UDK: 528.9:631.587:504.5

SYSTEMATIC AND COMPLEX APPROACH TO MAPPING THE ECOLOGICAL STATE OF IRRIGATED LANDS

R.K. Oymatov – Head of the Department of "Geodesy and Geoinformatics", "TIIAME" NRU, PhD, Associate Professor, Tashkent, Uzbekistan.

Annotatsiya. Ushbu maqolada sug'oriladigan yerlarning ekologik holatini baholash va xaritaga olish joriy ekotizimlar barqarorligini ta'minlashda muhim ahamiyatga ega. Ushbu jarayonda tizimli va kompleks yondashuvni qo'llash orqali tabiiy-iqlimiy, gidrogeologik va antropogen omillarni hisobga olish imkoni tug'iladi. Mazkur tadqiqotda sug'oriladigan yerlarda yuz berayotgan degradatsiya jarayonlari, suv va tuproq resurslarining ifloslanish darajasi, sho'ralanish kabi muammolarni aniqlash va modellashtirishga e'tibor qaratilgan.

Abstract. This article discusses the importance of assessing and mapping the ecological state of irrigated lands in ensuring the sustainability of existing ecosystems. This process takes into account natural, climatic, hydrogeological and anthropogenic factors through a systemic and integrated approach. This work focuses on identifying and modeling such problems as degradation processes occurring on irrigated lands, the level of pollution of water and soil resources, and salinization.

Annotatsiya. В данной статье рассматривается важность оценки и картирования экологического состояния орошаемых земель в обеспечении устойчивости существующих экосистем. Этот процесс учитывает природные, климатические, гидрогеологические и антропогенные факторы посредством системного и комплексного подхода. Данная работа сосредоточена на выявлении и моделировании таких проблем, как деградационные процессы, происходящие на орошаемых землях, уровень загрязнения водных и почвенных ресурсов, засоление.

INTRODUCTION

The study of ecological problems in irrigated lands began with the study of factors affecting them, as evidenced by the practical results of many scientific and research works [20]. Scientists have used different terms, different indicators, different criteria and definitions for natural factors and "anthropogenic load" as the main indicators determining the ecological state. For example, Professor Yu.A. Israel, a member of the Russian Academy of Sciences, assessed the ecological balance in systems using the anthropogenic load standard, and noted that its increase would cause significant damage to the ecosystem in the area [1].

The Russian geographer and cartographer, professor A.G. Isachenko (1980) suggested that the state of a certain ecological stability is the reaction of geosystems to external influences. This approach was also reflected in the research work of Yu.V. Novikov and V.M. Podolsky (1994).

Another Russian scientist I.I. Mamay (1997) developed the concept of an ecological norm and recommendations for this norm. In his opinion, it was emphasized that when assessing an ecological norm, it is necessary to carry out a number of experiments in regions with different natural conditions, and it was stated that the collected data can be analyzed and, based on experiments, criteria for ecological indicators can be developed.

S.E. Mirskhulova (2001) understands anthropogenic impact as the sum of all impacts on landscapes. The amount of this load should be the permissible standard level, which was explained using mathematical models based on “trust theory”.

Thus, as above, various qualitative and quantitative indicators have been developed using criteria such as “ecological tension” by V.G. Zaikanov et al. (2000), “ecological potential” by B.I. Kochurov (1999), “ecological stress” by Yu. Odum (1986), “ecological situation” by A.A. Rafikov (1997), “ecological situation” by A. Rakhmatullaev (2016) [21].

When explaining or mapping the ecological problems of a certain space, there is a need for a modern “term” that combines and complements the above-mentioned close, synonymous terms, scientifically substantiates the interrelationship between them, and determines the ecological state of a certain area in the conditions of current climate change, expressing natural and anthropogenic factors. Considering this issue on the example of irrigated lands, we will explain them as follows:

“Ecological status” – the general ecological quality of soil, water, biota and agrosystems. It takes into account soil fertility, salinity, salinization, agrobiological conditions;

“Ecological situation” – the level of negative impact of irrigated lands on society and nature during the study period;

“Ecological stress” – the degree of violation of ecological standards in irrigated lands;

“Ecological stability” – the ability of irrigated lands to maintain their fertility even under external influences;

“Anthropogenic load” – indicates the level of environmental load on the land as a result of human impact (activity).

"The study of scientific works on the restoration of ecosystems, the consequences of ecological stress and their assessment, the integration of population, community, and landscape indicators to assess the impact of stress factors, risk-based water quality for ecological reserve in freshwater surface water resources, an integrated habitat assessment system for rapid biological evaluation of rivers and streams, the use of biological criteria to assess and classify urban water flows, and to develop improved landscape indicators. As a result of fieldwork, the term **"ecological status"** was introduced. Based on this, a scientific definition was developed, representing a multi-component, complex concept that expresses the overall ecological condition of the study area (including irrigated lands) under the influence of biophysical, chemical, biological, and anthropogenic factors, its level of ecological stability, and its capacity to maintain and restore ecosystem services".

"Ecological status" – a set of characteristics that influence the capacity of irrigated lands to support the appropriate natural flora and fauna, as well as their ability to provide various goods and services for human needs.

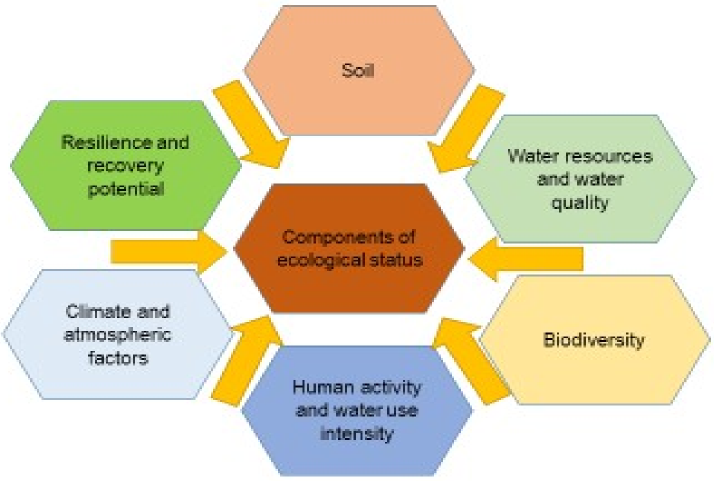
In order to provide a deeper and more detailed definition of the concept of **"ecological status",** we analyzed the meanings, key criteria, and interrelationships of other concepts used in ecological assessment of a territory — such as ecological condition, ecological situation, ecological vulnerability, ecological stability, and anthropogenic load (Table 1).

Table 1

Ecological concepts	**Definition Content**	**Main criteria**	**Dependence on other concepts**
Ecological state	General natural-agrobiological condition of the land	Soil, water, biocenoses	Changes through stability, tension, load
Ecological situation	Current problems and conditions	Pollution, water scarcity, salinity	Related to tension and load
Ecological stress	Level of risk, extent of degradation	Balance disturbance, recovery capacity	Inversely related to stability
Ecological sustainability	Resilience and recovery potential	Biological, agrotechnical, hydrological priority	Inversely related to load and tension
Anthropogenic load	Human-induced pressure	Fertilizers, pesticides, agro-intensity	Affects all other concepts

Ecological status	Final integrated ecological assessment	Status + situation + tension + stability	Includes all concepts

Thus, it can be seen from the table that, as we noted above, by adopting the concept of "ecological status" to encompass the general ecological state of irrigated lands under the influence of chemical, biological and anthropogenic factors, we will be able to obtain a multi-component complex result that reflects all



the remaining indicators. The main components of ecological status are natural and anthropogenic factors that are important in determining the ecological state of a land area and assessing its sustainability (Figure 1). These components are: soil, water resources and their quality, biodiversity, human activity and land use intensity, climatic factors, sustainability and recovery potential.

Figure 1. Main components determining the ecological status of irrigated lands

Based on the above, the following second definition can be given to irrigated lands in terms of the interconnectedness of a complex system consisting of soil, water, biota, human activity and climate factors:

Ecological status is a set of natural, biological and anthropogenic factors that affect the ability of irrigated lands to support native plant and animal species, as well as to provide ecologically sustainable goods and services for human needs.

Assessment based on ecological status in the study areas, as noted above, should include large-scale field and office work, data analysis, assessment methods, GIS and remote sensing technologies, software, visualization of geodatabases, integration of ecological and cartographic data (web maps, online platforms). In the future, research in this area is considered important for the fields of sustainable land resource management, land reclamation, agroecology and environmental security.

In the future, it is advisable to carry out the following research work to determine the ecological status of territories (irrigated lands):

1. Improving the indicators for assessing ecological status based on time and space - developing a set of biophysical and anthropogenic indicators adapted for different natural and climatic conditions. Automation of assessment methods (for example, scoring and scale assessment methods);

2. Reviewing and adapting the capabilities of GIS and remote sensing technologies for obtaining, processing, visualizing, developing thematic maps based on the indicators for assessing ecological status, as well as for monitoring purposes;

3. Analyzing the relationship between the potential of ecological services and ecological status;

4. Modeling the impact of anthropogenic loads on ecological status

5. Developing ecostrategic clusters for irrigated lands - involves developing strategies for land users based on ecological status.

Method and data

One of the scientific principles of the direction being developed in the field of mapping is an integrated approach, according to which, first of all, deviations from the norm of natural changes (climate change, groundwater levels, air temperature, etc.), as well as an increase in anthropogenic impact (in terms of types and levels of pollution), lead to changes in the ecological state of irrigated lands. In this case, each element, phenomenon and process related to nature, economy and man is considered as part of a certain natural-economic complex. Man is at the center of this process [5, 6, 7, 11, 15, 19,].

The principle of an integrated approach can be considered in various aspects:

a) each map (the natural, economic or population element reflected on it) is considered as part of a natural-economic complex;

b) several combined elements should be depicted in a complex map in an interconnected manner;

c) complex maps should be mutually consistent in content [60].

Another important scientific approach to the development and creation of ecological maps is the systematic approach. This approach involves the study of each component of the ecological state of irrigated lands as a part and the study of the integrity consisting of various, but interconnected components, phenomena and processes [2, 14, 16].

The main characteristics of the ecological assessment of irrigated lands are: multicomponent, highly organized, multidimensional, and the mobility of the main parameters [9, 10, 12, 13]. Therefore, the principles of integrated mapping methodology are logically related to the synthetic approach.

To study complex component systems using the mapping method, it is necessary to take into account the territorial aspect and principles of dividing systems into more fractional taxonomic categories and levels. In addition, when mapping complex systems, they resort to their meaningful division in various ways.

The principle of systematicity in mapping practice can be considered in different directions:

a) when developing a system of conditional symbols;

b) when compiling complex maps and atlases;

c) when developing synthetic maps of various contents, etc. [18].

One of the specific approaches to differentiating the ecological state of irrigated lands is zoning, in which integral sections with a certain composition of components, properties and their connections are identified. When dividing into territories, various criteria can be set for determining the boundaries: republic, regions, districts, contours, etc.

Another method of dividing the ecological state of irrigated lands into parts for mapping is mapping by components [17]. In this case, traditionally, analytical maps are compiled according to individual components of nature, natural-territorial complexes (NTCs) or assessment criteria. The subordination of the categories identified when compiling the map is provided for in map legends - systems of conditional symbols.

Based on the principles of a systematic approach, mapping involves modeling the content, dynamics and changes in the ecological state at different levels. The problems of systematic mapping also include the organization of a system for selecting, processing and storing primary information.

The use of a systematic approach should be present in the organization of various types of research, including the use of remote sensing materials, as well as in the rational sequence of technological processes, including the preparation of electronic versions of thematic ecological maps [17].

Results

Major figures in the field of cartography K.A. Salishev, I.P. Zarutskaya, A.M. Berlyant considered a systematic approach to mapping as the main scientific principles.

K.A. Salishev [18] proposed to understand systematic mapping as the creation of maps based on a systematic approach to both the phenomena being depicted and the implementation of the mapping itself.

A.M. Berlyant [3] considers thematic maps and atlases as “ecosystem models, when a series of analytical maps appear as models of the components of geosystems, analytical maps as models of their interaction, and dynamic and predictive maps as ecosystem models that model the functioning and development of geosystems.”

Berlyant A.M. [4] distinguishes several types of systems: material systems, systems-theories, and systems-methods. He describes these systems as follows:

a) systematic map creation - a set of interconnected and complementary scientific and technical tools, methods and algorithms for developing maps in the field and laboratory, as well as human society as a geographical environment;

b) systematic use of maps - a set of interconnected and interacting scientific and technical methods, principles and algorithms for analyzing maps in order to understand the geosystems depicted on them;

c) theoretical-cartographic systems - theoretical concepts for creating and using coordinated maps;

g) technical cartographic systems - a set of devices, hardware and software that interact in the process of collecting, storing, processing, distributing and analyzing cartographic works;

d) technological cartographic systems - a set of technological processes performed according to a given plan or program for creating, modifying and using cartographic products;

e) information (information-retrieval) cartographic systems - a set of programming languages, software and technical tools for storing, searching and providing cartographic and aerospace data on request.

Conclusion:

It is proposed to combine the above-mentioned cartographic systems into two groups:

a) a scientific and cognitive system (subsystem), which includes systems of creation, use and a theoretical and cartographic system;

b) a production-technical system (subsystem), which combines technical, technological and information components. The main task of the latter is to ensure the logistics of creating and using maps.

As a final conclusion, systematic mapping is a holistic set of theories, methods, technical and software tools that are part of scientific-cognitive and production-technical systems.

References:

1. Экология и контроль состояния природной среды [Текст] / Ю. А. Израэль. — 2-е изд., доп. — Москва: Гидрометеоиздат, 1984. — 560 с.

2. Асланикашвили А.Ф. Метакартография. Основные проблемы. - Тбилиси, 1974. -126 с.

3. Берлянт А.М. Картографическое моделирование и системный анализ //Пути развития картографии. - М.: Изд-во Моск. ун-та, 1975. - С. 98-106.

4. Берлянт А.М. Теоретические проблемы картографии. - М.: 1993. - 116 с.

5. Геофафическая картофафия и ее роль в реализации комплексных профамм (А.П.Золовский, К.А.Салищев, Л.Е.Смирнов) // Научно-практические задачи советской геофафии. - Л., 1985. - С.66-79.

6. Картографирование по космическим снимкам и охрана окружающей среды/ Востокова Е.А., Шевченко Л.А., Сущеня В.А. и др. - М.: Недра, 1982. -251 с.

7. Пересадько В.А. Состояние и перспективы эколого-географического картографирования // Эколого-географическое картографирование и оптимизация природопользования в Сибири. - Иркутск, 1989. - Вып. 2.

8. Заруцкая И.П., Красильникова Н.В. Картографирование природных условий и ресурсов. - М.: Недра, 1988. - 299 с.

9. Картографические исследования природопользования / Руденко Л.Г., Пархоменко Г.О., Молочко А.Н. и др. - Киев: Наукова думка, 1991,

10. Конусова Г.И., Ромашова Л.А. Принципы формирования системы гигиенического картографирования //Научно-технический сборник по геодезии, аэрокосмическим съемкам и картографии. - М.: ЦНГШГАиК, 1994. - С. 97-104.

11. Исаченко Г.А, Отечественное экологическое картографирование: первые РГО. - 1992. - Вып. 5.

12. Смирнов Л.Е. Генерализация при аэрокосмическом картографировании //Вестник Ленинградского ун-та. География. - 1982. - № 12. - С. 60-70.

13. Сочава В.Б. Введение в учение о геосистемах. - Новосибирск: Наука, 1978. -320 с.

14. Экологическое картографирование Сибири /В.В. Воробьев, А.Р. Батуев, А.В. Белов и др. - Новосибирск: Наука. Сибирская издательская фирма РАН, 1996. -279 с.

15. Комплексное экологическое картографирование / Под ред. Н.С. Касимова. - М.: Изд-во Моск. Ун-та, 1997. - 147 с.

16. Эколого-географическое картографирование и районирование Сибири. - Новосибирск: Наука, 1990. - 196 с.

17. Пластинин Л.А. Региональная серия экологических карт - современная база данных ГИС Байкальского региона. Интеркарто-3: ГИС для устойчивого развития окружающей среды. - Новосибирск: Сибгеоинформ, 1997. -С. 60-64.

18. Салищев К.А. Идеи и теоретические проблемы картографии 80-х годов // Итоги науки и техники/ ВР1НИТИ. - 1982. - Сер.картогр. т. 10.

19. Корытный Л.М. О классификации экологических карт // Актуальные экологические проблемы Республики Татарстан. - Казань, 1995.
20. Р.Ойматов, Э.Сафаров. Геоэкологик харитага олиш. Ўқув қўлланма. 2024
21. Рахматуллаев А.Р. Ўрта ва Қуйи Зарафшон воҳа геосистемаларида экологик вазиятни оптималлаштиришнинг географик асослари. – г.ф.д. дисс. –Т.:, 2016. – 220 б.