# Model and algorithm of creative approaches in determining the average value of soil quality points

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**Abstract.** The article describes the model and algorithm of creative approaches in determining the value of soil quality points concerning irrigated arable lands used in agriculture. Determining the natural productivity of agricultural lands on a scientific basis in the rational use of the land fund of Uzbekistan also requires qualitative assessment. According to the methods of land valuation, depending on the characteristics that determine soil fertility, is bonitation, namely the establishment of a comparative assessment. It plays an important role in the methodological justification of state land cadastre measures. The criterion of soil bonitation is its natural diagnostic and cultivating process, which affects the results of production. To do this, it will be necessary to conduct a scientifically based natural agricultural zoning, to develop a method of conducting their own land bonitation for large regions in order to apply it strictly within administrative boundaries. Productivity assessments are carried out taking into account the requirements for agricultural crops in a particular area. The identified productivity indicators can also be used to assess irrigated lands where all other crops (except rice and perennial fruit trees) are included in the cotton complex.

## 1 Introduction

Soil bonitation (quality assessment) is considered to be a comparative assessment of the quality of agricultural land on the basis of an equitable level of agricultural efficiency and agricultural productivity. It is known that the quality score is determined on the basis of objective characteristics of soils that are important for development [1–3]. The main purpose of bonitation is to show whether one soil type is better or worse than another in terms of relative and stable characteristics of the soil in terms of natural fertility. The amount of nutrients, which is a key factor in determining soil quality, is based on determining the value of their efficiency for crops, water, and heat regimes, and soil bonitation scores in irrigated areas [4]. These factors show the total reserves of mobile humus, nitrogen, phosphorus, and potassium at a one-meter depth of soil. The amount of humus and nutrients in the irrigated regions of Uzbekistan is inextricably linked with the genetic and mechanical

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composition of these soils, pebble soil formation, soil layer, thickness, structure, and other diagnostic features of the fine-grained layer. The amount of nutrients in irrigated soils is mainly determined by the period of irrigation and the degree of cultivation.

Land assessment takes into account the main characteristics and natural conditions of the soil: genetic characteristics, duration of the irrigation period, mechanical composition, the genesis of soil-forming rocks, groundwater permeability, salinity, erosion, stony and gypsum levels, and others [5–7].

Assessment is based on a closed scale of 100 points [8]. Soils with the best characteristics and highest yields are assigned 100 points. The quality score on the rating scale of irrigated soils is reflected in the quality score in relation to their genetic affiliation, irrigation period and level of cultivation. The scale also takes into account the soil humus reserves and plant nutrients, absorption capacity, physical characteristics and biological activity.

The characteristics of irrigated soils also change radically depending on the period of development. For instance, the oldest irrigated soils are basic soils, which are fertile in all respects. The bonitation scale of irrigated soils in Uzbekistan is divided into low, medium and high types of cultivation. The organic reserve and the lack of moving compounds of phosphorus indicate the slowness of the biological process, the low level of soil cultivation. Highly cultivated soils are formed mainly under the conditions of high agrotechnical, systemic use of high levels of mineral and organic fertilizers and, accordingly, a high level of nitrogen and phosphorus with mobile compounds, thus enriched in humus. To assess the climate in different regions of irrigated agriculture, it is possible to determine which group of cotton varieties are suitable according to the ripening periods, as well as the possible biological productivity of intermediate or repeated crops intended for grain or silage. Among the complex characteristics that determine soil fertility, its mechanical composition also plays an important role. Therefore, in the process of determining soil enrichment, reduction coefficients are applied on the mechanical composition of different soils. In the assessment of soil in the conditions of irrigated lands, it is important to take into account its salinity and reclamation conditions. Factors that reduce soil fertility include water and wind erosion. It is notable for its relief, in newly irrigated areas, on high slopes. Soil layers in these regions are mainly composed of loess and alluvial deposits.

## 2 Materials and methods

The calculation of the quality score of a particular soil in the irrigated area is determined by multiplying the correction coefficients corresponding to the score given to the soil type on its main characteristics, namely:

$$Б_к = Б_1 \cdot К_1 \cdot К_2 \cdot К_3 \cdots\cdots К_n \quad (1)$$

In this case,

$Б_1$ – the quality score of the soil on a basic scale;

$K_1 \cdot K_2 \cdot K_3 \cdots\cdots K_n$ – correction coefficients.

It is possible to calculate the quality score of the total irrigated lands on the farm, based on the quality score data of the soil type obtained separately. For this purpose, it is necessary to calculate the area of soil types according to the types of agricultural lands.

The irrigated area of a particular farm is defined as the average value of the bonitet points of the different soil types that make up the quality of the soil layer, namely:

$$Б_{х.к.} = \frac{Б_1 M_1 + Б_2 M_2 + ... + Б_n M_n}{M_1 + M_2 + ... + M_n} = \sum_{i=1}^{n} \frac{Б_i M_i}{M_i} \quad (2)$$

In this case,

$Б_1, Б_2, ... Б_n$ – quality score of soil varieties;

$M_1, M_2, ... M_n$ – areas occupied by these soils, hectares [1].

Depending on the nature of the content of this formula, starting from a part of a specific land contour, land plot, farm (or company farm, subsidiary farm, experimental farm, agrocluster, etc.), municipality, district can be determined at the republican and regional levels.

The following is an example of determining the average quality of irrigated lands of the farm specializing in cotton and grain “Kaytmas” in the territory of the farm (municipality) “Kaytmas”, Urta Chirchik district of Tashkent region (Figure 1).

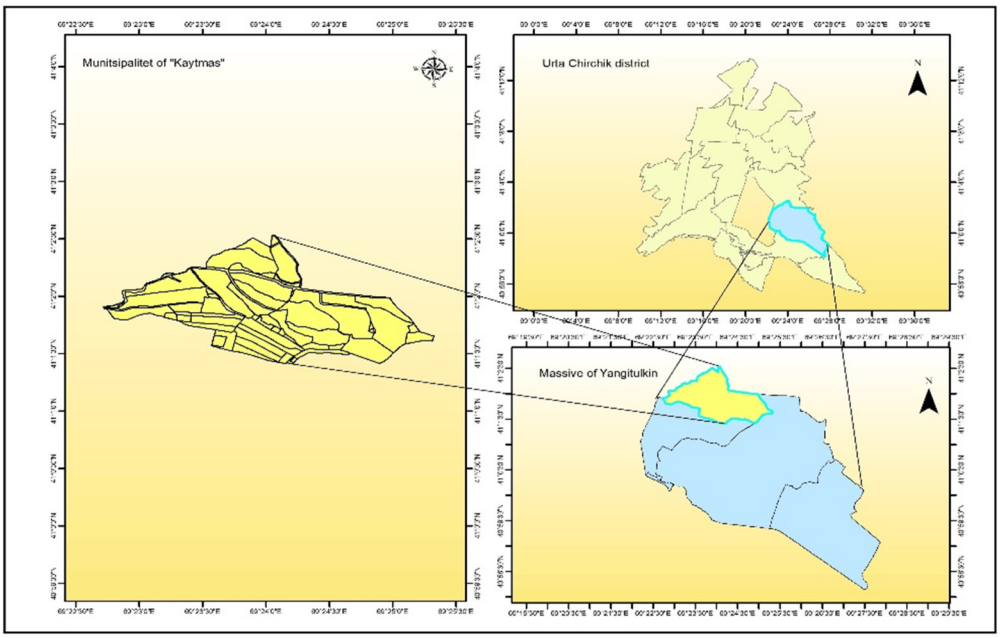


**Fig. 1.** Study area locality map.

For instance, 31.0 hectares of the farm with an area of 60.0 hectares were rated 72 points, 16.0 hectares 62 points, 13.0 hectares 46 points. In this case, the average quality of the farm is 64.0 points, namely:

$$Б_{farm} = \frac{Б_1 M_1 + Б_2 M_2 + \cdots + Б_n M_n}{M_1 + M_2 + \cdots + M_n} = \frac{(31.0 \times 72) + (16.0 \times 62) + (13.0 \times 46)}{(31.0 + 16.0 + 13.0)} = 63{,}7 \approx 64$$

## 3 Results and discussion

It is known that the land cadastre documents contain indicators of qualitative assessment of agricultural lands. Land cadastre documents mainly use the results of two types of work: natural soil fertility and normative assessment[9,10].

Thus, in the formation of land cadastre information we note the need to use the results of determining the indicators of natural fertility of agricultural land, namely bonitation scores. The irrigated crop area of a particular farm is determined using the second formula as the

average value of the bonitation scores of the different soil types that make up the soil layer.

Based on the formulas below, calculations were performed taking into account changes in bonitation scores of the soil. Using the second formula mentioned above, the value of the average soil quality is determined by the land contour, plot of land, farm (or company farm, subsidiary farm, experimental farm, agrocluster, etc.), municipality, district, region and can be determined at the republican and regional levels.

It is recommended to determine the soil score quality for a specific land contour using the following formula:

$$Б_{\text{land cont.(average)}} = \frac{Б_1М_1 + Б_2М_2 + \cdots + Б_nМ_n}{М_1 + М_2 + \cdots + М_n} \quad (3)$$

In this case, Б – the average soil quality score of the land contour;

$Б_{1...}Б_n$ – the soil quality score of the part of the land contour;

$М_{1...}М_n$ – the average soil quality score of the land contour, the crop areas belonging to a part of the land contour, hectares.

The average soil quality score at the farm plot level is determined using the following formula (4):

$$Б_{\text{plot of land.(average)}} = \frac{Б_1М_1 + \cdots + Б_nМ_n}{М_1 + \cdots + М_n} = \sum_{n=1}^{n} \frac{Б_nМ_n}{P_n} \quad (4)$$

In this case, $Б_{\text{plot of land.(average)}}$ – the average soil quality score for per plot of land;

$Б_{1...}Б_n$ – the average soil quality score for land contours;

$М_{1...}М_n$ – crop areas belonging to land contours, hectares.

According to the next formula, the average score of the score on the situation can be determined by (5), when the land plots of the farm are located in two or more areas is determined by the following formula.

$$Б_{farm\ (average)} = \frac{Б_1М_1 + Б_2М_2 + \cdots + Б_nМ_n}{М_1 + М_2 + \cdots + М_n} \quad (5)$$

In this case,

$Б_{\text{farm (average)}}$ – the average soil quality score on the farm;

$Б_{1...}Б_n$ – average soil quality score of land plots;

$М_{1...}М_n$ – arable land belonging to land plots, hectares.

Using equation (5), the average soil quality score for a particular municipality is determined using the following formula.

$$Б_{\text{municipality}\ (average)} = \frac{Б_1М_1 + Б_2М_2 + \cdots + Б_nМ_n}{М_1 + М_2 + \cdots + М_n} \quad (6)$$

In this case,

$Б_{\text{municipality(average)}}$ – the average soil quality score on the farm in the municipality;

$Б_{1...}Б_n$ – the average soil quality score on farms;

$М_{1...}М_n$ – arable land belonging to farms, hectares.

The average quality scores of irrigated lands in the administrative district can be determined using formula (7).

$$Б_{district\ (average\ )} = \frac{Б_1 М_{1(\text{municipality }\ )} + Б_2 М_{2(\text{municipality }\ )} + \cdots + Б_n М_{n(\text{municipality }\ )}}{М_{1(\text{municipality }\ )} + М_{2(\text{municipality }\ )} + \cdots + М_{n(\text{municipality }\ )}} \quad (7)$$

In this case,

Б $_{district(average)}$ – the average soil quality score on district;
$Б_{1...}Б_n$ – soil quality score of avanues or municipality;
$М_{1...}М_n$ – irrigated arable land belonging to avanues or municipalities, hectares.

Based on these formulas, it is possible to calculate the average quality scores using equation (8).

$$Б_{region\ (average\ )} = \frac{Б_1 М_1 + Б_2 М_2 + \cdots + Б_n М_n}{М_1 + М_2 + \cdots + М_n} \quad (8)$$

In this case,

Б $_{region(average)}$ – the average soil quality score on the region;
$Б_{1...}Б_n$ – the average soil quality score on districts;
$М_{1...}М_n$ – irrigated arable lands of districts, hectares.

## 4 Conclusions

On the basis of the proposed formulas on the example of the farm “Karasuv” located in the territory of the farm “Kaytmas” in Urta Chirchik district of Tashkent region, the following results are recorded in determining the average values of soil quality scores.

An average score of 61 points was determined for the crop areas of 5 contours on the territory of the farm. The average soil score of 4 farms operating on the farm “Kaytmas” is 59 points; The average soil quality score in Urta Chirchik district is 62 points, and in Tashkent region – 59 points. The average score on irrigated lands in the country is 56 points.

The final conclusion is that it is recommended to put into practice the proposed multi-purpose formulas for irrigated lands within a given area. Using quality scores on the area under cultivation, it serves to determine the average yield of crops, the level of soil fertility, the normative value of arable land and other economic indicators.The practical application of the chain and model of determining the average value of the soil score quality in the sequence of the proposed formulas makes it possible to obtain data over a specific area rapidly.

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