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DEVELOPMENT OF LAND SUITABILITY ANALYSES BY GIS TECHNOLOGIES FOR OPTIMAL PLACEMENT OF CROPS (AN EXAMPLE OF SURKHANDARYA REGION)

Z.J. Mamatkulov[1], V.W. Malgorzata[2]
[1] National Research University "TIIAME" (Tashkent), Uzbekistan
[2] Óbuda University Alba Regia Technical Faculty, Hungary

Abstract. *Quality indicators of agricultural land are of great importance for the production and processing of all types of agricultural products. Among the many features of land as a means of production, agro-ecological and social conditions, which can be finished by artificial means and not, have a high importance for the development of agricultural crops, including latitude, relief, soil layer, flora, hydrogeological and hydrographic conditions. Some of the main features of existing infrastructure are listed. In this study, suitability levels of irrigated land using GIStechnologies were developed in Surkhandarya region.*

Keywords: *ArcGIS pro-2.7, suitability modeler, raster, agro-ecological factor, crops, irrigated land.*

Introduction. It is necessary to take into account the natural, agro-ecological and socio-economic factors of each region in the organization of the optimal placement of crops. In order to achieve good development of crops and high productivity, it is necessary to determine the levels of comfort of land areas for crop types by conducting an analysis of factors affecting them. Based on them, it is possible to achieve the expected amount of agricultural production as a result of the placement of crop types [1, 2]. Development of suitability levels of arable land for crop types provides necessary information for optimal placement of crops and guarantees sustainable use of land resources [3]. Agro-ecological, economic and social factors play an important role in determining the suitability of land areas for crop types. While agroecological factors mainly explain the quality of soils, economic factors include demand and supply of agricultural products in the domestic and foreign markets, as well as costs and revenues [4]. Social factors are characterized by the availability of infrastructure, services and labor force necessary for the management of agriculture, especially for crop maintenance [5, 6].

Methodology. This study was carried out on the basis of the principle of determining the usability levels of land areas developed by FAO. In this case, the amenities of land areas are divided into 5 main levels: very convenient, convenient, more convenient, low convenience and uncomfortable (Table 1) [7, 8].

Table 1

Structure of the FAO land suitability classification

No	Suitable levels	Details of irrigated land
1	Highly suitable	Land area has no significant limiting factors.
2	Moderately suitable	The land area has favorable conditions, but there are several limiting factors or some necessary agrotechnical measures should be taken to achieve maximum productivity.
3	Marginally suitable	There are many limiting factors for land area and these in turn reduce productivity and income.
4	Currently not suitable	Areas of land that have fallen out of use or are difficult to use.
5	Permanently not suitable	Lands that cannot be used for cultivation at all.

A total of 12 agro-ecological and social factors were included in the study in developing the comfort levels of land areas for crop types, and their comfort levels were classified based on the scientific recommendations developed by scientists for the cotton crop, which is the main technical crop of our agriculture (table 2).

Table 2

Factors influencing irrigated lands and their asuitability levels

No	Factors	Кулайлик даражалари				
		Highly suitable	Moderate-ly suitable	Margi-nally suitable	Currently not suitable	Permanently not suitable
1.	Soil mechanical composition	Medium grainy	Heavy mechanical composition	Lightly creamy	Sand dunes	Stones
2.	Slope, degree	<2	2-3	3-5	5-7	>7
3.	Soil salinity, EC (dS/m)	0-2	2-4	4-8	8-16	>16
4.	Proximity to irrigation networks, km	< 1	1-3	3-5	5-10	>10
5.	Proximity to collector-drainage networks, km	< 1	1-2	2-3	3-5	>5
6.	Groundwater level, m	> 3	2-3	1.5-2	1 -1	<1
7.	Salinity of groundwater, g/l	> 0.5	0.5-1.5	1.5-3.0	3.0-8.0	>8.0
8.	Proximity to roads, km	< 1.0	1.0-2.0	2.0-4.0	4.0-5.0	> 5.0
9.	Proximity to residential areas, km	< 1,0	1.0-2.0	2.0-3.0	3.0-5.0	> 5.0
10.	Population density	Very dense	Dense	Medium dense	Scattered	Very scattered
11.	Average annual temperature, 0C	>18	15 - 18	12-15	9-12	< 9
12.	Average NDVI	1-0,8	0,8-0,6	0,6-0,3	0,3-0,1	0,1-(-1)

One of the main tasks of the research is to map the suitability levels of land areas for crop types based on the included factors, and this is a complex process in itself. The main reason for this is that, in this process, the classification of several factors according to comfort levels is assigned the task of representing them on a comfort map based on a single unit. Today, the geo-information system, one of the geo-innovative technologies, has high potential for multi-factor analysis and quick decision-making [9, 10].

In this scientific study, the suitability levels of cultivated land areas were determined using the "Suitability modeller" application of ArcGIS Pro 2.7 software, which belongs to the family of geoinformation system technologies.

Through an amenity modeling application, work can be divided into the following steps: data download, transformation, factor influence determination, and amenity mapping [11].

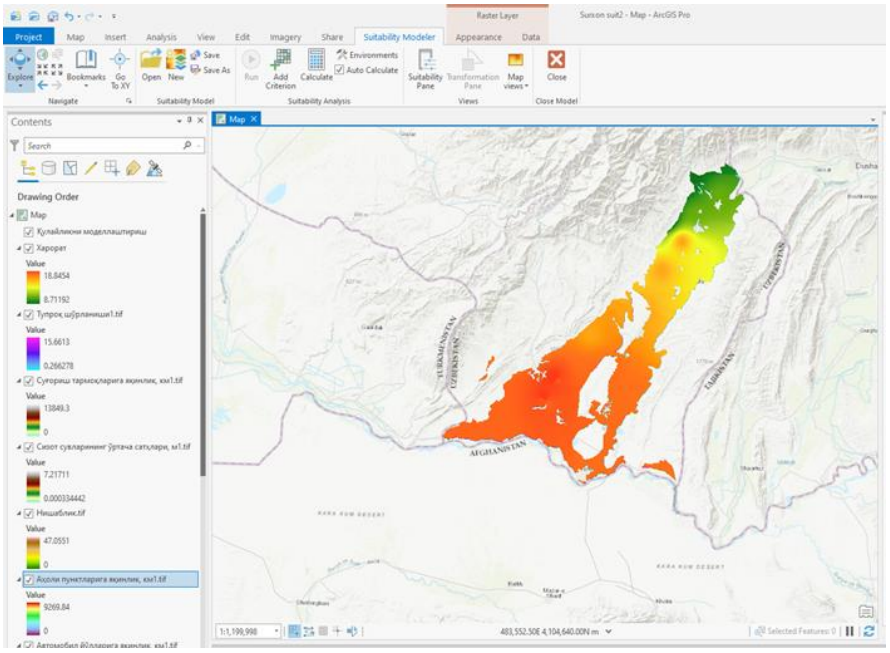

Figure 1. Determining accessibility levels of irrigated agricultural land based on ArcGIS Pro software

Data is loaded into the facility modeling application only in the form of raster data. Raster data developed on the basis of factor analysis are mainly classified or combined. In classified raster data, events and incidents are represented as separate areas. In this case, the indicators have boundaries between certain intervals and are in the form of separate demarcated areas. Coordinated raster data represents events and event metrics by color matching from top to bottom (Figure 1).

In convenience modeling, the stage of data transformation involves bringing raster data with various indicators and appearance into a single format and defining their functional tasks. At this stage, all the raster data of different indicators and appearance are limited in the range from 1 to 5, and 5 - Highly suitable, 4 - Moderately suitable, 3 - Marginally suitable, 2 - Currently not suitable and 1 - Permanently not suitable classification are logically represented (Fig. 2).

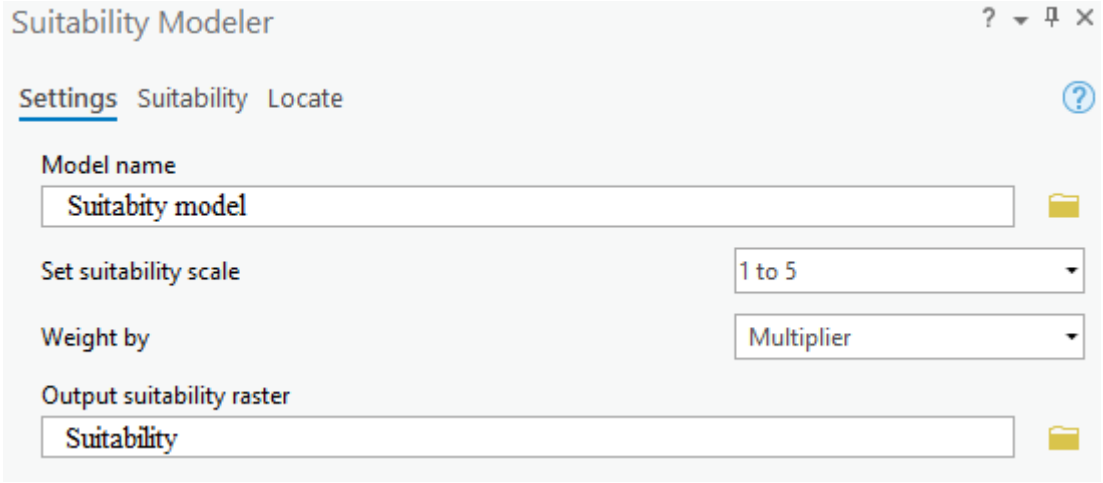

Figure 2. Raster data transformation

Determining the functional tasks of raster data serves to bring unstructured indicators into a single system. For example, the deeper the depth of groundwater is from the surface of the earth, the better the quality and fertility of the soil. On the contrary, the lower the mineralization of seepage water, the better the quality of the soil. This requires special functional approaches to raster data indicators. There are a total of 9 functional approaches in the ArcGIS Pro 2.7 program "Amenity Modeling", one of which is selected depending on the appearance and performance of the data represented in the raster (Figure 3).

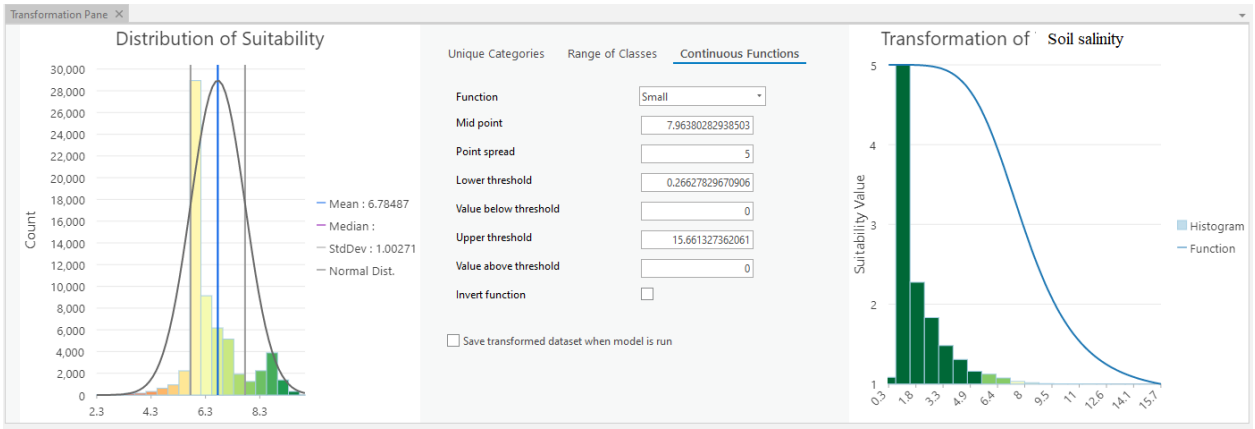

Figure 3. Determining the functional tasks of rasters representing factors affecting irrigated lands

Factor weighting is a key step in convenience modeling, as all agro-ecological and social factors taken into account may not have an equal impact on crop placement. In this case, the impact on the factors that have a direct impact on the development of crops was separated more (Table 3).

Table 3

Functional functions of the factors affecting the land areas

Factors (raster)	Functional tasks	Level of influence
Soil mechanical composition	Unique categories/Class	3.0
Slope, degree	Continues functions/Small	3.0
Soil salinity, EC (dS/m)	Continues functions/Small	3.0
Proximity to irrigation networks, km	Continues functions/Small	2.0
Proximity to collector-drainage networks, km	Continues functions/Small	2.0
Groundwater level, m	Continues functions/Large	2.5
Groundwater salinity g/l	Continues functions/Small	2.0
Proximity to roads, km	Continues functions/Small	1.5
Proximity to residential areas, km	Unique categories/Small	2.0
Population density	Unique categories/Large	1.5
Average annual temperature, ^{0}C	Unique categories/Large	2.0
Average NDVI	Unique categories/Large	3.0

Factors such as soil mechanical composition, soil salinity, seepage water level, slope and NDVI plant biomass were shown to be the main ones. Because today, it is considered as the main indicators in the work carried out in the assessment of the quality of the soil of the Republic of Uzbekistan (Figure 4).

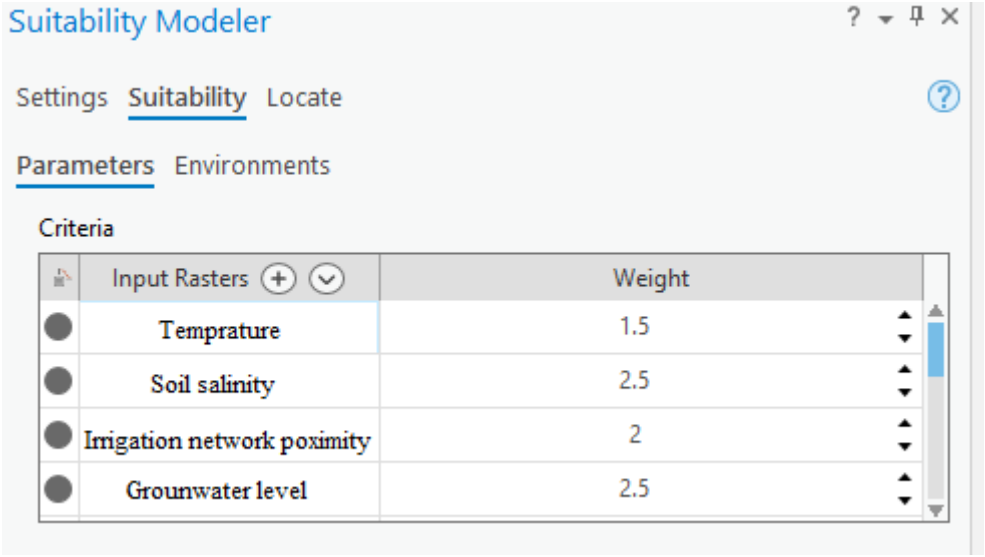

Figure 4. Determining the share of influence of factors

Results. In general, suitability modeling in ArcGIS Pro 2.7 is a non-linear, iterative process. Provides analytical feedback at each stage of the facility modeling process and allows seamless back and forth between each stage of model development. Suitability Modeler makes informed decisions about model parameter selection with instant feedback provided through interactions between graphs, panels and maps. Through the factors included in the model and the specified parameters, a final amenity map was created and the reliability of the information provided by the map was studied. In convenience modeling, each step of the modeling process can be scientifically validated by the user through the available interactive features of the application. As a result, it will be possible to make reliable decisions in the development of comfort levels of land areas.

Mapping and assessment of irrigated land suitability represents the distribution of amenity indicators of available land across the region (Figure 5).

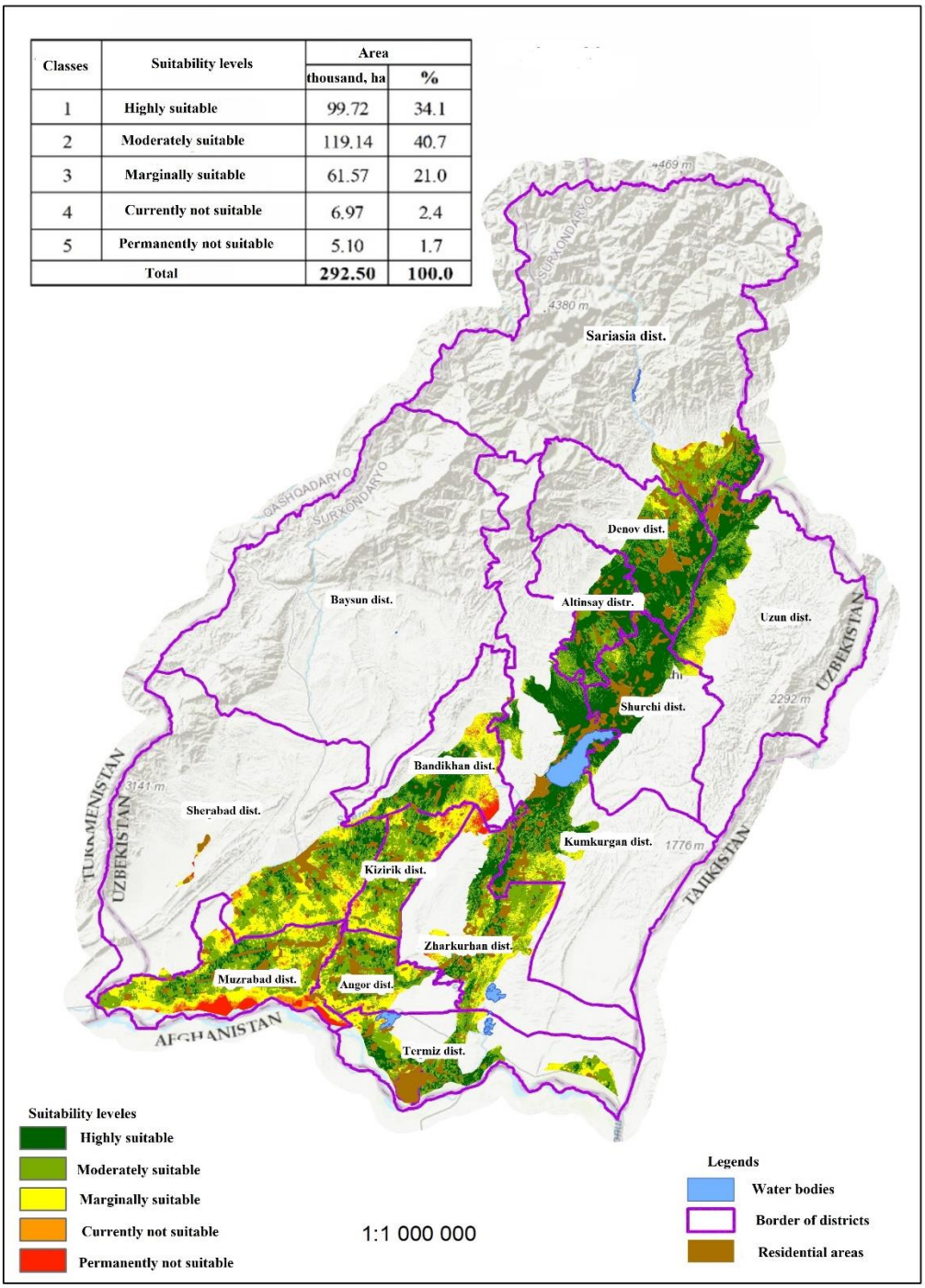

Figure 5. Map of land suitability levels for cotton cultivation of irrigated lands of Surkhandarya region

Discussion. The analysis shows that 34.1% of the irrigated land of Surhondarya region, i.e. 99.72 thousand ha, is very suitable for planting technical agricultural crops, 40.7% (119.14 thousand ha) is suitable, 21% (61.57 thousand ha) is moderately suitable, 2.4% (6.97 thousand ha)) - low favorable and 1.7% (5.1 thousand ha) - unfavorable areas.

Shorchi district is the district with the largest share of "very favorable" land area, and the land in this taifa is 79% of the district's irrigated land area, i.e. 15.6 thousand ha. Districts of Muzrobod (8.1%), Bandikhon (4.6%), Zharkurgan (2.1%), and Kyziriq (1.2%) are the districts with the largest share of "unfavorable" land areas in relation to the total land area.

In order to assess the accuracy of the developed comfort levels, a total of 28 massifs of Denov, Zharkurgan, Muzrobod, Sherabad and Kyziriq districts were selected and their correlation with the data of soil quality maps on a scale of 1:25,000 was analyzed. Correlative dependence was carried out based on the following correlation coefficient - r2 = 0.80, showed a positive result.

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РАЗРАБОТКА АНАЛИЗОВ ПРИГОДНОСТИ ЗЕМЕЛЬ ПО ГИС ТЕХНОЛОГИЯМ ДЛЯ ОПТИМАЛЬНОГО РАЗМЕЩЕНИЯ ПОСЕВОВ (ПРИМЕР СУРХАНДАРЬИНСКОЙ ОБЛАСТИ)

З.Дж. Маматкулов[1], В.В. Малгорзата[2]
[1] Национальный исследовательский университет «ТИИАМЕ» (Ташкент), Узбекистан
Технический факультет Университета Обуда Альба Реджиа, Венгрия

Аннотация. *Показатели качества земель сельскохозяйственного назначения имеют большое значение для производства и переработки всех видов сельскохозяйственной продукции. Среди множества особенностей земли как средства производства большое значение для развития сельскохозяйственных культур имеют агроэкологические и социальные условия, которые могут быть закончены искусственными средствами и нет, включая широту, рельеф, почвенный слой, флору, гидрогеологические и гидрографические условия. Перечислены некоторые основные особенности существующей инфраструктуры. В этом исследовании были разработаны уровни пригодности орошаемых земель с использованием ГИС-технологий в Сурхандарьинской области.*

Ключевые слова: *ArcGIS pro-2.7, моделист пригодности, растр, агроэкологический фактор, сельскохозяйственные культуры, орошаемые земли.*