Methods of Mathematical Modeling of Landscapes Use in Economic Development of Kokand Oasis

by

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Abstract

There are ways of using the landscapes and mathematical modeling of Kokand oasis in economic development. It also includes the determination of variation in oasis landscapes through interdependence and functional formulas and the distribution of parameters. It also provides methods for assessing landscape changes under the influence of anthropogenic factors, the Soh River as a key factor in the development of landscape types, and the use of mathematical modeling techniques for the efficient use of landscapes and optimization of landscape and environmental problems.

Key words: human, oasis, economy, optimization, anthropogenic factor, landscape, mathematics, modeling, type of location, component, correlation coefficient.

Introduction:

The Soh River is one of the key factors in the formation and development of Kokand oasis landscapes. Only 0.8% of this area is allocated for irrigated agriculture. The average annual air temperature in the oasis is 13-400 C and the precipitation is 98 mm. Due to the favorable natural conditions in the semi-desert, steppe and hill landscapes due to their geomorphological structure, the wide-scale development of people caused the spread of various types of landscapes.

Currently, there are no landscape types in the Kokand oasis, which do not directly or indirectly affect the economic activity of the people. As it is known, the scientist of landscape oasis KM Boymirzaev noted that "green areas surrounded by deserts, which are heavily assimilated by human activity, irrigation facilities and natural conditions are understood."

Table 1 Landscape and typological complexes of the Kokand oasis (2001)[1]

Type of place									
The tugai forests	**Plain terraces**	**Adyrs**	**The Adyr Plains**	**Plains**	**Eol sands**	**The salty deserts**	**Grassland swamps**	**Mountain valleys**	**Total**
703	602	87	671	513	852	154	79	67	3728
7.4	7.2	33.9	12.9	26.4	1.6	4.4	1.0	5.2	100

Note: 703 - Area of type of location (km2). 7.4 -% of area of area (%).

[1] Source: Author's own work

As can be seen from the table, the most common type of landscape in the Kokand oasis is the Eol sands. These landscape types are subject to strong anthropogenic effects. It is widely understood that the landscapes of the Kokand oasis have already undergone profound changes.

Also, the landscapes of the piedmont region are also characterized by the cultural features influenced by people's economic activities. Water from this area has been and is being developed and used both as pasture for grazing animals and for the cultivation and development of agricultural crops, including the creation of new settlements. The growing population of the region indicates that the impact on the landscapes will be even stronger in the future. In Kokand oasis, wetlands and mountain valleys are one of the smallest landscapes. The wetlands in the Oasis (2001) occupy an area of 79 km.kv. With each passing day, the direct influence of people on the landscapes is growing and new cultural landscapes are emerging.

Table 2 Landscape and typological complexes of the Kokand oasis (2005)[2]

Type of place										
The tugai forests	**Plain terraces**	**Adyrs**	**The Adyr Plains**	**Plains**	**Eol sands**	**The salty deserts**	**grassland swamps**	**The tugai forests**	**Newly mastered landscapes**	**Total**
608	309	64	670	439	900	143	74	56	3084	63 47
6.4	5.2	33.2	13.9	26.1	0.6	3.7	0.7	5.2	5	100

Note: 608 - area type area (km2). 6.4 -% of valley area (%).

Looking at the table, the newly developed landscapes with the impact of humans on all landscape types from 2001 to 2005 were 3084 sq. Km. made up the area. As a result of the development of the Adyr and piedmont plains, the area of the Adyr Plains decreased by 97 km.kv. Comparing the first and second tables, we can see that the area has shrunk by 293 square kilometers as a result of the extensive development of overland terraces from landscape types. Impacts on wetlands are insignificant.

Table 3 Landscape and typological complexes of Kokand oasis (2010)[3]

Type of place										
The tugai forests	**Plain terraces**	**Adyrs**	**The Adyr Plains**	**Plains**	**Eol sands**	**The salty deserts**	**grassland swamps**	**The tugai forests**	**Newly mastered landscapes**	**Total**
534	461	59	693	357	784	216	81	67	4569	7821
5.4	4.2	32.9	14.4	25.9	0.2	3.4	0.5	5.2	7.9	100

Note: 1537 - Area of type of location (km2). 5.4 -% of valley area (%).

[2] Source: Author's own work
[3] Source: Author's own work

Comparing 2005 and 2010, we can see that the impact on landscapes has accelerated over the past 4 years. This is because of the powerful influence of people on the nature of the oasis, while creating cultural landscapes, it also creates problems for the protection of landscape components.

It is well known that by affecting one or two components of the landscape, people affect the whole landscape, changing its dynamic composition and function and losing its balance. As a result, the following environmental events are observed in the oasis:

- The loss of natural vegetative cover and the emergence of cultural plants;
- man-made landscapes, rather than oasis landscapes;
- reduction of some species in the animal kingdom;
- the emergence of new cultural soils, saline soils and re-salinization;
- inadequate location of industrial enterprises and environmental pollution with their harmful emissions.

All the phenomena and processes in nature are inextricably intertwined. Changing one of them will cause the other to change. In particular, the activities of industrial enterprises will depend on agriculture, transport, etc., deforestation on mountain slopes will result in landscape change, increased soil erosion, local climate change, reduced water resources and plant species, and loss of animals.

The links between such processes are of two types:

1. Functional connection
2. Correlation linkage

If different values correspond to the values of one variable, such links are called correlation links. Also, temperatures in the 12^{00} are different every day. The relationship between landscapes can be determined by the correlation coefficient and calculated using the following formula:

$$r_{x_i y_i} = \frac{n \cdot \sum_{i=1}^{n} x_i y_i - \sum_{i=1}^{n} x_i \cdot \sum_{i=1}^{n} y_i}{\sqrt{(n\sum_{i=1}^{n} x_i^{\,2} - (\sum_{i=1}^{n} x_i)^2) \cdot (n\sum_{i=1}^{n} y_i^{\,2} - (\sum_{i=1}^{n} y_i)^2)}}$$

Of the valley landscape types, we first calculated the correlation coefficients between the tugai forests and the upland terraces.

— The tugai forests – X_i
— Plain terraces – Y_i

Table – 4 relationship between landscape types[4]

№	X_i	Y_i	X_i Y_i	X_i^2	Y_i^2
1	7.4	7.2	53.28	54.76	51.84
2	6.4	5.2	33.28	40.96	27.04
3	5.4	4.2	22.68	29.16	17.64
$\sum^{i}$	19.2	16.6	109.24	124.88	96.52

$$r_{x_i y_i} = \frac{3 \cdot 109,24 - 19,2 \cdot 16,6}{\sqrt{(3 \cdot 124,88 - 19,2^2) \cdot (3 \cdot 96,52 - 16,6^2)}} = \frac{327,72 \cdot 318,72}{\sqrt{6 \cdot 14}} = \frac{9}{\sqrt{84}} = \frac{9}{9,2} = 0,9782$$

When the correlation coefficient is 0.9 or greater, the bond strength is considered too high. According to him, we calculate the correlation coefficient between the upper tugai forests and the upland $r_{x_i y_i} = 0,9782$ terraces.

This shows that the connection between the tugai forests and the alpine terraces is quite high. In the same way, the correlation coefficients of all other landscape types were calculated.

Table 5 Correlation link between oasis landscape types[5]

No	Landscape types	The value of the correlation coefficient	The power of bonding
1	The tugai forests Plain terraces	0.9782	Too high
2	Plain terraces Grassland swamps	0.9583	-
3	Adyrs The Adyr Plains	0.9957	-
4	The Adyr Plains Plains	0.9957	-
5	Adyrs Plains	0.8888	High
6	Eol sands The salty deserts	0.9823	Too high

As can be seen from the table, the overlapping strength of the oasis landscape types is directly influenced by the effects of human behavior on one landscape type. We will now evaluate student relativity to determine how significant correlation coefficients are. Parameter estimation is calculated using the following formula:

[4] Source: Author's own work
[5] Source: Author's own work

$$t = \frac{r_i y_i \cdot \sqrt{n-2}}{1 - r_i^2 y_i}$$

Here, if T ≥ 3, the correlation coefficient is significant. We evaluate parameters for the first tugai forests and terracotta terraces. The value of the correlation coefficient between these two landscape types $r_{x_i y_i} = 0,9782$ га тенг. $n = 3$

$$t = \frac{0,9782 \cdot \sqrt{3-2}}{1-(0,9782)^2} = \frac{0,9782}{1-0,9568} = \frac{0,9782}{0,0432} = 22,6$$

$t = 22,6 > 3$ means that the correlation coefficient is significant when we estimate student allocation.

Table 6 Estimation of parameters by student distribution[6]

No	Landscape types	T_{true}	Level of materiality
1	The tugai forests Plain terraces	22.6	meaningful
2	Plain terraces Grassland swamps	11.7	-
3	Adyrs The Adyr Plains	11.5	-
4	The Adyr Plains Plains	11.5	-
5	Adyrs Plains	4.2	-
6	Eol sands The salty deserts	27.9	-

For mathematical modeling of landscapes, we make the connection between the landscapes y = ax + b. This equation is called a linear regression equation. Our main goal is to find and evaluate parameters a and b using mathematical methods.

From landscape types of oasis, we make forests and slopes terraces to y-axis.

- The tugai forests – X_k
- Surface terraces – Y_k

[6] Source: Author's own work

Table – 7 Relationship between landscape types of tugai forests and sheltered terraces[7]

№	X_k	Y_k	$X_k\ Y_k$	X_k^2
1	7.4	7.2	53.3	54.7
2	6.4	5.2	33.3	41
3	5.4	4.2	22.7	29.2
$\sum$ i	19.2	16.6	109.3	125

$$\begin{cases} a\sum_{k-i}^{n} x_k^{\,2} + b\sum_{k-i}^{n} x_k \cdot y_k \\ a\sum_{k-i}^{n} x_k + bn = \sum_{k-i}^{n} y_k \end{cases} \Rightarrow \begin{cases} 125a + 19b = 109 \\ 19a + 3b = 16,6 \end{cases}$$

$$\Delta = \begin{vmatrix} 125 & 19 \\ 19 & 3 \end{vmatrix} = 375 - 361 = 14$$

$$\Delta a = \begin{vmatrix} 109 & 19 \\ 16,6 & 3 \end{vmatrix} = 327 - 315,4 = 11,6$$

$$\Delta б = \begin{vmatrix} 125 & 109 \\ 19 & 16,6 \end{vmatrix} = 2075 - 2071 = 4$$

$$a = \frac{\Delta a}{\Delta} = \frac{11,6}{14} = 0,8$$

$$б = \frac{\Delta б}{\Delta} = \frac{4}{14} = 0,3$$

it means $y = 0,8x + 0,3$

Mathematical modeling of all the landscape types in the oasis was made in this way and converted to y = ax + b.

[7] Source: Author's own work

Table 8 Mathematical model of oasis landscape types[8]

№	Landscape types	The linear regression equation
1	The tugai forests Plain terraces	y = 0.8x + 0.3
2	Plain terraces Grassland swamps	y = 0.2x – 0.3
3	Adyrs The Adyr Plains	y = -0.4x + 12.8
4	The Adyr Plains Plains	y = -0.3x + 30.2
5	Adyrs Plains	y = -1.5x + 0.02
6	Eol sands The salty deserts	y = 0.5x + 3.5

Analysis:

The mathematical models of valley landscape types are analyzed as follows:

- Mathematical model of tugai and slopes has become y = 0.8x + 0.3. Its graph also shows that overgrown tugai terraces also grow, or vice versa, as the area of tugai forests decreases.
- Mathematical model of wetlands and wetlands In the graphical analysis of y = 0.2x - 0.3 the area of wetland terraces increases with x, so that the area of wetlands may increase or vice versa.
- Mathematical model of the Adyrian Plains and Alpine Plains y = -0.3x + 30.2. At the same time, as the area of the Adyr Plateau expands, the area of the piedmont plains becomes narrower.
- Mathematical model of adir plane and hill plain landscapes y = -1.5x + 0.02. In this case, the increase in the area of the hills will result in a decrease in the area of the adyr plains, or the development of the hill area, which will in turn lead to an increase and expansion of the area of the hills.
- Mathematical model of wind erosion sandy and saline desert landscape types y = 0.5x + 3.5. An increase in the sandy sands in the graph also results in an increase in saline deserts, and a decrease in saline deserts.

Conclusion:

In conclusion, it is advisable to use mathematical modeling techniques to assess landscape changes under the influence of anthropogenic factors, to effectively use landscapes and optimize landscape and environmental problems.

[8] Source: Author's own work

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