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Towards Sustainable Pasture Agrolandscapes: A Landscape-Ecological-Indicative Approach to Environmental Audits and Impact Assessments

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Abstract: Reliable environmental audits and impact assessments are essential to achieve effective pasture utilization and ensure the production of high-quality livestock products. This study aims to develop an environmental audit and impact assessment method for pasture agrolandscapes to promote sustainable livestock practices, using Central Kazakhstan as a case study. To provide a strong foundation for this research, the study utilized representations of pasture agrolandscapes, landscape-ecological and landscape-indicative approaches, and interactions between environmental audits and impact assessments in Kazakhstan. The authors acknowledge that their understanding of the environmental audit and impact assessment for pasture agrolandscapes is a complex method that requires specific knowledge and information about the landscape environment from users. They note that solving the challenges of national food security and environmentally safe territorial development can be achieved through the development of a private method that uses landscape environment status indicators. Methods similar to this enable the study of geocomplexes and their crucial characteristics, leading to a unique system of reliable indicators for environmental issues. This approach facilitates the creation of a scientifically based plan for optimal regional land use and land management systems regarding pasture agrolandscapes.

Keywords: environmental audit; impact assessment; pasture agrolandscapes; sustainable livestock practices; landscape-ecological approach; landscape-indicative approach; central Kazakhstan; geocomplexes

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1. Introduction

The World Community agreed on a long-term paradigm in the field of global development and balanced environmental management based on the 17 sustainable development goals, which impose certain obligations on individual countries when they choose models of economic use for specific territories [1,2]. In the framework of the 70th United Nations (UN) General Assembly at the UN Summit on adoption of Agenda for the period after 2015, former President of Kazakhstan Nursultan Nazarbayev signed this document together with other leaders of UN member states in September 2015 and noted the full consistency of the sustainable development goals with the state priorities of the Republic of Kazakhstan. The efficient and environmentally safe use of pasture agro (agricultural landscapes) for the production of livestock products, as one of the components of the country's food security, is of particular importance [3–6]. Agrolandscapes represent a crucial and distinct area of intersection where the interests of various stakeholders converge, particularly in terms of two primary aspects [7–9]: (a) maximizing the efficient and comprehensive utilization of pasturelands and (b) ensuring the consistent production of superior quality livestock products. However, accomplishing these objectives can prove to be challenging without access to dependable techniques for conducting environmental audits and impact assessments. Therefore, the development and implementation of such methods are essential for effectively managing agrolandscapes and promoting sustainable livestock practices.

Exploitation of pasture agrolandscapes for monofunctional land use only in livestock grazing is challenging because different types of land use overlap within their limits [10,11]. Pasture agrolandscapes are complex and dynamic systems that involve the interaction of various components, such as soil, vegetation, climate, and land use [12]. These landscapes are crucial not only for the production of high-quality livestock products but also for maintaining environmental health and providing ecosystem services [13]. However, due to the overlapping of different types of land use within the limits of pasture agrolandscapes, achieving monofunctional land use only in livestock grazing is difficult [14]. The coexistence of multiple land uses, such as crop cultivation, forestry, and wildlife habitat, can result in conflicts among stakeholders and lead to the degradation of the ecosystem [15]. To address this issue, a holistic and integrated approach is required that considers the various ecological, economic, and social factors involved in the management of pasture agrolandscapes [16]. This approach should incorporate sustainable land use practices that balance the different land uses, promote biodiversity, and enhance the resilience of the ecosystem to environmental stresses [17]. Additionally, it is essential to develop reliable methods for environmental audits and impact assessments to monitor the ecological health and productivity of pasture agrolandscapes and ensure the sustainable use of these valuable resources.

Among Kazakhstan's pasture agrolandscapes, there is the widest range of anthropogenic sources with environmental impacts, some of which are quite dangerous from an environmental point of view [18]. A particularly challenging situation has arisen in the southern part of the Karaganda region of Kazakhstan due to its unique natural and economic features. The territory is characterized by natural landscapes of Betpakdala stratum plains and structurally dissected plateaus, as well as Saryarka denudated, elevated, wavy plains, and hills (Kazakhskiy Melkosopochnik) of semidesert and desert types. There is no permanent hydrologic network, no permanent settlements, and areas where booster stages from Baikonur Cosmodrome fall. Additionally, oil and gas fields are being developed locally, among other activities. The situation is further complicated by the peculiarities of territorial development, which include the high vulnerability of natural landscapes to anthropogenic impact, concentration of production in limited areas against the backdrop of low overall development of the territory, incomplete cycles of using natural resources with high losses, use of environmentally hazardous methods of land development in conditions of low technical equipment of nature users, poor development of planned transport infrastructure, and others.

In recent years, there has been a growing recognition of the importance of sustainable land use practices in agricultural landscapes. However, the lack of an appropriate methodology for environmental auditing and impact evaluation has hindered the implementation of sustainable land use practices. Therefore, this paper proposes a framework for such a methodology that aims to optimize land use and improve the efficiency of land environmental management. The proposed methodology includes three main components: landscape analysis, environmental impact assessment, and the creation of schemes for the stages of ecological degradation. Through these components, the proposed methodology provides a comprehensive understanding of the ecological health status of the landscape and offers valuable recommendations for its sustainable management. This framework has the potential to contribute to the development of sustainable land use practices in agricultural landscapes and can serve as a guide for future research in this field.

2. Theoretical Background

When providing the theoretical basis for the study, the main attention was given to (a) pasture agrolandscapes as the primary resource base for sustainable livestock production; (b) representations of landscape-ecological and landscape-indicative approaches, which are well described in modern domestic scientific literature and less detailed in foreign literature; and (c) the problem of interaction between environmental audit and environmental assessment from a methodological point of view, which is perceived ambiguously in both the scientific and practical fields.

2.1. Pasture Agrolandscapes

Agrolandscape is a natural-territorial complex that, as a whole, preserves the natural regime of the dynamics in all processes, although it has been modified by economic measures to create highly productive agrobiocenoses [19–24]. Pasture agrolandscapes are formed for grazing or haymaking. Their characteristic and most important feature is the constant vegetation cover and certain phytocenotic parameters that are regulated by humans [16,25–27]. Spatial structure optimization of pasture agrolandscapes implies a certain ratio of grassy, forest protected and other geocomplexes, which are correctly placed from the viewpoint of landscape ecology [28]. Among the technological methods, the regulation of surface runoff [29], crop rotations [30], methods of crop cultivation [31], special methods of tillage [32], increased soil infiltration [33], fertilizers [34], equipment and terms for their application, land reclamation and others can be used. It is necessary to carry out measures for improving the soil fertility of pastures, which are focused on the humus state, water-air and water-physical property regimes, acid-base properties and many others [35].

Agrolandscape is a natural-territorial complex that, as a whole, preserves the natural regime of dynamics in all processes, although it has been modified by economic measures to create highly productive agrobiocenoses [19,20]. Pasture agrolandscapes are formed for grazing or haymaking. Their characteristic and most important feature is the constant vegetation cover and specific phytocenotic parameters that are regulated by humans [16,25–27]. Spatial structure optimization of pasture agrolandscapes implies a certain ratio of grassy, forest-protected, and other geocomplexes, which are correctly placed from the viewpoint of landscape ecology [28]. Among the technological methods, the regulation of surface runoff [29], crop rotations [30], methods of crop cultivation [31], special methods of tillage [32], increased soil infiltration [33], fertilizers [34], equipment, and terms for their application, land reclamation, and others can be used. It is necessary to carry out measures to improve the soil fertility of pastures, which focus on the humus state, water-air and water-physical property regimes, acid-base properties, and many others [35].

2.2. Landscape-Ecological and Landscape-Indicative Approaches

The landscape environment is the shell of the Earth, encompassing natural, natural-anthropogenic, and anthropogenic territorial landscapes (geocomplexes) with all their interrelationships and possessing several special properties [36–38]. One such property is the landscape-ecological state, which is an integral characteristic of the anthropogenic impact effects on geocomplexes based on an assessment of the degree of equilibrium for internal properties (including individual components) and information about the conditions of ecological existence [39–43].

The use of the landscape as a tool for environmentally safe territorial development is a multidisciplinary direction in modern geography that employs various measures to determine optimal control mechanisms for specific landscape parameters. For successful agricultural production, it is essential to allocate territories with distinct quality properties [44,45]. Landscape-indicative typification divides a territory based on the principle of uniformity for landscape-indicative parameters or ecological state, as well as the nature of economic use [46]. Special landscape-ecological zoning is required to regulate the diversity of natural conditions and ecological states of pasture areas [43,47–50]. This zoning involves the optimal placement of different pasture types on a regional scale (macrozoning), administrative districts (mesozoning), and cattle-breeding farms (microzoning). The fundamental principles of zoning include an integrated approach to analyzing all landscape-ecological factors related to agricultural production, optimal and differentiated land use, and the appropriate selection of cultivated plant species, taking into account the current ecological state of geocomplexes. Additionally, it includes the separation of landscape-ecological complexes according to the degree of ecological destabilization risk, typification of geocomplexes for managing anthropogenic load, and the value of geocomplexes from the perspective of social demand for the quantity of livestock products for the population [51–53]. An essential component of landscape-ecological zoning is the landscape-ecological skeleton, which serves as the basis for integrating diverse approaches for creating landscape and environmentally balanced models of pasture land use and management forms [6,54]. Finally, a separate economic regime is determined for each geocomplex based on its role in maintaining environmental sustainability [55–57].

2.3. Interaction between the Environmental Audit and Impact Assessment in Kazakhstan

An environmental audit is an independent assessment of compliance with regulatory requirements in the field of environmental protection, which includes the preparation of special recommendation sets for environmental activities [58]. The concept of modern environmental auditing originated in the early 1980s. In 1982, the European Economic Cooperation Directive on environmental auditing was adopted, and in 1984, the US National Environmental Protection Agency developed the concept of environmental auditing for federal agencies. Since 1993, sovereign Kazakhstan has utilized environmental audits, which are categorized as either obligatory or initiative audits. In the field of pasture livestock farming, the following types of audits are commonly employed: identifying environmental problems and proposing measures to solve them; determining the rationality of environmental management in a specific territory; verifying economic activity compliance with environmental requirements for each category of land; assessing the environmental safety of the methods and technologies used in business activities; assessing the environmental risk resulting from natural and human-made processes; evaluating the damage caused by pollution and hazardous waste; assessing the effectiveness of the environmental management system; and justifying legal acts from the standpoint of environmental safety [59,60].

Special terminology has been developed in English due to the peculiarities of the formation of environmental assessment mechanisms, and it continues to evolve with the development of practice. The United States Federal Law in the sphere of the National Environmental Policy Act (NEPA) introduced a formal system for assessing the impact of planned activities on the environment for the first time [61,62]. Initially, the assessment process according to NEPA was referred to as the NEPA process. Later, it was given the name Environmental Impact Analysis and was eventually changed to Environmental Impact Assessment (EIA). EIA became the main term in the late 1970s, indicating a systematic process of analyzing the potential environmental consequences of planned activities and considering their results in the decision-making process. In the 1980s, interest in analyzing potential environmental consequences increased not only for projects involving the construction of economic facilities but also for strategic decisions, such as plans for territorial and sectoral development, integrated programs, strategies, and regulatory acts. The environmental impact analysis of strategic decisions is known as a strategic environmental assessment (SEA). With the development of this tool, the meaning of the term "EIA" has transformed towards assessing projects concerning specific economic objects. Over the past 20–30 years, the term "environmental assessment (EA)" has become more widespread, encompassing project-level EIA and strategic environmental assessment (SEA) [63–67].

The conceptual basics described above are characteristic of the international scientific community and international documents such as conventions and agreements. However, the system of terms used in different countries may vary, and the same terms may refer to fundamentally different concepts or similar concepts in different ways. Translating these terms into other languages can also pose additional difficulties. To address terminological and methodological problems at the national level, Kazakhstan has adopted several legal acts in the field of environmental auditing and economic activity impact assessment over the years. The Governmental Decree of the Republic of Kazakhstan dated 23 August 2004, No. 889, "On certain issues of licensing and environmental auditing," was developed for environmental auditing, while a document titled "On approval of the instructions for conducting the assessment of planned economic and other activity impacts on the environment in frameworks of preplanning, preproject and project documentation development" (Order of the Minister of Environment Protection of the Republic of Kazakhstan, No. 68-P, 28 February 2004, registered in the Ministry of Justice of Kazakhstan on 31 March 2004, No. 2769) was prepared for the assessment of economic activities' impacts on the environment. All the essential state documents were later consolidated into the "Environmental Code of the Republic of Kazakhstan" (Code of the Republic of Kazakhstan, No. 212, 9 January 2007), which identified objectives for the environmentally sustainable development of Kazakhstan. These objectives include identifying environmental problems, analyzing and assessing the environmental aspects of economic and other projects, evaluating environmental legal regulations, developing sustainable production and consumption models, justifying environmental policies and strategies, and initiating environmental activities.

3. Research Frameworks

3.1. Research Background and Previous Studies

This study was conducted in 2018 as a part of a doctoral dissertation, building upon larger research works such as "Scientific support of ecological certification of Kazakhstan's rural territories" (conducted by LLP "Institute of Geography" by order of the Ministry of Education and Sciences and the Ministry of Agriculture of Kazakhstan from 2004–2007), "Combating desertification in Kazakhstan," "Creating the republican atlas and integrated database for assessing the risks of emergency situations and managing them using GIS technologies," and "Water safety of the Republic of Kazakhstan as a strategy for sustainable water supply" (conducted by LLP "Institute of Geography" by order of the Ministry of Education and Science of Kazakhstan from 2005–2015, 2008–2009, and 2015–2017). These projects, to some extent, addressed the issue of environmental assessment of pasture agrolandscapes in Kazakhstan [68–72]. This study presented in this article, however, focuses specifically on providing methodological support to address the problem of environmentally safe and sustainable livestock development in the Central Kazakhstan region through a combination of elements from the sphere of environmental audits and impact assessments on pasture agrolandscapes.

3.2. Problems of State Management in the Field of Pasture Ecological Status

The Ministry of Environment and Water Resources of the Republic of Kazakhstan served as the central executive body responsible for leading and coordinating intersectoral state policy tasks related to environmental protection and nature management, ultimately ensuring environmentally sustainable development. Despite undergoing numerous name and function changes throughout its existence, it was established in 1995 and dissolved in 2014 as part of a restructuring effort within state administration bodies. As a result, its functions were transferred to the newly created Ministry of Energy of Kazakhstan. Various state organizations now carry out separate functions related to managing the ecological status of pastures (see Figure 1). This fragmentation of public administration entities poses obstacles to obtaining integrated information and complicates the creation of optimal conditions for environmentally safe and sustainable development of pasture agrolandscapes in Kazakhstan.

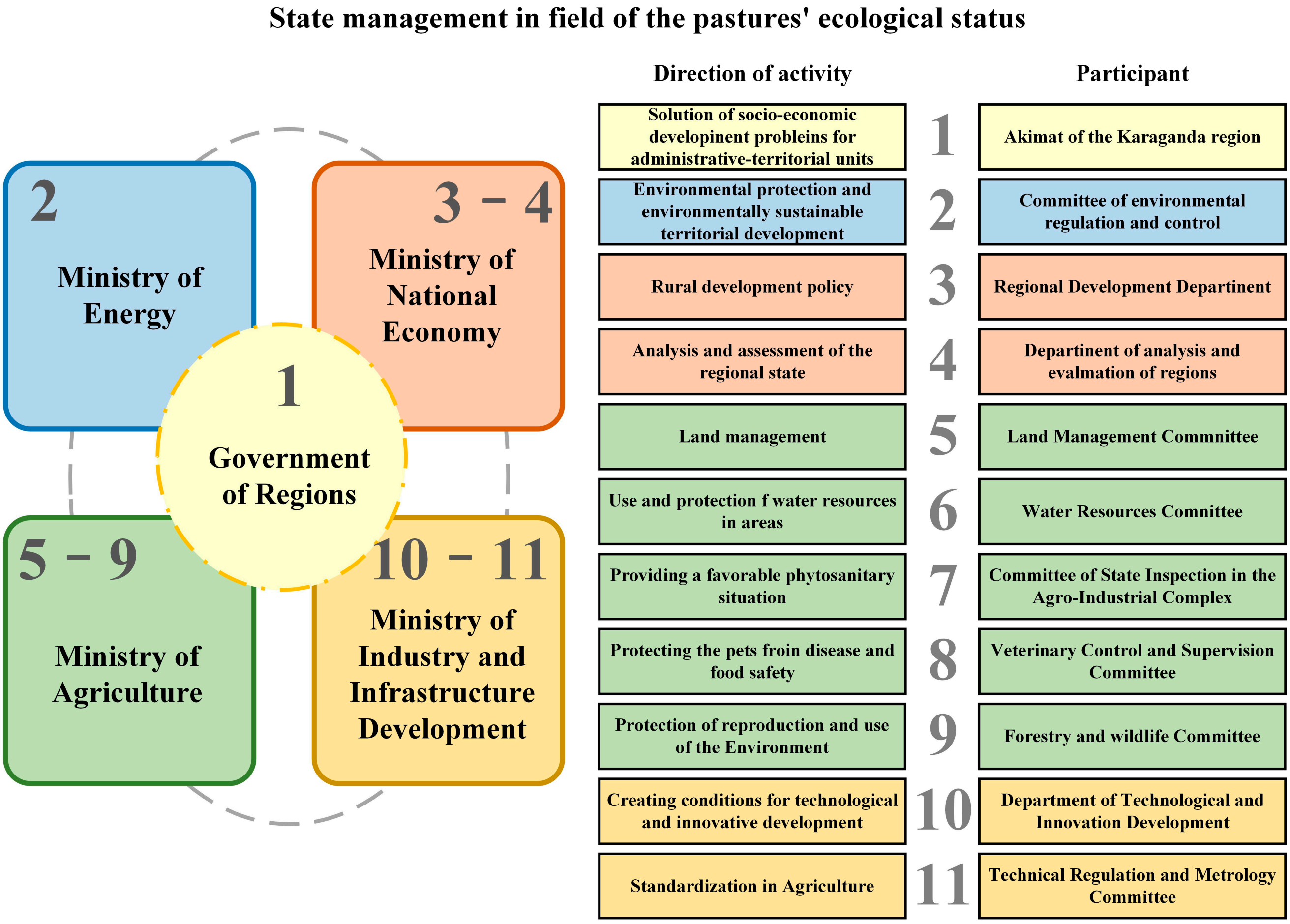

Figure 1. Main participants in state management in the field of pasture ecological status.

3.3. Location

The research was conducted in the Karaganda region, which is the only region in Central Kazakhstan. It shares borders with the Aktobe region to the west, the Kostanay region to the northwest, the Akmola region to the north, the Pavlodar region to the northeast, and the Zhambyl, South Kazakhstan, and Kyzylorda regions to the south. The southeastern border runs along the coast of Balkhash Lake. The region covers an area of 428 thousand km^2, which constitutes 15.3 percent of the country's total area. The region stretches 590 km from north to south and 1050 km from west to east. It comprises 9 rural districts, 11 cities (9 of regional and 2 of local significance), and 10 other settlements, including 421 rural settlements and 196 settlements and aul subdistricts [73]. The city of Karaganda serves as the administrative center, with a population of 1378.5 thousand people as of 1 January 2019, accounting for 8 percent of Kazakhstan's population, and a population density of 3.2 persons per 1 km^2 (the second smallest in the country after the Aktobe region) [74].

The territory is divided into four flat natural landscape zones: steppe, dry steppe, semidesert, and desert. The eastern part is characterized by smoothed and typical low hills, while erosion-tectonic ("island") low mountains are present in the center. The western part mainly consists of high plains and sandy massifs. The terrain is predominantly low-hill, hilly, and rolling plains, sometimes with "island" lowlands. The Aral Karakum, Moyynkum, Zhetykonyr, and other sandy massifs are located in the southwest and south. The climate is continental with cold winters, little snow, and hot, arid summers. In January, the average temperatures range from −16 to −17 °C in the north, −14 °C in the low mountains, and −13 °C in the south. In July, the average temperatures range from +20 to +21 °C in the north, +19 °C in the lowlands, and +26 °C in the south. Annual precipitation ranges from 250–300 mm in the north, 150–200 mm in the south, and 300–400 mm in the lowlands. The main rivers are Nura, Torgai, Sarysu, Shiderty, Ulyzhilanshik, Kulanotpes, Kalmakkirgan, Tundyk, Tokrauyn, Zharly, and Taldy. The region has several small, mostly saline lakes, as well as larger ones such as Balkhash (with a water mirror area of 118.2 thousand km^2), Karasor (154 km^2), Karakoiyin (72.5 km^2), Kypshak (64.7 km^2), Kerey (62.8 km^2), Kiyakty (51.6 km^2), Shoshkakol (32 km^2), and Balyktykol (25.8 km^2). Reservoirs have been built on several rivers, including the Nura (Temirtau, Sherubainurinskoe water reservoirs), the Kengir (Kengir, Zhezdinskoe water reservoirs), and the Atasu (Kylysh water reservoir). The Ertis-Karaganda-Zhezkazgan channel is also in operation [73,75–78].

3.4. Materials and Methods

The study utilized statistical, analytical, and cartographic materials as sources of initial information, along with official data on public and private institutions from 1991 to 2018. Additional qualitative and quantitative data were collected between 2017 and 2018, using existing information systems and other updatable and replenishable sources. Important information resources included annual reports, speeches by the Akim and Heads of institutions and organizations in the Karaganda region, the archive of the "National Center for Scientific and Technical Information" of Kazakhstan, the authors' scientific articles, materials of scientific and practical conferences, and publications in mass media.

The study employed geosystem, landscape-ecological, and landscape-indication approaches to consider the landscape environment as a holistic integrity formed by various natural, natural-anthropogenic, and anthropogenic territorial geocomplexes, taking into account the diversity of relations and interactions between them and economic objects. The work utilized a combination of methods and technologies, including common scientific descriptive, comparative and analogies paradigm; web analysis for identification and evaluation of useful information resources; content analysis for documentary and archive data, scientific literature, and other textual materials; classifications and typifications for logical structuring and synthesis of information; landscape analysis and study of relief plastic for establishing the patterns of geocomplexes, phenomena, and process development, as well as determining the possibility of their repetition; expert assessment to obtain information in the absence of data for analysis; using private and integral indicators and their gradation in the form of an assessment scale; landscape-ecological zoning as a process of dividing the territory into homogeneous areas based on the criteria/indicators of the landscape-ecological state and performed functions; logical synthesis and extrapolation of the identified patterns to homogeneous areas according to natural territorial characteristics; and the study of spatial geographic information based on ArcGIS 10 software by ESRI and ERDAS IMAGINE.

4. Results and Discussion

4.1. The Order of Works in the Framework

The method used for conducting an environmental audit and impact assessment on pasture agrolandscapes aims to optimize land use and improve the efficiency of territorial environmental management [21,79–85]. In a case study of Central Kazakhstan, this method was applied to ensure sustainable livestock practices. The initial hypothesis was that pasture agrolandscapes cannot be limited to a territory with only one type of natural-territorial complex. Therefore, their typological and individual properties must be taken into account, emphasizing the main landscape-ecological requirement of the method—the identification and consideration of the peculiarities of the territory's landscape organization based on the indication features system. Essential tasks in this method include studying zonal, regional, and local laws and features of the territory's landscape structure. Figure 2 illustrates the sequence of tasks within the developed method's framework.

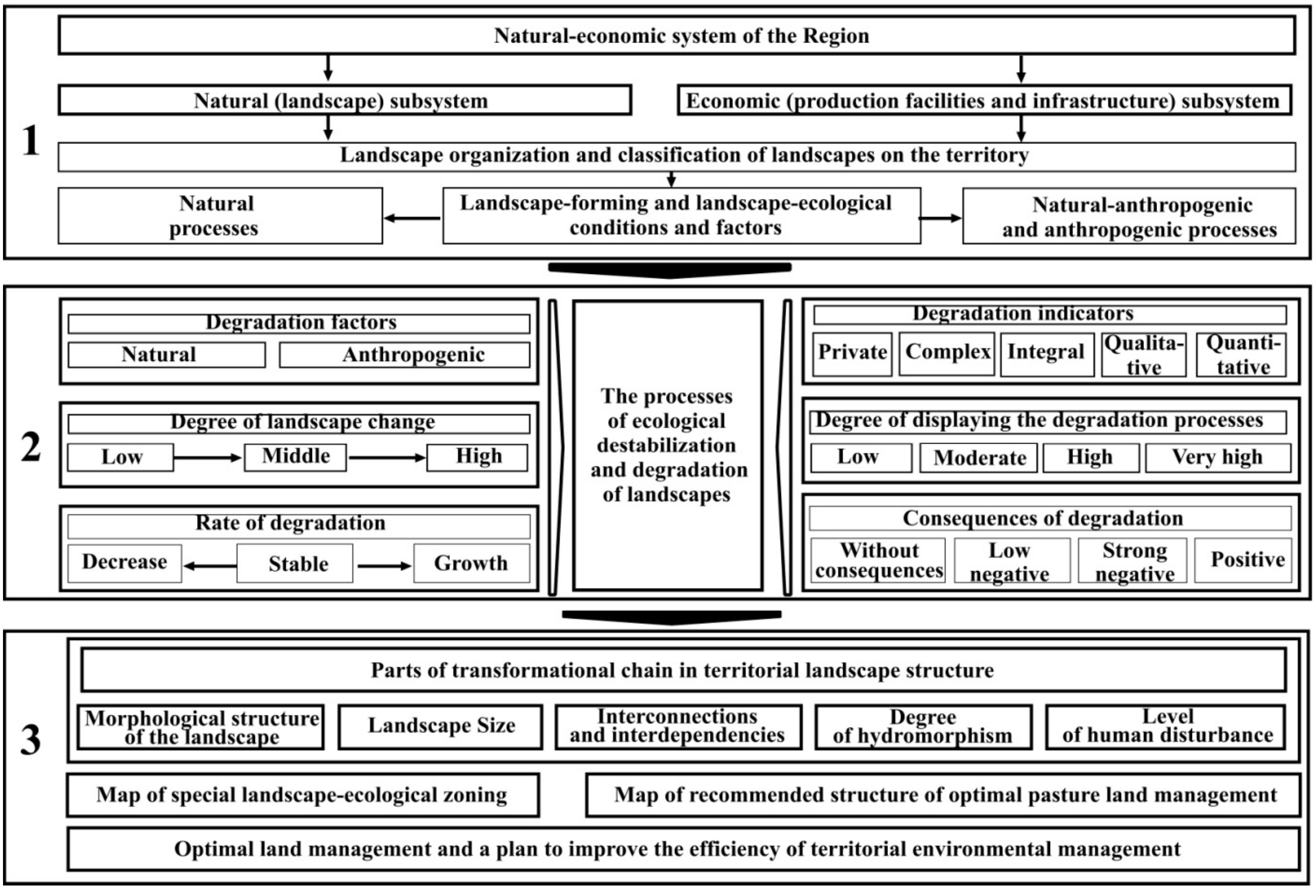

Figure 2. The order of works in the framework of the developed method of environmental audit.

4.2. Natural-Economic System of the Region

The first component of the method aims to achieve a comprehensive understanding of the territory's landscape organization. This understanding includes the territory's placement within the broader natural regionalization system and the diversity of its landscapes [86]. The component requires a detailed analysis of the ecological, geological, and climatic conditions of the area, along with an assessment of the landscape's cultural and historical context. By examining the territory's natural resources, ecological characteristics, and socioeconomic factors, researchers can identify the most suitable land use practices and management strategies to ensure the sustainability of agrolandscapes [87]. Additionally, the first component of the method takes into account the industrial facilities and infrastructure that can have environmental impacts on landscapes. Identifying potential sources of pollution and their effects on agrolandscapes is crucial for implementing effective measures for environmental management. Mining activities, oil and gas extraction, and transportation infrastructure [88,89], for example, can cause significant damage to the landscape's ecological balance, leading to soil erosion, water pollution, and loss of biodiversity. By understanding the potential impacts of these activities, researchers can develop strategies to mitigate their effects and minimize environmental risks.

To analyze the structural organization and patterns involved in the formation and development of geocomplexes, it is necessary to create a spatially explicit landscape cartographic model [90]. The model should include retrospective information and sufficient details to identify and analyze indicators of the landscape-ecological status and degradation processes. Using the dominant low-transformed geocomplexes as a baseline for ecological status, subsequent trends of transformation can be identified and analyzed through the prism of the main landscape-forming conditions, factors, and processes stimulated by natural and anthropogenic factors [91,92]. The high level of anthropogenic disturbance of geocomplexes serves as the primary criterion for the development of ecological degradation processes [93]. Studying the interrelationships and interdependencies of landscape properties is a crucial aspect of research in the first component.

Production facilities and infrastructure define the modern economic subsystem of any territory and form spatial models of the economic development of geocomplexes. According to satellite images, these can be reduced to focal-mosaic, linear, dendritic, distributed, banded, and circular types. Identifying these on the territory of the Karaganda region, in conjunction with interpretation of satellite images and analysis of environmental information, allowed for the classification of all geocomplexes into categories such as natural and quasinatural areas, technogenic assignments, technogenic producers, old industrial areas, agricultural areas, residential areas, linear technogenic areas, water management areas, forestral areas, recreational areas, environmental areas, pyrogenic areas, and archaeological and historical areas.

4.3. The Processes of Ecological Destabilization and Degradation of Landscapes

The second component of the method involves a comprehensive study and analysis of ecological destabilization and degradation processes in landscapes, which are important objects of indication works. However, the list and manifestations of such processes are diverse, and it is not always possible to study them in their entirety [94]. Thus, it is essential to select the processes that have the greatest areal development and are available for study. The analysis of processes, including their depth, intensity, and spatial display, can be made based on studying the natural and anthropogenic factors of their creation and development [95]. The degree of anthropogenic disturbance is determined based on the cumulative effect of leading factors of environmental degradation and the results of assessing the environmental sustainability of geocomplexes to anthropogenic impact [96,97]. It is crucial to identify three degrees of changes in natural landscapes: (a) low degree of anthropogenic variability, mainly forestry and agricultural use, with manifestations of mainly spontaneous degradation processes (salinization, water erosion, waterlogging, and others) due to natural predisposition; (b) average degree of anthropogenic variability with a wide range of manifestations of natural and anthropogenically caused processes associated with areal, linear, and local anthropogenic influences; and (c) high degree of changes with an area of economic use of 80 percent or more and a wide range of manifestations of anthropogenically caused degradation processes.

A low degree of anthropogenic variability is observed primarily in the geocomplexes of low-hill, low-mountain, middle-mountain, and high-mountain subclasses, as well as geocomplexes of the lake-alluvial and alluvial plains due to soil salinization. An average degree of anthropogenic variability is characteristic of geocomplexes of the deluvial-proluvial, aeolian, and hilly denudation plains. A high degree of anthropogenic variability is confined to the geocomplexes of river valleys and the rest of alluvial-proluvial plains. Private soil, geobotanical, geomorphological, agricultural, and technogenic indicators are identified within field and cameral conditions to identify indicators of environmental destabilization and landscape degradation. These indicators are closely related to the criteria for assessing the degree of manifestation of processes. Each diagnostic indicator can be characterized by four levels: (1) low (relatively undisturbed geocomplexes); (2) moderate (poorly disturbed geocomplexes); (3) strong (moderately disturbed geocomplexes); and (4) very strong (destabilized geocomplexes). The extreme degree of manifestation for ecological trouble and degradation in geocomplexes refers to the destruction or severe disturbance of the lithogenic basis. The speed and consequences of degradation are the most important determinants in the indication of the status and development of processes in geocomplexes.

4.4. Parts of the Transformational Chain in Territorial Landscape Structure

The third component of the method is crucial for the success of the environmental audit and impact assessment on pasture agrolandscapes. Creating schemes for the stages of ecological degradation is an essential step in evaluating the ecological health status of the landscape [98]. By assessing the different stages of ecological degradation, researchers can identify the factors that contribute to the decline of the ecosystem and develop strategies to mitigate their effects [99]. This component is particularly relevant for pasture agrolandscapes, where intensive land use practices can lead to ecological degradation.

Establishing assessment criteria is necessary to create schemes for the stages of ecological degradation, which should contain clear and unambiguous rules for attributing a landscape, its components, or processes to a certain class of ecological health. This involves analyzing changes in the spatial and temporal differentiation of landscapes and specific parameters related to ecological health, such as soil quality, vegetation cover, and water availability [100]. By using these criteria, researchers can develop a classification system that categorizes the ecological health status of pasture agrolandscapes.

The final documents produced from this component of the method are the special landscape-ecological zoning map and the recommended structure for optimal pasture land management map [101]. The special landscape-ecological zoning map identifies areas that require special attention for ecological restoration and management, while the recommended structure for optimal pasture land management map provides a detailed overview of the most suitable land use practices for each area, taking into account its ecological health status and the specific needs of the livestock industry.

In summary, the third component of the method includes creating schemes for transformational stages of degradation processes as an integral indicator of the ecological well-being level for pasture agrolandscapes. Assessment criteria should contain clear and unambiguous rules for attributing a landscape, its components, or processes to a certain class of well-being, formulated by using information about changes in the spatial and temporal differentiation of landscapes and private parameters. The final documents, which summarize all the results of the work and demonstrate them in visual form, are the special landscape-ecological zoning map and the recommended structure for optimal pasture land management map.

5. Conclusions and Recommendations

The concept of sustainable development has become increasingly important in recent years, aiming to balance economic growth with the preservation of the environment for future generations. One of the key principles of sustainable development is recognizing the inherent qualities of landscapes and ensuring their appropriate protection and management. Failing to do so and utilizing landscapes solely for economic gain can be seen as a form of economic dumping, prioritizing immediate economic benefits over long-term environmental sustainability. However, many countries are grappling with finding a balance between economic development and environmental protection, leading to a crisis in nature management. This issue is particularly pertinent in the context of pasture agrolandscapes, which often undergo intensive land use practices that can lead to ecological degradation.

To tackle this challenge, it is crucial to establish national approaches for environmental auditing and impact assessment of pasture agrolandscapes that align with global trends and sustainable livestock management concepts. These methods should take into account the unique characteristics of each landscape and provide practical recommendations for sustainable land use practices that strike a balance between economic development and environmental protection. By doing so, countries can contribute to the global effort to achieve sustainable development and ensure that the natural attributes of landscapes are conserved for future generations.

The concept of sustainable development highlights that ignoring the natural properties of landscapes can lead to economic dumping. In light of the crisis in nature management, it is necessary to create national methods for environmental audit and impact assessment on pasture agrolandscapes that align with global trends for sustainable livestock management. This paper proposes a framework for a methodology that aims to optimize land use and improve agricultural landscape management. The methodology has three components: agricultural landscape analysis, environmental impact assessment, and the creation of schemes for the stages of ecological degradation. The first component involves identifying the landscape's key features and understanding its current ecological health status. The second component evaluates the environmental impact of land use practices, while the third component aims to provide practical recommendations for sustainable agricultural landscape practices that balance economic development with environmental protection.

This proposed methodology offers a comprehensive approach to managing ecological health in agricultural landscapes and can guide policymakers, environmental practitioners, and researchers in developing sustainable land use practices that promote economic growth while ensuring long-term environmental sustainability. The framework's adaptability to various agricultural landscapes and potential to contribute to the development of sustainable land use practices make it a valuable tool for future research in this field. Overall, this methodology offers a promising approach to addressing the challenges of sustainable land use in agricultural landscapes and contributing to global sustainable development.

However, this methodology has some limitations. It may require significant resources and expertise to implement, particularly in developing countries with limited funding and technical capacity. Additionally, the methodology heavily relies on data availability and accuracy, which may pose a challenge in some contexts. Its effectiveness may also vary depending on cultural, political, and economic contexts. The implementation of sustainable agricultural landscape practices may require significant changes to existing social and economic systems, which may be challenging to achieve in some contexts. Lastly, the proposed methodology may be resource-intensive, requiring significant funding and technical expertise to be effectively implemented. Therefore, it is crucial to address these limitations and consider ways to mitigate them when applying this methodology in practice.

Our experience has shown that achieving national food security and environmentally safe territorial development can be accomplished through the development of specific methods for assessing progress towards selected goals based on indicators of the landscape's environmental status. These interdisciplinary studies provide a scientific approach, and the resulting method can be used to integrate state management participants and ensure the ecological status of pastures in their practical activities. Similar methods facilitate the study of geocomplexes and their essential characteristics through a unique system of reliable indicators for environmental problems, ultimately leading to the creation of a scientifically-based plan for optimal regional land use and land management systems regarding pasture agrolandscapes.

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Abbreviations

UN	United Nations
NEPA	National Environmental Policy Act
EIA	Environmental Impact Assessment
SEA	Strategic Environmental Assessment
EA	Environmental Assessment
SEA	Strategic Environmental Assessment

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