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Determination of the Meliorative Condition of Irrigated Lands Using Rapid Devices

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Abstract: This article analyzes the assessment of the meliorative condition of irrigated lands using modern devices. Modern technologies were applied to study the level of soil salinity, its changing trends, and the effectiveness of meliorative measures. The article also develops scientifically grounded recommendations for effective reclamation measures to combat soil salinization.

Keywords: Modern devices, meliorative condition, soil salinity, Diver device, electrical conductivity meter

Introduction: Irrigated agriculture is one of the main sectors of agriculture in Uzbekistan and plays an important role in ensuring food security for the population. However, soil salinization is widespread in irrigated lands, and this process negatively affects the efficient use of land resources. It has been determined that nearly 50% of the total irrigated areas in the republic are affected by salinity to varying degrees. Furthermore, salinization of irrigated lands is one of the most significant environmental and economic problems in Uzbekistan's agriculture. Excess soluble salts in the soil limit plants' ability to absorb water and nutrients, reduce crop yields, and therefore controlling soil salinity, ensuring the effective functioning of meliorative systems, and applying modern measures are of great importance. Soil salinization is the accumulation of easily soluble salts in varying amounts within the upper layers of the soil. In recent scientific literature, this concept is defined somewhat differently. Specifically, saline soils are those with a saturated soil extract electrical conductivity (EC) greater than 4 dS/m and an exchangeable sodium percentage (ESP) of less than 15%. The pH of such soils is usually below 8.5. Previously, these soils were referred to as "white alkali soils" because their surface layer was often covered with a white salt crust. Saline soils develop as a result of the accumulation of water-soluble salts. The majority of soluble salts in the soil solution consist of cations such as sodium, calcium, and magnesium, and anions such as chloride, sulfate, and bicarbonate. Smaller amounts of potassium, ammonium, nitrate, and carbonate may also be present.

Groundwater measuring device (diver)

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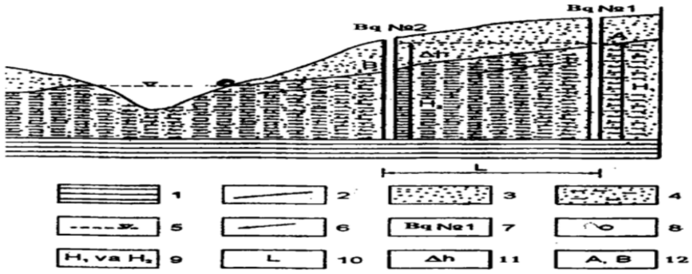
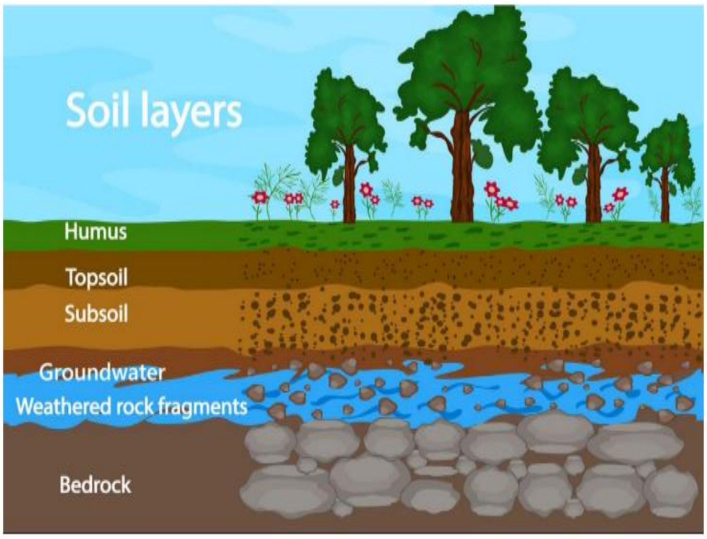


1-rasm. *Yer osti grunt suvlarining harakat yo'nalishi.*
1-suv o'tkazmas qatlam; 2-yer osti grunt suvining sathi; 3-suvsiz jins qatlami; 4-suvli qatlam; 5-daryodagi suv sathi; 6-yer osti grunt suvining harakat yo'nalishi; 7-burg'u quduqlari va ularning raqamlari; 8-yer osti grunt suvining buloq holatida daryo vodiysidagi chiqish yo'li; 9-№1 va №2 quduqlardagi yer osti suv balandligi; 10-№1 va №2 quduqlar oralig'i masofasi; 11-№1 va №2 quduqlardagi yer osti grunt suvlari sath balandliklarining farqi; 12-№1 va №2 quduqlardagi suv balandliklarini ko'rsatuvchi nuqtalar.



Research Methodology. On saline lands, crop yields decrease and quality deteriorates, leading to reduced harvests. It has been practically proven that, on such fields, the yield of agricultural crops can decrease by 25–40%. Therefore, issues related to the origin of salts and the main sources of salt accumulation remain significant both theoretically and practically for science and agriculture. Currently, in many countries, including irrigated lands in our republic, the depth of groundwater and its salinity, as well as the salinity of soils, are rapidly determined using specialized instruments such as Dayver and electroconductometers. The Dayver device automatically measures the level and salinity of groundwater and transmits data remotely. The reclamation condition of irrigated lands is primarily assessed based on the ability of existing collector and drainage networks to perform their functions, the groundwater level and salinity, and the salt content in soils with different degrees of salinity. One of the main factors in assessing the reclamation condition of irrigated lands is the depth and salinity of groundwater. The depth of groundwater in the field varies depending on the location of irrigation canals and collector-drainage networks. According to the normative requirements of the Ministry of Water Resources of the Republic of Uzbekistan, when installing monitoring wells, it is recommended to take into account the reclamation condition of the land, soil texture, water permeability, and the availability of collector-drainage networks. For an area of 100–200 hectares, one observation well is recommended. Wells should be located: no closer than 20 m from temporary channels; no closer than 40 m from primary drains; no closer than 120 m from inter-farm channels and collectors; no closer than 200 m from main (trunk) canals. For modern, digital measurement and monitoring of groundwater level and salinity in observation wells, the Dayver device is used. In Uzbekistan, the "SMART-WELL" model of the Dayver system is widely implemented. The Dayver "SMART-WELL" is a durable, long-lasting, high-precision measuring and recording device with a corrosion-resistant casing, designed for a measurement range from 0 to 120 mS/cm and capable of long-term online monitoring even in highly saline waters.
In areas where groundwater mineralization exceeds 3 g/L, it is recommended to conduct monitoring, cleaning, and routine maintenance of installed Dayver devices together with the scheduled repairs of observation wells

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used for reclamation monitoring. The degree of soil salinity can be rapidly determined using an electroconductometer. To assess soil salinity, soil samples are taken from different depths (0–30 cm, 30–70 cm, 70–100 cm) and sent to a laboratory for analysis. The content of salts (HCO_3^-, Cl^-, SO_4^{2-}) is then determined. This process is labor-intensive, time-consuming, and requires the intervention of highly qualified specialists. In the United States and Europe, the level of salinity is determined by measuring the electrical conductivity (EC) of soil extracts using specialized instruments. This method is well-tested and is also being applied in our country. It is a very simple and fast method that requires a specialized battery-powered EC device. Using this method, up to 100 measurements per day can be performed.
If farmers want to quickly assess the salinity level of soil and water in their fields, they can use an electrical conductivity meter. In this method, the salinity level is determined by measuring the electrical conductivity of a 1:1 soil–water suspension, as well as by analyzing waters of different origins (irrigation water, collector-drainage water, and groundwater). This method is widely used abroad and is now being applied in our republic as well. As a result of scientific research conducted by scientists of the former SANIIRI, now the Research Institute of Irrigation and Water Problems, particularly in the "Soil Analysis and Land Leaching" laboratory, significant achievements have been made. These include the development of a compact field conductometer (an instrument adapted for measuring electrical conductivity). According to international classification standards, a correction scale for assessing soil salinity levels specific to Central Asian soils has been developed, which allows for a more accurate evaluation of salinity conditions. This scale is presented in Table 4.4.1.

International classification of soil salinity (FAO) and correction scale for Central Asian soils based on $EC_{(1:1)}$:

FAO EC (dS/m)	Degree of Soil Salinity	Correction Scale $EC_{(1:1)}$ (dS/m, K=3.5)
0–2	Non-saline	0–0.6
2–4	Slightly saline	0.61–1.15
4–8	Moderately saline	1.16–2.30
8–16	Highly saline	2.31–4.7
>16	Very highly (extremely) saline	>4.7

The device is designed to measure electrical conductivity (EC) within the range of 0.1 to 40 dS/m and has three modes. Under convenient stationary conditions, it allows up to 100 measurements per day. The procedure for determining soil salinity is as follows: To measure soil salinity, a 1:1 soil–water suspension is prepared. This involves mixing 30 g of finely ground soil (or approximately 3 teaspoons) with 30 ml of distilled water in a 100 ml chemical beaker. The electrical conductivity is measured by immersing the electrode of the conductivity meter about 1 cm into the suspension. After pressing the device button, the EC value of the suspension is displayed on the screen in dS/m (the international unit for EC measurement). Before the next measurement, the electrode is rinsed in distilled water and wiped with a simple rubber piece attached to the device. Experiments have shown that conducting EC measurements directly in the field is more convenient. During large-scale field studies, soil samples collected throughout the day are labeled, placed in bags, and then taken to the laboratory for further analysis. This approach reduces issues related to cleaning containers and other logistical challenges. Measurement of water electrical conductivity (irrigation, drainage, and groundwater) is also more convenient when performed directly in the field. For this, a sufficient amount of water sample is poured into a beaker, and the electrode of the conductivity meter is immersed to a depth of about 1 cm. After pressing the button, the displayed value is recorded. Based on EC data, water salinity can be estimated using the following formula: Salinity (g/L) ≈ ECw (dS/m)

Conclusion: Based on the above discussion, as well as the proposed suggestions and recommendations, it is necessary to continue comprehensive scientific studies of the current meliorative condition of irrigated soils in the region and to provide an objective assessment. At the same time, it is important to restore, improve, and maintain soil fertility, and to ensure high yields from saline lands by implementing more effective meliorative

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measures. For the successful solution of melioration problems, irrigated agricultural lands in each farm, district, and region should be regularly monitored and recorded annually. Priority should be given to identifying lands requiring melioration, and in such areas, agro-meliorative and other measures aimed at improving soil conditions and ensuring high productivity should be implemented. In already improved (meliorated) areas, continuous monitoring must be maintained.

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