

Comparing the provinces of salting accumulation with hydro chemical types of underground water is seen that on saline composition they are practically identical. This phenomena is not casual, it has a genetic base that allows, on the one hand, spread the hydro chemical categorizations of water on types of salting the ground, but on the other hand, forecast of the evolution of the types of salination of the ground in connection with time history hydro chemical type of subsoil water. This is confirmed by studies of V.M. Borovskiy (1989) from which follows that any way of the irrigation "contributes scolded change to process of the development of the whole landscape of the irrigated array", since object to land reclamations becomes whole landscape in which ground and грунтовые of water follows to consider as united interconnected system. The Scheme of the collation гидрохимических types with types of salt accumulation in the ground is given on fig. 1.

Here vertical arrow are shown directions of metamorphization of the underground water and saline composition of the ground. In analogy with hydro geological terminology is offered the name of the transition from sulphate-soda type of salination to chloride metamorphization saline composition in the straight direction, but transition from chloride to sulphate-soda type - a metamorphization in the inverse direction. In nature the specified above scheme is realized as a rule.

As far back as 1976 D.M.KAth by the example of Kutuluksk irrigation system (Russia, Kuybyshevskaya area) makes conclusions that contents of the sodium reached 28-29% from the amount of the absorbed bases. In this condition metamorphization of chloride –sulphate type of salination in the sulphate - soda. E.S.Varuncyan (1977), indicates that for the period, passed from 1931, on drainage lands of North Mugani (Azerbaijan) at the reduction of mineralization of subsoil water from 60-70 till 2,0-2,5 g/l normal

carbonates are discovered in the majority of the tests of underground water. The accumulation of normal carbonate in the underground water has resulted in broad development of soda salination of the ground. He makes the correct conclusion about that discovery of high alkalinity, desalination and forming the normal soda in the soil of the North Mugani are an objective final stage to land reclamations and under natural current of the processes inevitable. As G.Yuldashev and S.Zokirova (2007), note that formation of CaCO3 exists in subsoil water of Central Fergany in Uzbekistan and MgCO3, from time to time the appearing soda requires chemical and biochemical study for the given process.

Thus, in the arid zone there often exists the process of soda forming that is connected with arrival fraudulent sodium from dark alkaline soil, broadly wide-spread in complex types of ground. This is indicative that as a result of irrigated lands reclamation in composition of the saline complex of ground occur changes not only in positive (with standpoint of the person), but also in negative sides. However these changes are natural - after all they are much closely connected with the main law of metamorphization of chemical composition of natural water, itself process to evolutions of the saline look of ground is defined this law and, hereupon, can be predicted.

As V.A.Kovda (2008) notes, till the present time it was not taken into account the differences and particularities of the processes of salt accumulation in the soil solution and the subsoil water.(p.178) However, crowding interdependence between the evolution of underground water, their mineralization and saline profiles of the sorts were known long ago. It was installed that if dominate the processes filtration and diffusion of leaching, that determined vertical hydro chemical zone (from top to bottom change of hydro carbonate, sulphate and chloride zones) corresponds to (from below upwards) specific litho logical zone: on the change of the sort with chloride salt come the sorts, containing gypsum and anhydride, which, in turn, are replaced the zone of carbonate and silicate. Specified zone can have and inverse nature [4]. At thickening the soil solution (the process, inverse of leaching) specified regularity reveals itself also very obviously, only with the inverse sign i.e. chlorides are localized in the upper horizon of the capillary border, hereinafter downwards dominate the sulphates and, finally, carbonate salts. At large contents of carbonate in the subsoil water and significant increasing of the temperature of the ground with approximation to day surface to carbonate salts can fall out in sediment, not yet having reached capillary border i.e. in most water flowing horizon. Herewith they form the utter salts, which in Central Asia and Kazakhstan carry the name "arzik" or "branch". The similar zone exists in horizontal direction. Subsoil water on measure of the motion is downwards impoverished less-soluble, but then and average-soluble salt. Close by the base of the sewer dominate the most rolling salts of chlorine both in ground, and in the subsoil water [23].

The above-mentioned not at all means that as leading processes of solution-forming it is possible to admit only the leaching and thickening. Moreover, it is possible to consider that exaggeration of the influence of some one process or factor for the reason of introduction in hydro chemistry physical-chemical and the other methods, can result in the wrong conclusion.

Below, on the example of the South of Uzbekistan, are considered some regularities of the change in the saline composition of subsoil waters under long irrigated lands. The used program "Statistics" for generalization mass of hydro chemical analysis. All results were obtained by the following formula:

The Median:

$$x_{Me} = \begin{cases} x_{k+1}, & n = 2k+1 \\ \dfrac{x_k + x_{k+1}}{2}, & n = 2k \end{cases} \quad (1)$$

The Mode:

$$x_{Mo} = \text{element of the selection with higher frequency} \quad (2)$$

(3)

The Selective dispersion and standard selective dispersion:

$$\sigma^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2 \quad (4)$$

and:

$$\sigma = \sqrt{\sigma^2} \quad (5)$$

The Factor of correlations:

$$\rho = \frac{\sigma}{\bar{x}} * 100\% \quad (6)$$

Substituting importance, calculating the factors of correlations:

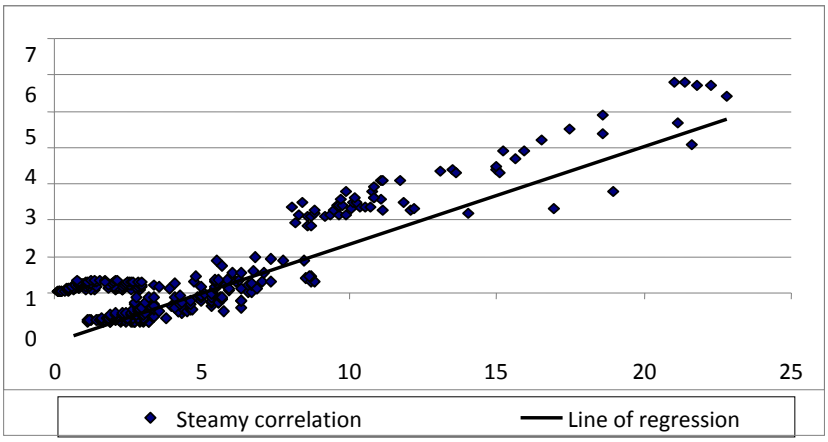
$$\rho = \frac{\sum n_{xy} xy - n\bar{x}\bar{y}}{n\sigma_x \sigma_y} \qquad (7)$$

where, nxy - a frequency vapor (pair) (x,y); - arithmetical average, for x and y accordingly; ?x, ?y - a standard dispersion for x and y accordingly.
The Equation to regressions Y on X:

$$\bar{y}_x = \bar{y} + \rho \frac{\sigma_y}{\sigma_x}(x - \bar{x})$$

4. Results and discussing the studies

The dependencies of ion were built on the base of calculations =f (M) for ion Na++ K+, Mg2+ , Ca2+, Cl- and SO42- (pic.2).



Pic.2 Interdependence of "Na+K" and M (r = 0,97), Kashkadarya Pool

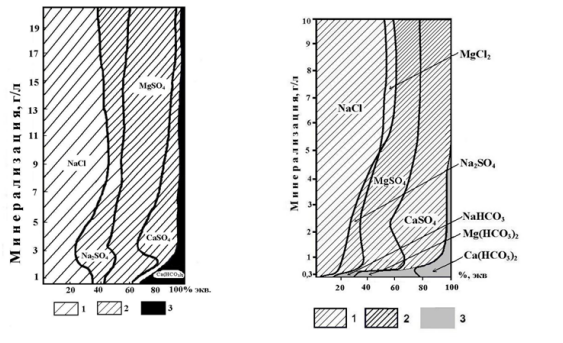
The Equation of linear regression of dependencies between Na++ K+ and M, is assigned by following formula:

$$y = 0.24 * x - 0.15$$

The Statistical curves were recalculated in milligrams - equivalent and equivalent - a percent form, but were then defined also some correlations individual ion. As of these calculations are built diagrams of the hypothetical saline composition of subsoil waters (Pic. 3) and graphs ion factor (pic.4).

From the consideration of pic.3 it is followed that probable saline composition of subsoil water in the pool. of . Kashkadarya from 0,5 till 20 g/l is characterized with the presence of five salts: NaCl, Na2SO4, MgSO4, CaSO4 and Ca(HCO3)2 i.e. water on fair - a statistical data pertain to sulphate-sodium-vapor of hydfo chemical to type on categorizations of Sulina V.A. Coming thereof, it is followed to expect that salination of the ground will occur at the expense of sulphate salts and sodium chloride basically. And really, on actual data, salination of the ground in all natural-water farm regions (NWFR), pertains to sulphate-chloride and chloride-sulpahte types.

а) Кашкадарьинский бассейн б) Сурхан-Шерабадский бассейн

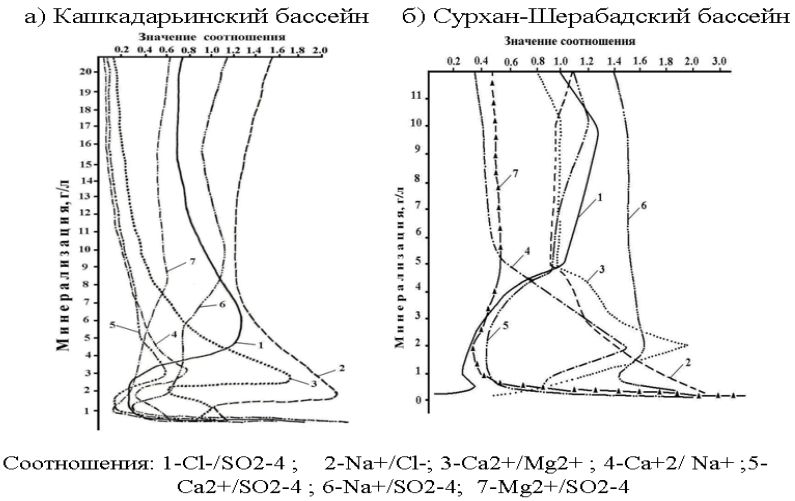


Соли: 1-хлоридные; 2-сульфатные; 3- гидрокарбонатные.

Salts: 1-chlorides; 2-sulpahtes; 3-hydro carbonates

a) Kashkadarya Pool
b) Surkhan-Sherabad Pool

With increasing mineralization of subsoil waters the role of the separate salts decreases. So, at mineralization of 2-3 g/l begins sharp hydro carbonates. The relative contents of the gypsum in solution are great at mineralization of 3-4 g/l. The contents of the sodium chloride exists the minimum at mineralization of 2-4 g/l. From the consideration of fig. 3.3 and crooked change the correlations Ca2+/ Mg2+, Ca2+/SO2-4 on fig. 3.5 it is possible to draw a conclusion that one of solution-forming factors at increasing mineralization of solution above 2-3r/l are a fallout from solution first hydro carbonates and carbonates, but then and gypsum on background firm and nearly proportional increase to concentrations of the salts MgSO4, Na2SO4 and NaCl.



a) Kashkadarya Pool
b) Surkhan-Sherabad Pool
amount of correlations
mineralization g/l

Picture3. Hypothetical saline compound of subsoil water with the dependence of the amount of mineralization

On pic.4 it is particularly distinctly seen that main transformations of the ion composition occur in interval from 0,5 till 5 g/l. **Lessovye** sorts, as are well known, in significant measure enriched fraudulent calcium. Hydro carbonate and carbonate calcium solution, equaled with fraudulent calcium of the sorts, begins quickly to stand out from solution with carbonate at mineralization of 1,5-2,0 g/l already. The Balance is broken, but soon again is restored, since in solution go the additional portions fraudulent calcium, which associate with sulphate by ion. At mineralization of over 5g/l contents Saso4 in water goes on decrease, and relative share sodium in solution increases before 50-55%. The absorbed complex of the sorts is also enriched with sodium. Thereby, under concentrating the solution there exists rather complex picture of flowing ion-changed processes, basically, to account of the redistribution Sa2+ and Na+.

The Analysis on Surhan-Sherabad pool has allowed to reveal some regularities (pictures 3b,4b). The forecasted saline composition of subsoil waters in the interval of 0,3-10 g/l is characterized by the presence of eight salts: NaCl, MgCl, Na2SO4, MgSO4, CaSO4, Mg(HCO3)2, Ca(HCO3)2, NaHCO3 that is to say that water at the average statistical data depend on sulphate-sodium-vapor of hydro chemical type. It is followed to expect that desalination of the soil will occur at the expense of sulphate salts and sodium chloride basically. With increasing the mineralization of subsoil waters the role of the separate salts in the process salination is changed, so at the mineralization of 0,3-4,5 g/l in the solution appear hydro carbonates. Under the most further growing from the solution falls out the first hydro carbonates but then sulphate sodium on the background firm and is nearly proportional increase of concentrations of the salts MgSO4, CaSO4, NaCl. The main re-forming of the ion composition occurs in the interval of 0,3-4,5 g/l. The process appearance of hydro carbonates Ca2+, Mg2+ and normally Na+ in the upper natural water-farm districts where low temperature of the subsoil waters can be speed also in the big dissolution of the carbonic acid of the air.

5. Conclusions

For forecasting the nature of salting the soil of the region in the future most interest will be presented statistical data on the most fresh subsoil waters (mineralization 0,3-1,0 g/l). As seen from picture 3, they contain much hydro carbonate (25-35%; 30-

80%;), nearly is absent the gypsum and much little typical (specific) for sulphate-sodium-vapor type of underground water of salts Na2SO4, (4-10%; 10-15%). Thereby, there exists the total trend of the approach with the composition of water to hydro-carbonate-sodium-vapor type, since after the full disappearance of the sulphate sodium on its change can appear hydro carbonates sodium, but fixed assets against soda - a sulphate calcium - in this water nearly is absent.

In consequence of which, the appearance in the south of Uzbekistan centre soda salination of the soil on the prospect is not excluded. However geological spares chlorine and sulphate of the salts here are so significant that under the existing scale carrying out their irrigation-drainage water it will occur not earlier than through 3-5 years.

9/5/2012