

COMPARATIVE ANALYSES OF THE CRITERION FOR LAND RECLAMTION OF ANIZOTROPICAL-HALOMORPHIC SOILS

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Abstract: *The results of experimental investigations implemented at Messopotamia and Vojvodina (“Slatine”), have proved the concept and methods of Land Reclamation.*

The basic method of Land Reclamation of “Slatine”, have been applied at the 3 locations in Vojvodina, covering all three chalomorphic classes of soils: Solončak (Banat), Solonjec (Bačka), Solođ (Srem).

Four stages of Land Reclamation have been established: I. Preparation and organization of experimental plots, prior to initial salt leaching, II. Mechanical land preparation for salt leaching, III. Initial salt leaching), IV. Reclamative crop production.

The study sublimated experimental investigations realized at the south-east Mesopotamia (yrs.1985, 2001, 2007).

Key words: *Anizotropical soils, resalinizationj, alkalization , halomorphic soils, salt leaching*

INTRODUCTION

The obtained experimental results initiate the fact that the application of the confirmed and in practice adopted and verified concept of land Reclamation of saline soils can transfer a halomorphic soils of Serbia into the “normal”, in order to provide the significant and high agriculture production, i.e. stable financial and economical country potential.

It is strengthened, that the researching results performed at anizotropical highly saline multi layer soils, with the identical forming conditions, texture and structure properties, can be equally used for amelioration and desalinization of “slatine” in Serbia. The main reason lays in identical origin conditions of Vojvodina soils and region where the basic examinations have been performed (Mesopotamian valley).

In addition to the proper organization of experimental fields, the complete technological procedures and instructions have been specified, representing the material basis for the further researchers in sense of collecting the dates and results in order to verify accepted methods and procedures as well as concept of Land Reclamation in whole.

In the study, the common-general classification of all halomorphic soils of arid and semi-arid regions in the world has been adopted: Class of saline soils-Solončak, class of alkaline soils-Solonec and class of dealkaline soils-Solođ.

The basic concept, methods and technological procedures of Reclamation of “Slatine” are applied at 3 locations in Vojvodina, embracing all three selected halomorphic soil classes.

The study has incorporated and presented part of the experimental examination results executed at the region of South – East Mesopotamia in the course of 3 different periods (yrs. 1985, 2001 and 2007)

MATERIALS AND METHODS

Common classification of Halomorphic soils of arid and semi-arid climatic while world has been adopted and accepted as [7,5]:

- Class of saline soils (in Vojvodina-Solončak),
- Class of alkaline soils (in Vojvodina-Solonec),
- Class of dealkaline soils (in Vojvodina-Solođ).

The volume and kind of land Reclamation methods and procedures are stipulated by the initial soil salinity type and degree, including soil alkalization extension through the soil profile [4].

Within the above mentioned selected locations, it was important to provide the following conditions and procedures, works and activities organization, prior to realization of initial soil salt leaching:

- Nearness of natural or artificial water resources for initial soil salt leaching.
- The choice of equal and uniform experimental plots dimensions, with distance between open collector drains of 300-400 m.
- Possibility of water evacuation from protected area (lake, accumulation with pumping station, etc.).
- The minimal experimental plot area of 20 ha (total 60 ha).
- The plot unit area can provide conditions for field drainage system installation.
- Optimal conditions for leaching-irrigation field infrastructures placement (efficient connection between water intakes and hydrants positions).
- Since the initial salt leaching is realized by flooding from cassettes-checks, formed between two field drains (60 and 75 m spacing), it is important to place distributor pipe feeder at the highest topographic position providing uniform water release into the checks.
- To provide certain conditions for land preparation for salt leaching [2]
- Piezometers nets installation for ground water oscillation registrations.
- Defending the places for opening of deep, medium and shallow pedological profiles and shallow Auger holes, where soil samples will be taken.
- To provide nearness of referent- stable meteorological station.
- Placement of field climatologic-meteorological portable station.
- It's necessary to provide required basis for preparation of certain levels of designs. It's recommended to choose such plots having required infrastructures for reclamation measures realization, such as:
 - a. Pedological and hydro-pedological basin and ground works [3].
 - b. Geodetically basis.
 - c. Agricultural basis.
 - d. Field drainage system designs (if not available).
 - e. Irrigation designs (if not available).

Herewith the following stages of complete amelioration-reclamation of "Slatine" based on recent experimental results in the world, particularly the results given by the author [9], sublimed and presented by fundamental technical-technological Concept of land Reclamation:

- **I Stage** of land Reclamation (procedures and activities of experimental plots organization for initial salt leaching execution).

- **II Stage** of Land Reclamation (Mechanical soil preparation including the field infrastructure for salt leaching).
- **III Stage** of and Reclamation (Initial salt leaching).
- **IV Stage** of Land Reclamation (Reclamation production)

I Stage-The chosen experimental plots at all 3 locations should have the identical shape and dimensions with existing or newly designed field leaching-irrigation infrastructures fulfilling the following criterion:

- Plot area not less than 20 ha.
- Existence of field-pipe drainage with the uniform drain spacing within the plot units.
- Elevation at the upper plot side where irrigation feeders and tube manifolds are installed must be settled at the highest point, providing the general leaching units slope at downstream direction [1].
- Initial salt leaching of drainage leaching units realized by check flooding.
- The length and width of leaching units correlates with the spacing between earth irrigation canal or pipe, up stream and collector drainage canal, downstream.
- To provide connection of lateral distributor canal (over the gates) or irrigation pipeline (using hydrants, or stationary systems).

Within the experimental plots and selected leaching units the following activities are designed:

- a. Placement and opening of 1 deep pedological profile up to 200 cm.
- b. Placement and opening of 4 medium deep profiles up to 150 cm (2 by 2 at upper part of the plot).
- c. Placement and opening of 4 shallow pedological profile up to 100 cm depth (location as under b.).
- d. At the first half of the plot along the irrigation canal-pipe, to settling the place for digging of 33 shallow holes up to 60 cm, at each cassette line. At one of the central cassette-check, at each angle, 1 hole should be excavated (total 4). The same location where 1 deep profile is opened.
- e. At the position of central cassettes, 6 piezometers should be placed.

II Stage-Mechanical Reclamation-Soil Preparation. The following technological operations are introduced:

- Ameliorative sub soiling from 40 to 60 cm depth, rarely deep ploughing parallel to field drains direction.
- Disk harrowing in both directions.
- Fine land levelling with agriculture land levellers.
- Construction of embankments 40 to 60 cm height and cassettes-shacks for leaching the salts forming. The strip of 4-6 m width above the field drains axle should be constructed.
- Lateral, longitudinal pipes of certain diameters at highest position, will be installed. From the both pipe sides, the water should be released towards the cassettes. At the experimental fields organized by the author, earth distributaries have been used.

III Stage – Experimental units are classified within the 3 classes, due to the salinity content up to 1 m of soil profile depth:

- a. Class I-soils requiring a small volume of reclamation measures, where $EC_o < 4$ mmhos/cm.
- b. Class II-soils requiring a medium volume of reclamation measures, where $20 < EC_o < 40$ mmhos/cm.
- c. Class III-soils requiring big volume of reclamation measures, where $EC_o > 40$ mmhos/cm.

The following technological operations and procedures are implemented:

1. The first leaching rate of 25 cm net or 30 cm gross in accordance to the operational plane (during the summer), divided into two norms and interval between 5-10 days.
2. Sampling and salinity control, to confirm achieved leaching criteria, i.e. < 4 mmhos/cm, classification into I class soil, and reclamation crop production commencement.
3. Releasing of the next leaching rate (17 cm net or 20 cm gross), classified as salinity classes II and III.
4. The second leaching efficiency verification, -classification in II and III class. At the areas classified as class II, the reclamation crop production will be introduced.
5. Dismantling of cassettes embankments and fine land levelling operation of III class soils, where the leaching process will continue.
6. At the units classified as III salinity class, the ploughing to 15 cm depth increasing the soil infiltration capacity, will take place.
7. Second embankments and cassettes excavation-construction.
8. Application of third leaching norm of 25 cm water depth (30 cm gross), at the areas covered by III salinity class.
9. The third leaching efficiency verification, by taking the soil samples at the entire areas classified as III salinity class.

IV Stage-Reclamative production by the execution of the following operations and activities:

1. Disintegration and soil planning of all longitudinal and cross earth embankments.
2. Land levelling with agriculture leveller at the entire area.
3. Ploughing 20-25 cm dept.
4. Disk harrowing with heavy disc plates in both directions.
5. Fine land levelling.
6. Pre sowing soil preparation including the pre plant irrigation.
7. Application of NPK fertilizer, before ploughing (2/3PK and 1/2 N) and the rest of before disc harrowing.
8. The sowing of the selected reclamation production crops tolerant to salt.
9. Irrigation with so called "additional water quantities" of 40-50 mm monthly rate to maintaining the obtained salinity level.
10. Harvesting and cutting the grass swaths, optionally with legumes green mass ploughing for organic matter increasing.
11. Depending on the water availability:
 - a. Fallow, or
 - b. Salt leaching during the reclamation plant production.

12. Salinity control at the whole investigated areas of all soil classes and their transfer to the Regular Agriculture Production.

RESULTS AND DISCUSSION

It is important to distinguish, that the pedo genetically processes and forming of our soils, comparing to the soils where basic experimental investigations took place, are rather similar.

The basic concept, methods and technological procedures of Reclamation of "Slatine" are applied at 3 locations in Vojvodina, embracing all three selected halomorphic soil classes. The chosen locations are representative from the aspect of required inputs. The following locations are selected: Solončak (Banat), Solonjec (Bačka) and Solođ (Srem).

The study has incorporated and presented part of the experimental examination results executed at the region of South – East Mesopotamia in the course of 3 different periods (yrs. 1985, 2001 and 2007).

Based on the soil salinity classes, the following Land Reclamation dynamics, i.e. time scheduling has been adopted [6]. :

1. Class I ($EC < 20$ mmhos/cm): Leaching commences in month of October,
 - Initial salt leaching (lasting 45-50 days),
 - Reclamation plant production including the additional leaching water quantities (lasting 23 months).
2. Class II ($20 < EC < 40$ mmhos/cm): Leaching starts in October month,
 - Initial salt leaching (lasting 90 days),
 - Reclamation plant production including the additional leaching water quantities (lasting 19,5 months),
 - At the mead April tills the end of September (during the second year) and than optionally setting the entire area under the fallow, or under regular irrigation (if enough water during the summer time is available).
3. Class III ($EC > 40$ mmhos/cm):
 - Initial salt leaching (lasts 125 days),
 - Reclamation crop production (lasting 19, 5 months).

For the climatic conditions of Vojvodina the following Land Reclamation dynamics and time scheduling are introduced:

Salinity Class I: Depending on seasonal climatic conditions, the salt leaching starts from 15 March to 1 of April, using the following technology:

- Initial salt leaching in two applications(20 cm and 10 cm gross water depth), with 7 days interval at the whole area of all salinity classes,
- Taking the soil samples in order to verify initial salt leaching process efficiency and than soil classification in II and III, and introducing the reclamation production all over the I class soils.
- reclamation plant production using vegetative as well as additional leaching water requirements lasting up to end of October month (808.5 months),
- land conservation by fallow, from October of current production year till the beginning of April month next year (4-4.5 months).
- At the end of March and begging of April second year, preparation for sowing and sowing of the reclamation production crops using the regular and additional irrigation-leaching up to the end of September the same year (6-6.5 months).

2. For elaboration of Land Reclamation concept execution, the general scheme and time schedule related to different reclamative works and treatments have been emphasized.
3. The volume and dynamic of Land Reclamation process are influenced by the salinity classes specified as: Class I ($EC_e < 4$ mmhos/cm), Class II ($20 < EC_e < 40$ mmhos/cm), Class III ($EC_e > 40$ mmhos/cm).
4. Four stages of Land Reclamation-desalinization have been established: I. Stage (preparation and organization of experimental plots, prior to initial salt leaching), II. Stage (mechanical land preparation for salt leaching, including sets of designed technological operations), III. Stage (initial salt leaching), IV. Stage (reclamative crop production).
5. The biggest volume of reclamative measures and treatments have been applied at the Solončak and than to Solonec and Solod.
6. It was confirmed that the results of experimental investigations leded at highly saline anizotropical soils of Mesopotamian valley, comparing to the equivalent one in Vojvodina ("Slatine"), determinate the basic concept and methods of Land Reclamation Process.

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