Quantitative Assessment of Irrigated Soils Degradation

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The irrigated soils in Russia make up 4.5 million hectars. The characteristics, direction, features and scales of the main kinds of categories of soil degradation (physical, chemical, mineralogical) under the effect of irrigation were described. The convertible and irreversible processes of soil degradation differ. Quantitative parameters of the normal condition of irrigated soils and of various negative kinds of soil changes and rates of their development for different degradation degrees: light, moderate, severe and very severe are offered. Degradation degree of irrigated soils is evaluated by deterioration of soil properties, reduction of agricultural crops yield and decreasing soil ability to execute functions in biosphere at addition watering. Total assessment of soil degradation is determined by one or several parameters, possessing maximum worsening degree. Soils and groundwater degradation at irrigation results in deterioration of people life and health. It's taken into account at estimation of five classes of irrigated area ecological state. Irrigated soils of Russia on 19 % of area are overwetted, on 14 % are salted, on large their territories erosion, carbonates and humus losses, compaction, slitization, deterioration of physical properties are noted.

In Russia irrigated soils make up 4.5 million hectars or 4 % of plow lands area. Irrigation increases crops, creates new workplaces and recreation areas, but also accelerates change of soils and nature. Anthropogenic loads excess at over land stability results in soil degradation. Soil change depends on many factors, main of which are following: irrigating waters quality, area drainability, soil type, created aqueous mode and degree of humidifying, groundwater table and mineralization, level of agrontechnologies and irrigation method.

OBJECTS AND METHODS

Soils located in different geomorphological conditions in steppe and semidesert zones of Russia were research object. The investigated soils have light, medium and heave loam texture. Irrigation terms make up from 10 to 100 years. Impact of irrigation on different soil properties especially on such insufficiently explored ones as humus condition, soil microstructure and macrostructure, mineralogical composition of coarse and clay fractions were investigated.

RESULT AND DISCUSSION

Degradation of soils and degradation of soil cover are distinguished. Degradation of soils under the effect of irrigation is displayed in deterioration of their properties, in decreasing their ability to carry out ecological functions and in reduction of agricultural plants yield. Soils can execute following functions in biosphere: biocenotic, litological, atmogydrospheral, common biospheric and many others (Dobrovol'sky, Nikitin, 1990).
The deterioration of soil cover consists in complication of its structure, enlarging its humidity and complexity. Degradation of soils and soil cover result in deterioration of people life conditions and threat to their health. It's taken into account at estimation of classes of irrigated area ecological state. Irrigation impact on degree and rate of soils and groundwaters transformation are estimated quantitatively, on change of soil ability to carry out biospheric function and on alteration of people live and health are evaluated qualitatively.

Degradation of irrigated soil is assessed in comparison with the *etalon*. Soil investigated prior to the beginning irrigation or dry land near to irrigated area located on the identical relief shape can be accepted as etalon.

Categories, kinds, and degrees of irrigated soil degradation

Categories of irrigated soils degradation most frequently meeting can be divided into the following: physical, chemical, mineralogical and microbiological**.** *Kinds* of degradation are concrete form of categories display.

Physical soil degradation: decrease of organogenic horizon thickness at irrigation erosion, deterioration of agrophysical properties, including micro- and macrostructure, reduction of aggregation hydrophobicity, increase of compaction, crusting, exceeding of critical groundwater table. *Chemical soil degradation*: content reduction of humus, carbonates and nutrient elements, desaltation, secondary salinity and sodification, deterioration of humus quality, increase of its mobility. *Mineralogical soil degradation*: clay loss as result of destruction and migration, increase of water peptized clay content and conversion of some crystallites into superfine form.

Besides soil degradation promotes to increase of leaching of salts, fertilizers and toxic substances into groundwater, rivers, seas, oceans, that disturb their natural balance leading to undesirable contamination (all planetary danger).

Degree of soil degradation is expression level of various degradation kinds of to the fixed time. Four degrees of soil degradation kinds are distinguished.

1. *Light*, weakly influencing on soils, their functions in biosphere and plants yield.
2. *Moderate*, is characterized by considerable deterioration of soil properties, limiting fulfilment of soil functions in biosphere, the yield decreases on 25-50 %.
3. *Severe*, described by strong change of soil properties, weak ability of biospheric functions performance, decrease of crop on 51-75 %.
4. *Very severe*, as a result of which soils lose properties and ability of functions fulfilment in biosphere, the yield decreases more, than 75 %.

Summaltaneous evaluation of soil degradation is determined by a parameter or a number of parameters, possessing maximum degradation degree. It also needs to specify adverse processes, which have the highest rate. Nowadays soil some parameter can has a small degradation degree, however because of accelerated its deterioration soil may quickly become strongly degraded on this parameter.

Main *parameters are static* ones: the contents, area, as well as *dynamic* ones: rate of processes development and content change required for revealing main kinds of irrigated soils degradation were developed. Investigation of different hierarchical levels of soil organization: macro-, meso- and microlevels is necessary for more complete diagnostics of degradation processes at irrigation.

The *character* of degrading effect can be single and periodically repeated. Two *directions* of soil degradation - progressive and cyclic deterioration (alternately in one and other side) are differ. For soil cover the concept of *combination* of degradation kinds on territory and *abundance* of various degradation kinds in addition are given. The abundance is estimated on the scale: very seldom, seldom, often, very often or on area size subjected degradation.

The convertible and irreversible processes of soil degradation occur. *Convertible,* controlled changes at irrigation are: contents of humus, waterstable aggregates, gypsum, salts, nutration substances, groundwater level. *Irreversible* soil processes are following: microstructure destruction, adverse transformation of organic substances - content reduction of total and reactive-capable microforms, separation of coagulative and dispergative microforms and increase last one and mineral plasma changes - clay loss, super fine form of labile minerals and cutan apperance. Irreversible processes facilitate easing of connection between organic and mineral plasma and lead to them destruction, migration and transformation. Such

processes as destructurisation, compaction, humus destruction, decreasing buffering capacity display in maximum degree in secondary hydromorphic chernozems at irrigation of noncondition waters and reduce in chestnut and brown desert-steppe soils, whereas secondary salinity and solonetzesity increase in this direction.
On the basis of own researches and attraction of numerous literary sources (given in references) quantitative valuation of various kinds of irrigated soils degradation depending on its degree is given (tabl.)

Table. Indices and creteria of physical degradation and hydromophizm of irrigated soils

Indices	Degrees of soil degradation				
	absent	light	Moderate	severe	very severe
Decrease of humus horizon thickness, %	<10	10-20	21-51	51-100	>100
Increasing eroded soils area, %/year	<0.2	0.2-0.5	0.6-1.0	1.1-1.5	>1.5
Soil mass loss, t/year	<5	6-25	26-100	101-200	>200
Soil compaction, g/cm^3	1-1.3	1.3-1.4	1.41-1.5	1.51-1.6	>1.6
Water penitration, m/day	>1.0	0.3-1	0.1-0.3	0.01-0.1	<0.01
Aggregates content , %					
dry sieving, mm: >10	10-20	21-30	31-40	41-50	>50
10-0.25	60-80	50-59	40-49	30-39	<30
Critical droundwater table, m:					
mineral one	>5	3.1-5	2.1-3	2-1	<1
sweat one	>3	2.1-3	1.1-2	0.8-1	<0.8
increase more than critical level, %	0	<15	16-30	31-50	>50
Groundwater rise, m/year	0	<0.2	0.2-0.4	0.5-0.7	>0.7
Yield loss, %	<10	10-24	25-50	51-75	>75

Five classes of ecological state of irrigated area have been requized: satisfactory, tense, conflicting, crisis and catastrophic. *The satisfactory ecological state* of irrigated area develops, when soils and groundwaters are characterized by favourable properties, impact of irrigation on natural components and people is insignificant. Other four classes of ecological state of irrigated territory depend on rate and degree of soils and groundwater degradation; on change of soil ability to carry out biospheric functions and on alteration of health and residing condition of people under the effect of watering.
At the *catastrophic ecological state* of irrigated spaces the permissible anthropogenic loadings on a nature are exceeded many times. It results to irreversible degradation changes of soils and groundwaters, loss by soils of ability to carry out biospheric functions and to yield agricultural production, sharp deterioration of people life and hazard for their health. For rehabilitation of such irrigated spaces following measures are necessary: replacement of soil mass, change of a relief, drainage construction.
The crisis state arises, when degradation of natural complexes comes nearer to a threshold of nonreversibility. The soils can't carry out many of biospheric function. For people life and health large hazard is created. For situation normalization such measures, as engineering drainage creation, land wash and leveling are necessary to carried out.
For *conflicting situation* the moderate degree of destruction of irrigated ecosystem components, decreasing soil ability of performance of some biospheric function and health deterioration of separate groups of the population are characteristic. The urgent measures are necessary for liquidation of above mentioned consequences of irrigation.

At intense ecological state the slight degree of natural components deterioration and weak failures of people health and life space are observed. Their reduction is rather easily achievable.

CONCLUTION

To define all processes leading to soil degradation at irrigation are expensive. Therefore in Russia indexes for basic parameters determining irrigated soils state are offered by VNIIGiM VolzhNIIGiM institutes. In particular, the *unsatisfactory situation* is estimated by the groundwaters level on depth of 1,25-2,2 m, their mineralization more than 1g/l and soil salinity in the 0-1 m layer in moderate and great degrees. At area amount with the unsatisfactory ameliorative conditions less than 10 % satisfactory, with 10-20 % - intence, 21-30 % - conflicting, 31-50 % - crisis, more than 50 %. - catastrofic ecological state develop. On the basis of offered parameters, catastrophic ecological state of irrigated area in Kalmykia and Dagestan is revealed. Satisfactory conditions at irrigation the Ural, West-Siberian and Uncernozemic regions are characterized. Irrigated soils of Russia on 20 % of area are overwetted, on 15 % are salted (Kadastr, 2003), on large their territories erosion, humus and carbonates losses occur, on the great irrigated area compaction, rarely slitization, deterioration of physical properties and structure are noted.
Produced parameters for land degradation can be the basis of estimation of irrigated area ecological state in different regions. It's necessary monitoring of irrigated soils for degradation processes diagnostics.

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