# Changes in the granulometric composition of Zarafshan river soils under irrigation and comparative analysis

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**Abstract.** According to the granulometric composition of all soil types (typical, light gray, gray-meadow and meadow-alluvial) located on terraces I - II - III of the Zarafshan oasis, it is mainly medium and heavy sand, physical clay (<0.01 mm) and large dust ( 0.05 – 0.01 mm), medium dust (0.01 – 0.005 mm), fine dust (0.005 – 0.001 mm) and silt particles due to irrigation for many years reduced sand particles and increased the amount of dust and silt particles in all layers of the soil . It is explained by the erosion of feldspar, mica-like substances in the sand particles, the increase of dust and silt particles in the upper layers of the soil as a result of irrigation, and the fact that certain parts are washed to the lower layers of the soil.

## 1. Introduction

Widespread in the long-established farming regions of Uzbekistan thick agro-irrigated soils are, and these soils are distinguished as an independent type of oasis soils.

The soils of the middle reaches of the Zarafshan River are scattered in ancient agricultural oases. They were formed from natural gray soils during irrigation. However, as a result of human activities, the morphogenetic characteristics of the soil profile characteristic of natural gray soils have changed radically.

The process of soil formation under the influence of irrigation led to changes in the microclimate, moisture biota, distribution of salts and flora of these lands. Due to irrigation, the non-washable water regime of gray soils is replaced by the irrigation water regime. Periodic irrigation moistened the soil layer several times and led to the acceleration of the eluvial process.

During 1920-1932 under the leadership of N.A. Dimo, M.A. Orlov, N..B. Bogdanov, M.A. Pankov, D.M. Klavdienko and others compiled soil maps of irrigated lands in Central Asia, including Uzbekistan and soil types are described.

Orlov [1] defined it as "Culturally irrigated" soils. Currently, Uzbek soil scientists have developed a classification of gray soil region and oasis soils of the desert zone. The classification of irrigated soils of Uzbekistan created by B.V. Gorbunov and N.V. Kimberg (1962, 1975) was divided into soil types and information was given on gray oasis soils.

According to Kimberg [2], in such soils, the layer consisting of irrigation supplies reaches from 0.5 to 2-3 m. Depending on the thickness of the agro-irrigation horizon, it is divided into thin (up to 0.5 m), medium thick (up to 0.5 - 1.0 m) and thick (above 1.0 m) types.

Kimberg's article "Zarafshan Valley" contains information on soils and conditions of soil formation [2]. The Base points were taken from the parts of Zarafshan river divided into Aqdarya and Karadarya, on the left and right banks of the Aqdarya, with flat relief and long cultivated lands.

Geomorphological and hydrogeological conditions of soils according to Kovda [3], it consists of complex alluvial deposits. Beneath these alluvial deposits are layers of gravel, sand, and silt.

According to Molodsov [4], 10.8-17.9 tons of mud flows with water per hectare of irrigated land in the Zarafshan river basin every year, as a result of which it was determined that the thickness of the irrigation deposits increases by 0.8-1.3 mm per year.

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The soil cover in the middle reaches of the Zarafshan River is typical and light gray soils, which are composed of automorphic and hydromorphic soils and are very complex, which is also related to the geomorphological structure of the region and the nature of the soil. It is explained by the soil-forming rocks, hydrogeological conditions, and differences in the development distance and processing of individual plots [5-10].
According to the conditions of soil development, main characteristics and the influence of irrigation, studies were carried out on 4 types of gray oasis soils (old-irrigated typical gray, pale gray, gray-meadow and meadow-alluvial) distributed in the studied area of the middle course of the Zarafshan River.
The soils distributed in these areas were developed in the upper terraces I, II and III of Zarafshan [6].

## 2. Methods

Field-soil studies and camera-analytical works "Metody agrokhimicheskikh, agrofizicheskikh i microbiologicheskikh issledovaniy v polivnykh pochvax khlopkovyx rayonakh" developed at UzPITI and "Rukovodstva k proveteniyu khimicheskikh i agrofizicheskix analizov pochv pri monitoringa zemel" developed at TAITI and R. Ko'ziev and others were carried out on the basis of methodological manuals entitled "Instructions for conducting soil surveys and drawing up soil maps for the maintenance of the state land cadastre".
At each physical point of observation, soil sections were lowered to a depth of 1.5-2.0 m to seepage waters, soil samples were taken for analysis of granulometric composition in laboratory conditions, and the granulometric composition of the obtained soil samples was determined by the pipette method of Kachinsky [8].

## 3. Results and Discussions

### *3.1. Irrigated typical gray soils*

"Tilovqabilov Mahmudjan" farm, "Tilovqabilov Mahmudjon" farm, Kattakurgan district, Samarkand region, the soil cover of contour №125 is typical gray soils with old irrigation. It developed on the terrace of Zarafshan III.
*Comparative analysis of the changes of typical old irrigated gray soils distributed in the middle reaches of the Zarafshan River under the influence of irrigation and treatments.* Typical irrigated gray soils morphologically retain some of the characteristics of dry gray soils, especially significant changes in the topsoil. Although a new driving layer is formed here, the mechanical and material structure remains the same. The reason for this is that the upper and lower layers are mixed in the same way during soil cultivation every year.

**Table 1.** Variation of the granulometric composition of typical gray soils, %

| Soil section | Layer. cm | Fractional amount [%] and particle size [mm] | | | | | | | physical mud. < 0,01 | Names of soils according to their granulometric composition |
|---|---|---|---|---|---|---|---|---|---|---|
| | | sand | | | dust | | | il | | |
| | | >0,25 | 0,25-0,1 | 0,1-0,05 | 0,05-0,01 | 0,01-0,005 | 0,005-0,001 | <0,001 | | |
| Typical gray soil (1963 y) | | | | | | | | | | |
| 50 | 0-20 | 2,07 | 9,29 | 15,82 | 36,08 | 9,6 | 15,82 | 11,32 | 36,74 | Medium sand |
| | 20-34 | 1,6 | 8,39 | 13,69 | 38 | 11,26 | 14,72 | 12,34 | 38,32 | Medium sand |
| | 34-68 | 1,02 | 11,03 | 6,29 | 41,96 | 8,78 | 18,64 | 12,28 | 39,7 | Medium sand |
| | 68-82 | 1,02 | 11,03 | 6,29 | 41,96 | 8,78 | 18,64 | 12,28 | 39,7 | Medium sand |
| | 82-109 | 1,49 | 13,59 | 18,56 | 32,94 | 10,18 | 14,52 | 8,72 | 33,42 | Medium sand |
| Typical gray soils (2020 y) | | | | | | | | | | |
| 5 | 0 – 23 | 1,9 | 7,11 | 14,02 | 36 | 12,09 | 15,01 | 13,87 | 40,97 | Medium sand |
| | 23 – 47 | 1,19 | 6,09 | 12,09 | 39,01 | 12,11 | 16,43 | 13,08 | 41,62 | Medium sand |
| | 47 – 71 | 1,02 | 9,04 | 5,99 | 39,42 | 10,39 | 19,03 | 15,11 | 43,53 | Medium sand |
| | 71 – 83 | 1,02 | 10,03 | 5,89 | 40,02 | 10,59 | 19,33 | 13,12 | 42,04 | Medium sand |
| | 83 – 109 | 1,49 | 11,31 | 16,69 | 33,29 | 12,69 | 15,31 | 9,22 | 37,22 | Medium sand |

A carbonate eluvial layer is formed in the lower part of the profile, and new creates (white pores, eselvak, etc.) are found. The agronomic importance of these soils is related to the degree of leaching. An increase in the level of leaching leads to the leaching of humus and other nutrients, and at the same time, their agrophysical properties deteriorate. The granulometric composition of typical gray soils has not changed much.
But a small agro-irrigation layer was formed in the upper layer of the soil. The reason for this is the distribution of typical gray soils in high and low terrain. For example: in the table, due to the increase in the amount of fine dust,

the amount of particles has increased. In some parts, it is noticeable that the upper part of the soil profile has changed. This can be explained by the fact that the relief is located in a somewhat flat part.
According to the granulometric composition of these old irrigated typical gray soils, it is mainly medium sandy, and the amount of physical clay particles (<0.01 mm) fluctuates between 40.97 - 41.62% in the arable layer and 43.53 - 37.22% in the lower layers. stood, large dust particles (0.05 - 0.01 mm) made up 36.0 - 39.01% in the arable layer of the soil and 39.42 - 33.29% in the lower layers, the average dust (0.01 - 0.005 mm) particles oscillated in a wide range and accounted for 11.09 - 12.69% in the cross-section of layers, while fine dust particles (0.005 - 0.001 mm) accounted for 15.01 - 16.43% in the arable layer and 19.03 - 15.03% in the lower layers. , 31% were observed, and il particles were 13.87 - 13.8% and 15.0 - 9.22% in the above layers, respectively (Table 1).
According to Kh.M.Abdukadirov, this type of soil belongs to the type of typical gray soil, and comparing the results of the 2020 study with the mechanical composition data of 1963, it was observed that the amount of sand particles, the amount of dust and silt particles increased in all layers of the soil. The main reason for this is explained by the erosion of feldspar and mica-like substances in the sand particles over many years, the increase of dust and silt particles in the upper layers of the soil as a result of irrigation, and the fact that certain parts are washed to the lower layers of the soil (Table 1).

### *3.2. Irrigated light gray soils*

The soil cover of plot № 45 in "Ismat Sarkarda" farm, Zarafshan massif, Narpay district, Samarkand region is pale gray soils that have been irrigated for a long time. It developed on the third terrace of Zarafshan.
*Comparative analysis of the changes of the old irrigated pale gray soils distributed in the middle reaches of the Zarafshan River under the influence of irrigation and tillage.* According to the granulometric composition of these pale gray soils, it is mainly heavy sand, the amount of physical clay particles (<0.01 mm) in the driving layer is 47.04 - 47.64%, large dust particles (0.05 - 0.01 mm) 33.55-34.09%, and average dust particles (0.01-0.005 mm) are 12.21-18.99%.

**Table 2.** Changes in the mechanical composition of light gray soils, %

| Soil section | Layer. cm | Fractional amount [%] and particle size [mm] | | | | | | | physical mud. < 0,01 il | Names of soils according to their granulometric composition |
|---|---|---|---|---|---|---|---|---|---|---|
| | | sand | | | dust | | | il | | |
| | | >0,25 | 0,25-0,1 | 0,1-0,05 | 0,05-0,01 | 0,01-0,005 | 0,005-0,001 | <0,001 | | |
| Light gray soils (1963 y) | | | | | | | | | | |
| 238 | 0 – 20 | 2 | 7,3 | 16,7 | 39,6 | 9,7 | 13,1 | 11,6 | 34,4 | Medium sand |
| | 20 – 28 | 1,3 | 2,6 | 12,1 | 43,4 | 12,2 | 15,8 | 12,6 | 40,6 | Medium sand |
| | 28 – 52 | 1,7 | 4,2 | 14,9 | 45,3 | 10,8 | 12,4 | 10,7 | 33,9 | Medium sand |
| | 52 – 69 | 0,6 | 6 | 29,8 | 42,4 | 6,6 | 7,7 | 6,9 | 21,1 | Light sand |
| | 69 – 110 | 1,6 | 6 | 29,8 | 42,4 | 6,6 | 7,7 | 7,9 | 21,1 | Medium sand |
| Light gray soils (2020 y) | | | | | | | | | | |
| 7 | 0 – 24 | 1,13 | 3,09 | 15,19 | 33,55 | 12,21 | 19,69 | 15,14 | 47,04 | heavy sand |
| | 24 – 32 | 0,89 | 2,19 | 15,19 | 34,09 | 13,29 | 18,99 | 15,36 | 47,64 | heavy sand |
| | 32 – 55 | 1,29 | 2,39 | 15,39 | 35,27 | 12,49 | 18,59 | 14,58 | 45,66 | Medium sand |
| | 55 – 71 | 1,54 | 4,58 | 14,25 | 35,69 | 13,49 | 18,55 | 11,90 | 43,94 | Medium sand |
| | 71 – 110 | 1,62 | 6,59 | 26,09 | 38,49 | 7,23 | 11,89 | 8,09 | 27,21 | Light sand |

Fine dust particles (0.005 - 0.001 mm) make up 19.69 - 118.99%, and dust particles make up 15.14 - 15.36%, and it was observed that their amounts decrease as they go to the lower layers (Table 2). On the contrary, in physical sand, their amount increased in the lower layers compared to the driving layers. We believe that this is definitely related to its granulometric composition.
According to H.M. Abdukadirov (1963), light-colored gray soils in the arable layer have a medium-sandy mechanical composition, and the main part of the mechanical elements consists of small sand and large dust particles. By 2020, the impact of irrigation has changed from medium sand to heavy sand in the aquifer layer, which can be justified by the increase of medium and fine dust and silt particles due to irrigation with muddy waters of the Zarafshan River (Table 2).

### *3.3. Irrigated gray-meadow soils*

Sh.Rashidov Massif, Samarkand District, Samarkand Region, "Mastura Sakhovati" farm, contour № 217, the soil cover is old irrigated gray-meadow soils, the soil appeared on alluvial deposits, medium and heavy sand with mechanical composition is not saline. It developed on the terrace of Karafshan III.

*Comparative analysis of the changes of old irrigated gray-meadow soils distributed in the middle reaches of the Zarafshan River under the influence of irrigation and treatments.* According to the granulometric composition of these old irrigated gray-meadow soils, it is mainly medium and heavy sand, and the amount of physical clay (<0.01 mm) in the lower layers fluctuates between 49.57 - 50.62%, large dust (0.05 - 0 .01 mm) 23.19 – 26.19%, average dust particles (0.01 – 0.005 mm) in the section of layers make up 10.09 – 13.9 %, fine dust particles (0.005 – 0.001 mm) 19, 19 - 21.44%, and il particles - 16.09 - 16.19%, compared to the data of 1963, an increase in average, fine dust and il particles was observed in the plowed layers of the soil, while it was observed to decrease in the lower layers (Table 3).

**Table 3.** Changes in the granulometric composition of gray-meadow soils, %

| Soil section | Layer Cm | Fractional amount [%] and particle size [mm] | | | | | | | physical mud. < 0,01 il | Names of soils according to their granulometric composition |
|---|---|---|---|---|---|---|---|---|---|---|
| | | sand | | | dust | | | il | | |
| | | >0,25 | 0,25-0,1 | 0,1-0,05 | 0,05-0,01 | 0,01-0,005 | 0,005-0,001 | <0,001 | | |
| Gray-meadow soils (1963 y) | | | | | | | | | | |
| 231 | 0 – 18 | 4,9 | 1,2 | 22 | 27 | 12,6 | 20,8 | 11,5 | 44,9 | Medium sand |
| | 18 – 31 | 5 | 1,7 | 22,3 | 26,5 | 12,6 | 19,4 | 12,5 | 44,5 | Medium sand |
| | 31 – 70 | 5,3 | 1,8 | 23 | 28,1 | 11,8 | 18,4 | 10,6 | 40,8 | Medium sand |
| Gray-meadow soils (2020 y) | | | | | | | | | | |
| 2 | 0 – 20 | 3,2 | 0,8 | 19,19 | 26,19 | 13,09 | 21,44 | 16,09 | 50,62 | heavy sand |
| | 20 – 35 | 3,59 | 0,9 | 22,75 | 23,19 | 14,19 | 19,19 | 16,19 | 49,57 | heavy sand |
| | 35 – 70 | 5,09 | 1,12 | 23,09 | 28,09 | 10,9 | 19,01 | 12,7 | 44,61 | Medium sand |

### *3.4. Irrigated meadow-alluvial soils*

The lands of the Nurmon Abdullaev farm, M. Joraev massif, Ishtikhon district, Samarkand region are meadow-alluvial soils, and the soil cover of the farm, contour № 51 is meadow-alluvial soils that have been irrigated for a long time. It developed on the upper terrace of Zarafshan II.

*Comparative analysis of changes of old irrigated meadow-alluvial soils distributed in the middle reaches of the Zarafshan River under the influence of irrigation and tillage.* Meadow alluvial soils were formed in terraces I-II of the middle part of the Zarafshan river. The terraces are mainly plains, with some meso- and macro-relief views of the terrain. Soils are developed in bodies of sand and clay mechanical composition of alluvial deposits. At 1-2-2.5 meters depth there are seepage waters and at 3-4 meters there are gravels. As a result of long-term irrigation of soils with muddy water, agro-irrigation sediments accumulated in its upper part.

Therefore, one of the main morphological characteristics of these soils is the presence of an agro-irrigation thickness of 1 meter. Even at 80-100 cm, the color remains saturated. The quantity of some nutrients elements has also undergone changes. During the 60-year irrigation period, the continuous mechanical tillage of the soil has led to the reduction of some nutrients in the soil. The reason for this is mainly the leaching of these elements into seepage waters under the influence of irrigation water. According to the granulometric composition of these soils, it is mainly heavy sand, the amount of physical clay particles (<0.01 mm) in the arable layer is 52.1 - 53.3%, large dust (0.05 - 0.01 mm) is 28.5 - 27.3% is average dust (0.01-0.005 mm), 11.4-13.3%, fine dust (0.005-0.001 mm) 24.5%, and 14.3-15.5 in the plowed layer with fine particles. %, and it was found that their amount decreases in the lower layers (Table 4).

On the other hand, physical sand particles are the opposite, and their amount is less in the upper layers and increases towards the lower layers. These grassland alluvial soils are composed of heavy and medium sands, and the composition of the fraction is dominated by fine sand and large dust.

They make up 50-60% of the soil mass, and when the share of large dust reaches 30-35%, their amount decreases downwards. By now, the granulometric composition of old irrigated soils has become heavier. It can be seen that the medium sands are preserved as thin layers in the lower layers of the soil profile (Table 4).

**Table 4.** Changes in the granulometric composition of meadow-alluvial soils, %

| Soil section | Layer. Cm | Fractional amount [%] and particle size [mm] | | | | | | | physical mud. < 0,01 il | Names of soils according to their granulometric composition |
|---|---|---|---|---|---|---|---|---|---|---|
| | | sand | | | Dust | | | il | | |
| | | >0,25 | 0,25-0,1 | 0,1-0,05 | 0,05-0,01 | 0,01-0,005 | 0,005-0,001 | <0,001 | | |
| Meadow-alluvial soils (1963 y) | | | | | | | | | | |
| 382 | 0 – 17 | 3,8 | 3,6 | 14,3 | 32,1 | 11,9 | 21,2 | 13,1 | 46,2 | heavy sand |
| | 17 – 31 | 3,8 | 3,6 | 14,4 | 32,3 | 11,3 | 22,3 | 12,3 | 45,9 | heavy sand |
| | 31 – 76 | 4,9 | 2 | 22,6 | 31,4 | 11,5 | 16,1 | 11,5 | 39,1 | Medium sand |
| | 76 – 120 | 5,3 | 1,5 | 23 | 31,5 | 12,1 | 15,5 | 11,1 | 38,7 | Medium sand |
| Meadow-alluvial soils (2020 y) | | | | | | | | | | |
| 4 | 0 – 20 | 3,5 | 3,4 | 12,5 | 28,5 | 13,3 | 24,5 | 14,3 | 52,1 | heavy sand |
| | 20 – 35 | 3,6 | 3,5 | 12,3 | 27,3 | 13,3 | 24,5 | 15,5 | 53,3 | heavy sand |
| | 35 – 77 | 4,8 | 2 | 22,7 | 29 | 11,4 | 19,6 | 10,5 | 41,5 | Medium sand |
| | 77 – 120 | 5,3 | 1,6 | 23,1 | 29,1 | 11,4 | 18,4 | 11,1 | 40,9 | Medium sand |

## 4. Conclusions

According to the granulometric composition of all soil types (typical, light gray, gray-meadow and meadow-alluvial) located on terraces I - II - III of the Zarafshan oasis, it is mainly medium and heavy loam, physical clay (<0.01 mm) is large dust (0.05 – 0.01 mm), medium dust (0.01 – 0.005 mm), fine dust (0.005 – 0.001 mm) and silt particles have been reduced by irrigation for many years (60 years), dust and silt The amount of particles increased in all layers of the soil. The feldspar and mica-like elements in the sand particles are explained by the erosion and the increase of dust and silt particles in the upper layers of the soil as a result of irrigation, and certain parts are washed to the lower layers of the soil.

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