

**SALINE SOILS IN THE SOUTHERN PART OF THE ARARAT VALLEY:
EXPERIENCE OF MAPPING BY LANDSAT-8 DATA**

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Abstract. *The distribution of saline soils in the southern part of the Ararat valley is considered in connection with the prospect of agriculture intensifying there. For an approximate assessment of the saline soils localization, satellite images of Landsat-8 with a resolution capacity of 30 m were used. Of the total area of the investigated territory, 111809 hectares, the plain part itself occupies about 75 thousand hectares, and the area of saline soils is 21503 ha. Consequently, within the plain part of*

the valley, suitable for agricultural use, saline soils, that require hydraulic engineering and (probably) chemical reclamation, occupy 28.7% of the area. Saline soils are least widespread in the western part of the plain, and most - in the central part at the foot of the Ararat Mount. In the eastern part, saline soils alternate with hydromorphic (overmoistened) soils.

Key words: *saline soils, space image, Ararat valley*

Introduction. The Ararat valley is a typical intermontane depression with an average height of 800-900 m, divided by the Araks River into the northern (Armenian) and southern

(Turkish) parts. It is surrounded by high mountain ranges (Fig. 1) with the peaks of Ararat (from the south) and Aragats (from the north).

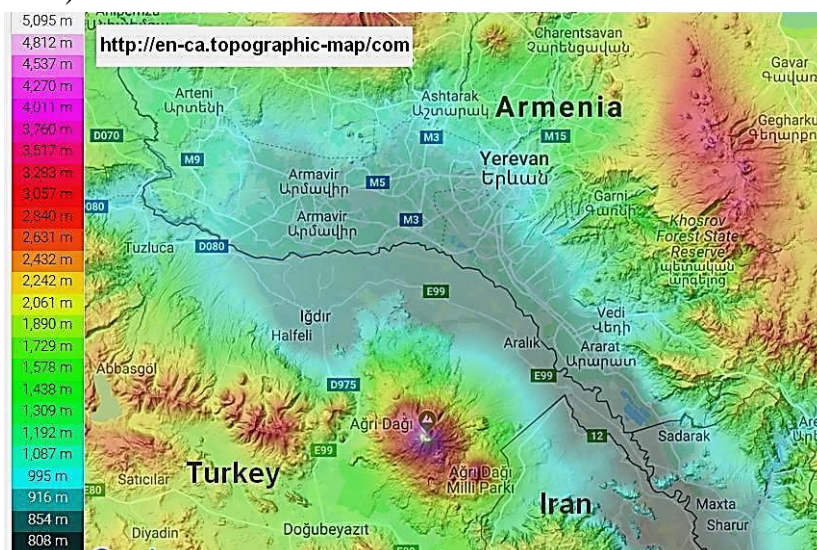


Fig. 1. Geomorphology of the Ararat valley region

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Geomorphologically, the Ararat valley is somewhat asymmetric. From the south, Mount Ararat passes into the plain formed by the Araks river, without forming significant debris cones

(proluvial-alluvial fans). From the north, mountain ridges are firstly replaced by debris cones of the Araks left-bank tributaries (Fig. 2).



Fig. 2. General view (3D) of the Ararat valley

The climate of the Ararat valley is sharply continental with large annual and daily fluctuations in temperature and humidity. The average monthly air temperature in the winter is minus 6-7 C⁰, and in the summer - plus 25-26 C⁰. The continentality of the region is explained by the penetration of overheated air masses through Iran in summer and the invasion of cold air masses in winter, as well as local cooling. Thermal contrasts cause the occurrence of strong mountain-valley winds, especially in summer, as well as the cool air descent from the mountains, which in the summer weakens the heat and causes night cooling. The Ararat valley is very arid, the annual

precipitation is 250-300 mm, and the relative humidity of the air is very low. The valley is also distinguished by the exceptional duration of sunshine (an average of about 2600 hours a year), therefore the climate is sometimes referred to as the Mediterranean type [1, 8].

The landscapes of the Ararat valley plain part are mostly semi-desert. Low-lying parts of the valley are occupied by semi-hydromorphic and hydromorphic soils, often saline and alkaline (sodicity effected), in combination with solonchaks and solonetztes [1, 2]. There are also sandy alluvial soils and even sandy mounds. According to the FAO classification [7],

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all these soils are classified as Antrosols. Elevated areas of the plain are occupied by brown semi-desert soils (according to the traditional classification of the former USSR) or Calcisols according to FAO classification, which became meadow-brown soils after prolonged irrigation [2].

The piedmont plains of the dry-steppe and steppe regions surrounding the Ararat valley are occupied by chestnut soils and chernozem. The soils of the valley are suitable under irrigation for growing fruits (peaches,

apricots, apples, pears, plums, and cherries), grapes, subtropical crops (figs, pomegranates, almonds) and various heat-loving crops (Fig. 3). But salinity and alkalinity of these soils reduce their fertility. Therefore, for many years, methods of amelioration of alkaline and saline soils [3 - 6] have been developed and introduced (mainly in the northern part of the valley). In recent decades, the accumulated experience of melioration of soda-saline soils has been largely lost, and areas of saline soils tend to expand.



Fig. 3. Irrigated fields in the Ararat valley
(https://ru.wikipedia.org/wiki/Ararat_valley#/media/File:Khor_Virap.jpg)

Irrigation in the Ararat valley is carried out by the waters of the Araks River and its left-bank tributaries. From the right bank of the Araks there is none tributaries at all. The water in the mountains is completely absorbed by porous mountain rocks of volcanic origin and enters the valley in the form of groundwater. Groundwater in the Ararat valley lies close to the surface

and determines the hydromorphicity of soils. They are also used for irrigation, and more recently - for the cultivation of aquatic biological resources.

Subject and research methods.

In connection with the increase in population and the intensification of economic activity in the southern part of the Ararat valley (within Turkey), this part of the valley was chosen for

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research. The subject of the study was the soil cover of the territory, characterized by a significant spread of saline and alkaline (sodicity effected) soils, requiring ameliorative measures during development. Landsat-8 satellite images with a resolution of 30 m were used for approximate mapping of saline soils. The so-called "unsupervised" classification was used to analyze the images.

Results of the study. Solonchaks and solonchakic soils (superficially saline soils), that are very often alkaline as well, are widespread throughout the Ararat valley and occupy about 10% of its territory [8]. However, they are concentrated to the greatest extent in the southern and south-eastern part of the valley on the right bank of the Araks river (Fig. 4 and 5). The distribution of saline and alkaline soils here is associated with the peculiarities of circulation and the chemical composition of groundwater flowing from surrounding mountain systems and unloading into the river valley. The centuries-old use of valley lands in irrigated agriculture also has a significant impact. At the foot of Mount Ararat, considerable areas of previously

irrigated lands are now highly saline and are solonchak fallow land with traces of ancient irrigation. Intensification of agricultural production in this part of the valley in recent decades has placed increased demands on the assessment of the ecological state of land resources and on the methods of melioration of saline and alkaline soils in the Ararat valley. A significant experience in reclamation of such soils was previously accumulated, especially in the left-bank part of the valley.

Estimation of the saline soils distribution containing a large amount of water-soluble salts on the surface was attempted (at the first approximation level) based on the analysis of the Landsat-8 space images for the summer and autumn of 2017, when saline white color on the surface is clearly visible (Fig. 4, 5). During this period, the reflectivity of such surfaces is significant and they are quite clearly traced in the satellite image. Naturally, the results of saline soils mapping on a satellite image require further clarification by ground-based soil studies.

Generalized classification of the Ararat valley surfaces according to the Landsat-8 image for September 5, 2017 (12 classes)

No. of surface classes	Surface types	Area, hectares	%% of total area	%% of plain area
1 - 4	Rocks	36985	33.1	---
5 - 8	Irrigated soils with crops of different maturity	40957	36.6	54.7
9	Gardens, vineyards and shrubs	12364	11.1	16.6
10	Moderately saline soils	10129	9.0	13.5
11- 12	Strongly saline soils and solonchaks	11374	10.2	15.2

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Total		111809	100.0	100.0
Including 10-12	Saline soils	21503	19.2	28.7

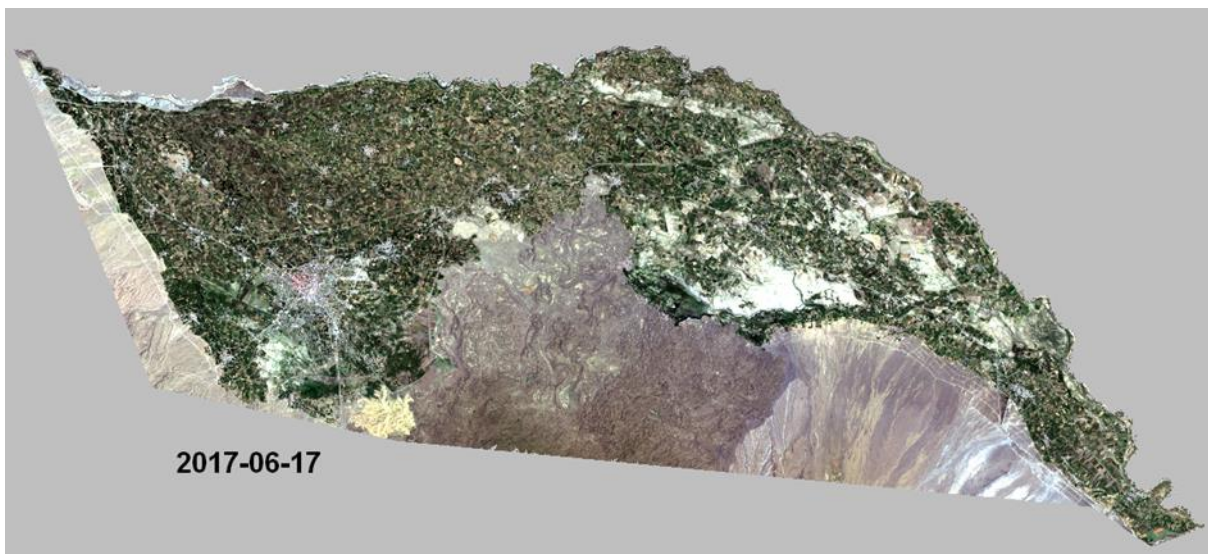


Fig. 4. Space image of the Ararat valley southern part, Landsat-8, 17.06.2017

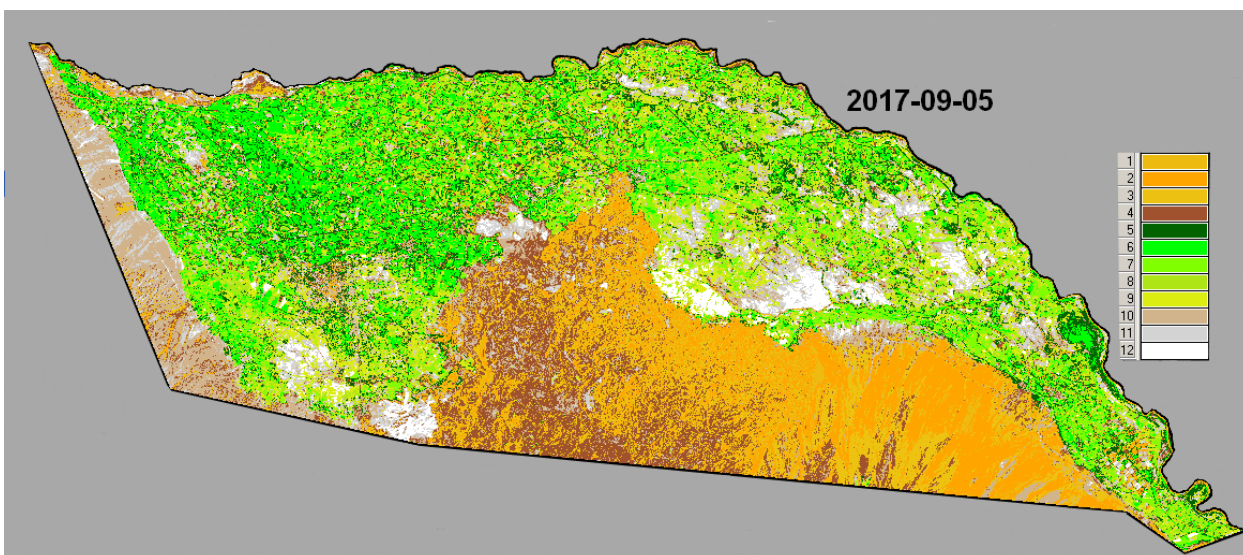


Fig. 5. Classification of the surfaces in the south part of the Ararat valley (the legend is shown in the table)

Conclusion. Out of the investigated territory total area in 111809 hectares, rock formations, including stony deposits and sand in the Araks riverbed, amounted to 36895 ha. A lowland, suitable for agricultural production, have 74824 hectares. Within this territory, saline soils and solonchaks, which require complex land

reclamation, occupy 21503 hectares, ie 19.2% of the investigated area and 28.7% of its flat part. The results obtained require clarification by ground-based research methods and chemical analyzes. The alkalinity of the Ararat valley soils has not been investigated by this method.

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**ЗАСОЛЕННЫЕ ПОЧВЫ ЮГА
АРАРАТСКОЙ ДОЛИНЫ:
ОПЫТ КАРТИРОВАНИЯ ПО
ДАНЫМ ЛАНДСАТ-8**

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Аннотация.

Рассмотрено распространение засоленных почв в южной части Араратской долины в связи с перспективой интенсификации здесь сельского хозяйства. Для приближенной оценки локализации засоленных почв использованы космические снимки Ландсат-8 с разрешительной способностью 30 м. Из общей площади исследованной территории 111809 га собственно равнинная часть занимает около 75 тыс. га, а площадь засоленных почв - 21503 га. Следовательно, в пределах равнинной части долины, пригодной для сельскохозяйственного

использования, засоленные почвы, требующие гидротехнических и (вероятно) химических мелиораций, занимают 28,7% площади. Наименее распространены засоленные почвы в западной части равнины, а наиболее – в центральной части у подножья горы Арарат. В восточной части засоленные почвы перемежаются с гидроморфными (переувлажненными).

Ключевые слова: засоленные почвы, космический снимок, Араратская долина

**ЗАСОЛЕНІ ГРУНТИ ПІВДНЯ
АРАРАТСЬКОЇ ДОЛИНИ:
ДОСВІД КАРТУВАННЯ ЗА
ДАНИМИ ЛАНДСАТ-8**

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Анотація. Розглянуто поширення засолених ґрунтів у південній частині Араратської долини у зв'язку з перспективою інтенсифікації тут сільського господарства. Для наближеної оцінки локалізації засолених ґрунтів використані космічні знімки Ландсат-8 з роздільною здатністю 30 м. Із загальної площі дослідженої території 111809 га власне рівнинна частина займає коло 75 тис. га, а площа засолених ґрунтів - 21503 га. Отже, в межах рівнинної частини долини, придатної для сільськогосподарського використання, засолені ґрунти, що вимагають гідротехнічних і (ймовірно) хімічних меліорацій, займають 28,7% площі. Найменше поширені засолені ґрунти в західній частині рівнини, а найбільше - в центральній частині біля підніжжя гори Арарат. У східній частині засолені ґрунти перемежовуються з гідроморфними (перезволоженими).

Ключові слова: засолені ґрунти, космічний знімок, Араратська долина