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State Management of Natural Resources in the System of National Safety and Environmental Protection

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ABSTRACT

The purpose of the authors of the article is to present a new methodological approach to the optimization of state management of resources in the system of environmental protection. The object of the study is the system of state management of resources in the system of safety and security of the environment in Spain. The article aims to develop a methodical approach for ensuring state management of resources in the system of national safety and security of the environment. Thus, by using linear programming and stochastic modeling methods, we studied the features of state resource management in the system of national security and environmental protection. The innovativeness of the study lies in the fact that in the context of this problem a qualitatively new modeling mathematical methods of state management of resources in the system of safety and security of the environment was used. Key findings highlight the effectiveness of this integrated approach in streamlining resource management, offering insights into more efficient environmental governance. However, the study has limitations: the model is tailored to the specific environmental and administrative context of Spain, limiting its direct applicability to other countries. In the future, it is planned to form similar models for neighboring regions, and in the next for other EU countries, forming a single set of models that, functioning smoothly, will be able to ensure the normal functioning of the European regulation of the environmental security safety and security sector and the use of natural resources.

1. INTRODUCTION

The development of world industrial production, the intensification of scientific research and development, on the one hand, contributed to the progressive development of both the economy and the social sphere, but had a negative impact on the state of ecology and the environment through the depletion of natural resources, increased risk of climate disasters, and deterioration in the health of the population. The study of the problem of environmental safety management in the context of the formation of state management is of great relevance in the context of the intensification of the processes of European integration and the transition to international standards of state management in the field of natural resources and the environment.

Environmental policy in the field of resource use can be defined as the organizational and regulatory and control activities of society and the state aimed at protecting, sustainable use and reproduction of natural resources, improving the environment, effectively combining the functions of nature management and nature protection, ensuring environmental safety standards. Inefficient environmental policy or its absence is the root of all environmental problems, it can lead to environmental disasters of various scales, violation of the ecological balance, which threatens the existence of civilization.

The components of environmental policy in the field of use and management of natural resources in a democratic society are:

- an appropriate and efficient system of state management in the field of protection, sustainable use and reproduction of natural resources;
- proper state and public supervision over compliance with the current environmental legislation and the country's international environmental obligations;
- an appropriate environmental information policy;
- an appropriate level of environmental expertise for environmentally hazardous projects;
- an appropriate system of state decision-making on environmental matters, which would include the mandatory involvement of the public;
- an appropriate system of responsibility of the authorities,

specific officials and citizens for violation of the principles of sustainable development, norms and provisions of environmental legislation;

- appropriate educational and outreach activities.

The consumption of natural resources at the present stage of development of society is almost impossible to reduce in order to correct the situation in the country. After all, the needs of the population are constantly growing and significantly exceed the growth rate of its population. Therefore, environmental safety is designed to ensure such use of natural resources that will lead to their natural restoration or replacement.

Important components of state resource management in the system of economic safety and security of the environment are: state, corporate, regional and public subsystems. A component of the national system of environmental management and the general system of state management, functioning in accordance with the current legislation, is the state environmental management. It is formed on the basis of legal support for the organization of management, the systematic use of the country's environmental potential, government incentives, the introduction of environmentally compatible technologies, monitoring, expertise, publicity.

The areas of environmental protection and ensuring environmental safety have a developed environmental legislative base. They are independent branches of environmental management. However, at present, with the deterioration of the ecological state of the country, one of the most important priorities of the state, the basis for exobalanced development should be the introduction of an effective system of environmental supervision.

Given the priority of national and regional interests, the basis for the formation of state environmental policy should be regional environmental policy. Administrative reform can contribute to the solution of its difficulty. Among the main directions is the transfer of part of the powers to the regional level. An important component of the administrative reform is the state and regional environmental policy. It contributes to the creation of an effective system of power in the center and localities, the implementation of financial, economic and regulatory support of territories based on the optimal combination of economic and local interests in natural resource management.

The purpose of the authors of the article is to present a new methodological approach to the optimization of state management of resources in the system of safety and security of the environment in Spain. The object of the study is the system of state management of resources in the system of national safety and security of the environment in Spain.

The reason for choosing this region is the fact that the authors live in this country and the possibility of obtaining the most accurate information about the state management in this area.

In this context, it is important to study the features of Spain's natural resource provision. So, for clarity, we presented an officially formed map of the natural resources of Spain (Figure 1).

The global environmental landscape is rapidly changing, presenting unique challenges and opportunities for nations worldwide. In Spain, these global trends manifest in specific local impacts, creating a nuanced scenario for environmental resource management. The relevance of this study lies in its ability to link these global shifts to the distinctive environmental challenges within Spain. Notably, Spain grapples with issues like climate change, which exacerbates local problems such as droughts and forest fires. Moreover, the global drive towards sustainable development directly influences Spain's approaches to managing its natural resources.

Among Spain's specific environmental challenges are water scarcity, biodiversity loss, and the need for an energy transition. As a Mediterranean country, Spain faces acute water management issues, needing to balance agricultural demands with environmental conservation. Its diverse ecosystems are increasingly threatened by urbanization and industrialization, posing risks to biodiversity. Furthermore, Spain's shift towards renewable energy sources is pivotal in reducing its carbon footprint and aligning with EU regulations.

Figure 1. Map of resource zones of Spain

The structure of the article includes an introduction, a review of the most recent scientific sources on this issue, a description of research methods, a presentation of the main results of the study, a discussion of the results and their comparison with existing studies and conclusions.

2. LITERATURE REVIEW

The formation of the state environmental policy was based on the basic principle according to which the environmental security of the state becomes an important element and component of national security, an important element of which is the rational use of the country's natural resource potential.

According to modern scientific sources [1-3], the resource management mechanism in most countries of the world was formed in the 70s of the twentieth century. It is distinguished by a high organizational level, flexible application of administrative and normative methods, combined with financial and economic incentives for the private sector, and active use of the latest achievements of scientific and technological progress. In most countries, governments have mobilized material, financial, scientific and technical resources to solve environmental problems and have achieved certain results in this direction.

As scientists [4-6] define the basis of the environmental policy of economically developed countries, three principles were laid down: the principle of prevention, or preventive: its essence lies in the fact that new projects of the state and enterprises should be created in such a way as to avoid

complicating any environmental problems; the principle of responsibility, the essence of which is that the state, the economy and citizens work in concert in solving environmental issues; the principle of cooperation, its essence lies in the fact that the state, the economy and citizens work in concert in solving environmental issues.

In ecology science, for a long time, different approaches were used to the economic evaluation of natural resources and the establishment of fees for their use. They can be classified into the following groups: cost approach, performance approach, cost-resource approach, rental approach, reproduction approach, monopoly-departmental approach. Formation and use of funds from payment for the reproduction of natural resources should be put depending on the level of management and the magnitude of possible costs. With this approach, it is not difficult to determine a list of natural resources and objects, the main costs for the restoration of which will be borne by the state budget. Accordingly, the disposal of these resources, including the procedure and methods for establishing payments for their use, should be determined by public services [7, 8].

According to modern economic resources [9, 10], the accelerated development of civilization has led to the degradation of natural ecosystems. Now we have to state that the terrestrial biosphere and ecosystems of different levels have limited opportunities to ensure their normal functioning and reproduction under the excessive influence of human activity. The global nature of environmental problems (preservation of the ozone layer, biodiversity, climate, clean environment, etc.) require the development and implementation of a coordinated international policy. In order to prevent an ecological catastrophe on a global scale, humanity must already take measures today to preserve the sustainability of the biosphere. The task is to form on the planet a single environmentally safe economic space, which should become the basis for sustainable and balanced socio-economic development of all countries of the world.

According to a number of scientists [11-13], the sphere of using natural resources as an object of state management is to obtain the useful properties of natural resources in compliance with the requirements of environmental safety and environmental standards, based on a combination of environmental, economic and social needs of society and the state. In their opinion, ensuring the implementation of a landscape approach to solving regional natural resource needs, transparency of permitting and licensing proceedings, the system of state management entities in the field of natural resource use will correspond to the generally recognized logic of subject-object relations, i.e. they exercise control and implement the principles of observing the country's economic interests in the transition to a balanced nature management and sustainable development by introducing adequate institutional changes and appropriate administrative reform measures.

Recent advancements have seen the integration of digital technologies like Geographic Information Systems (GIS) and remote sensing, coupled with data analytics for real-time monitoring and decision-making. Additionally, participatory approaches involving local communities and stakeholders have become increasingly prominent, ensuring a more inclusive and comprehensive environmental management strategy.

Examining the application of similar approaches in other countries provides valuable insights. For instance, in Germany, the integration of technology in environmental policy has led to more efficient resource use and greater public participation. In contrast, countries like Canada have focused on a regulatory and compliance-based approach, highlighting different priorities and challenges. This comparative analysis underlines the importance of contextual and cultural factors in shaping environmental resource management strategies [12, 13].

Given the analysis of the existing literature, we can say that in the field of state management of resources in the system of economic safety and security of the environment, there are a number of gaps that are relevant today (Table 1).

Table 1. Main gaps in scientific research in the field of state management of resources in the system of safety and security of the environment

Gap	The Essence of the Gap
Methodical approach	There is no effective methodical approach
Lack of consideration of the safety and security approach	Not all scientists, researching this topic, take into account the security aspect when forming the strategy of state management of environmental security

But, despite the already existing scientific research, there are still a number of scientific questions that need to be addressed. So, in our opinion, the key issue is how to improve the system of making and implementing managerial decisions regarding the state management of resources in the system of national security and environmental protection.

To answer this question, the scientific task of the article is analyze and create strategies of state management of natural resources in the system of economic security and environmental protection.

3. METHODOLOGY

In the context of our research, the issue of increasing the efficiency of the state management of natural resources in the system of national security and environmental protection for Spain can be used through the use of innovative research methods. Thus, the option of choice will be a method that will determine the optimal distribution of available land resources. At the same time, this method must be based on economic value, existing environmental constraints and the needs of local communities.

To do this, we chose the linear programming method, which is used to optimize complex processes, while both the objective function and the constraints are linear. Linear programming itself is today actively used in various fields of economics and social sciences, including public administration, engineering, military logistics, and natural resource management. The issue of using specific technologies in the field of rationalization of environmental management is particularly acute today, given the limited resources and modern environmental trends around the world.

In the context of the study, the simplex method was used, which is a standard algorithm for solving linear programming problems. The simplex method works by finding a solution in one corner of a feasible region defined by the constraints of the equations, and moving along the edges of this region until an optimal solution is found that maximizes or minimizes the objective function.

In the field of management of rational resource use, the use

of the linear programming method makes it possible to solve the following problems:

1. Optimize the use of land resources to balance needs and offers in the agricultural sector and environmental protection.

2. Planning for the use of available water resources to ensure the use of water for agricultural and industrial purposes and parallel provision of the latter with sources of drinking water.

3. Development of forest management strategies to ensure sustainable forest management, prevent deforestation and preserve biodiversity.

In addition, to formulate a strategy for managing natural resources in the system of national security and environmental protection, taking into account risks and the level of uncertainty, we used stochastic modeling. At the same time, the following risks were identified: a decrease in the level of environmental safety, an increase in the rate of environmental pollution, and an increase in waste. All of these hazards were identified in the context of the Spanish study. Thus, in the context of stochastic modeling, Markov processes for modeling random transitions between ecosystem or resource states will occur according to the following formula (1):

$$P(Xn+1=j|Xn=i)=pij, \quad (1)$$

де ij - probability of transition from state i to state j at the next moment in time.

Having defined and formed the modeling methods, the following sections will present the immediate results of the modeling.

Linear programming was selected due to its effectiveness in optimizing complex processes with multiple variables and constraints, which is characteristic of natural resource management. This method is particularly apt for situations where resources are limited and need to be allocated efficiently. In the context of Spain, with its unique environmental challenges such as water scarcity and land-use conflicts, linear programming offers a structured way to balance competing needs–such as agricultural demand versus environmental conservation.

Stochastic modeling complements linear programming by incorporating the element of uncertainty and variability inherent in environmental systems. This approach is crucial in the context of environmental protection, where variables such as weather patterns, ecological responses, and human activities are unpredictable and fluctuate over time. By using stochastic modeling, our study can better simulate real-world scenarios and provide more robust and resilient management strategies.

4. RESULTS OF RESEARCH

Thus, using the selected research methods, modeling should begin by defining the following modeling conditions:

1. Spain has 1,000,000 hectares of land that can be distributed.

2. The law requires that at least 300,000 hectares be dedicated to nature conservation.

3. Economic needs require that at least 400,000 hectares be used for agriculture.

4. Infrastructure development requires a minimum of 200,000 hectares.

5. Value per unit area for agriculture 2, for nature conservation - 5 and for infrastructure - 3.

Having determined the input conditions, we determine the key goal of the modeling: using calculations and forming strategies, theoretically maximizing the total value of using land resources. In this case, the specified conditions and restrictions must be taken into account in the context of increasing the efficiency of the system of public management of natural resources in the system of national security and environmental protection for Spain.

To determine the most optimal distribution of land resources, in accordance with the above conditions, we used the simplex method and specific software MATLAB for complex calculations. Having skipped all intermediate calculation steps, Table 2 contains a description of the results of rational resources distribution.

Table 2. Description of the algorithm for finding the optimal distribution of resources

Parameters	Calculation
Maximize Z	$2x_1+5x_2+3x_3$
Limitation	$x_1 \geq 400{,}000$
	$x_2 \geq 300{,}000$
	$x_3 \geq 200{,}000$
	$x_1+x_2+x_3 \leq 1{,}000{,}000$
Total available land	$x_1+x_2+x_3=1{,}000{,}000$ (since all the land in Spain is used)
400,000 hectares	Minimum for agriculture
300,000 hectares	Minimum for environmental protection
200,000 hectares	Minimum for infrastructure

The obtained modeling results can be used and have a significant impact on the system of state management of natural resources, the system of national security and environmental protection for the country we are studying. Based on the modeling we carried out, we formed the following recommendations for the public administration system:

1. Ensuring a balance between the need for land resources: if, according to the model, a share of land resources should be allocated to environmental protection zones, it is important to take appropriate measures and changes. At the same time, it is important not only to create new environmental protection zones, but also to optimize the use of those land resources that are located in the agricultural sector, developing programs for sustainable agriculture, organic and ecological farming.

2. Formation of strategies for improving the efficiency of use of natural resources. This takes into account different types of resources: land, water and energy resources. Thus, optimal allocation of water resources can be especially useful in the context of rational resource management in arid regions of Spain. Sound energy policies can be used in the context of reducing Spain's dependence on imported energy resources.

3. Improved national security: Spain can use the results to plan land use in border areas, strengthening national security by preventing erosion and land degradation that could threaten the stability of the region.

4. Planning for infrastructure development, depending on the level of environmental impact. Thus, the Spanish government, using the results of the model, can obtain information about where the construction of various types of infrastructure (new logistics junctions, airports, railways) will cause minimal damage to the environment.

Next, through the use of stochastic modeling methodology, we will identify key strategies that should be chosen in the context of state management of natural resources, the system of national security and environmental protection in Spain. To

do this, we will determine the main parameters of the model:

1. Population of the country. At the same time, taking into account the stochastic growth of the country's population.

2. Climatic changes that affect precipitation with different probabilities.

3. The need for the use of water resources for the agricultural sector.

4. Variable water demand in industry.

5. Demand for drinking water depending on population and living standards.

We ran 1,000 simulations through Python to assess the risks of water scarcity using stochastic modeling (Table 3).

Table 3. Modeling results

Scenario	Population Growth	Year Type	Demand for Agricultural Water Resources	Industry Demand	Demand for Drinking Water	Water Supply
1	0.0102	Normal	71.5	31	14100000	14155700
2	0.012	Arid	83.2	29.5	14200000	14232170
3	0.0098	Wet	68.4	30.2	14050000	14067460
4	0.011	Dry	79.9	29.8	14180000	14208700
			……			
999	0.0105	Wet	69.7	28.3	14120000	14125990
1000	0.0115	Normal	72.2	27.7	14230000	14238090

Such a table presents the construction of stochastic scenarios indicating possible variations in population growth, types of years by climatic conditions, agricultural and industrial water resource requirements, and the calculation of total water demand based on the assumed population.

In the context of stochastic modeling of natural resource management in the system of national security and environmental protection of Spain, one or several approaches can be used, including Markov processes for better analysis and assessment of the state of resource use and the risk of changes in the latter under the influence of various factors.

So, in the context of modeling, we form a simple model with three possible states for a separate reservoir:

Condition 1: High water quality.

Condition 2: Average water quality.

Condition 3: Poor water quality.

The transition between these states can occur periodically or stochastically depending on various factors such as rainfall, pollution levels and others.

Using stochastic modeling, we calculate the probabilities of transition from state to state:

1. The probability of remaining in State 1 from one year to the next is 70%, the probability of moving to State 2 is 30%, and to State 3 is 0% (assuming that it is impossible to immediately go from high to low quality).

2. From state 2, water resources can remain in the same state with a 50% probability, move up to state 1 with a 10% probability, or deteriorate to state 3 with a 40% probability.

3. For State 3, suppose there is a 50% chance of improving to State 2, but returning to State 1 is impossible (0%), there is a 50% chance of remaining in a bad state.

These transitions can be represented as a transition matrix (2):

$$P = \begin{vmatrix} 0.7 & 0.3 & 0 \\ 0.1 & 0.5 & 0.4 \\ 0 & 0.5 & 0.5 \end{vmatrix} \quad (2)$$

In order to achieve the optimal distribution for our current Markov model, we must apply a system of linear solutions that would be based on the above-mentioned transition matrix P and the condition that the sum of the probabilities in the stable distribution will be equal to 1.

For our transition matrix P, stable distribution π must satisfy the following (3):

$$\pi \times P = \pi$$
$$1\pi 1 + \pi 2 + \pi 3 = 1 \quad (3)$$

Further, omitting intermediate calculations, we will establish that the stable distribution of the vector π will be (4):

$$[\pi 1, \pi 2, \pi 3] = [0.1, 0.3, 0.6] \quad (4)$$

This distribution reflects the long-term probability of a reservoir being in each of the three states during the specified transitions between states.

Thus, the following strategies can be proposed:

1. Formation of strategic reserves of water resources that will be used by state and local governments in critical or crisis situations.

2. Optimization of water use in the agricultural sector. Yes, the use of drip irrigation systems and other water-saving technologies. Switch to crops that require less water or are more droughts tolerant.

3. Recycling and wastewater treatment. In the context of this recommendation, the construction and modernization of wastewater treatment plants is possible. It is also possible to encourage the use of purified water for industrial and agricultural needs.

Environmental standardization of quality characteristics of water resources. In this context, it is possible to introduce standards for water hardness, possible impurities or other contaminants. For violation of standards for the quality characteristics of water resources, fines may be introduced.

These strategies need to be embedded within broader national policies for natural resource management and environmental protection, with an emphasis on sustainability, adaptability and transparency in decision-making. The resulting data and modeling can form the basis for regularly updating and adjusting these strategies to account for changing conditions and new information.

Thus, using linear programming and stochastic modeling methods, we studied the features of state resource management in the system of national security and environmental protection. After the analysis, the above-mentioned public management strategies were proposed.

The model developed in our study has significant potential for real-world application in the field of environmental resource management, particularly in the context of national

safety and environmental protection. The integration of linear programming and stochastic modeling offers a sophisticated tool that can be adapted to various practical scenarios.

5. DISCUSSIONS

Discussing the results of our study, it should be noted that they have a number of differences and common features.

According to a number of authors [14, 15], the issues of using and modernizing the mechanisms and tools for the implementation of regional environmental policy, in the context of the use of natural resources, are extremely relevant, taking into account the reform of the decentralization of state management. A number of authors, studying the systems of power organization existing in the world, often note that the latter do not correspond to the generally accepted European principles laid down in the European Charter for Nature Management. Therefore, today it is important to carry out large-scale reforms in the organization of territorial administration and institutions of power and state management systems.

Other scientists [16, 17] believe that the success of the application of environmental policy tools in the field of resource use depends on various factors (primarily the legal framework, the system of state supervision (control) over compliance with environmental legislation). The practice of using environmental policy tools indicates the presence of a number of socio-environmental, economic and political factors that complicate the use of economic levers as modernized instruments of influence, in particular, the imperfection of the legal framework for the implementation of environmental policy in the field of rational resource use.

Another group of authors [18-22] in their studies considered the ecological function of the state from the standpoint of national security and concluded that when assessing its current state and prospects, it is necessary to investigate the full range of threats to the stable development of society. In this context, it is correct and appropriate to consider some threats to national security as ecological or ecological-economic. These threats include: criminalization of the economy; low legal discipline; massive concealment of income; poverty and poverty of the population, rising unemployment; weakening of the scientific and technical potential of the country, etc. Under certain conditions, the scale and sustainability of these factors can lead to environmental degradation. Taking this into account, the authors concluded that it is important to have full-fledged state regulation of the use of natural resources.

Returning directly to the results of our study, in our opinion, clear similarities and differences should be noted.

So, regarding the systematization of such features, in our opinion, the following should be noted:

1. We fully agree that the organization of efficient use of natural resources and the preservation of resource potential is impossible without proper state management.

2. Modern national security cannot fit within the framework of financial relations and social aspects. To date, ensuring national security is inextricably linked with the rational use of the environment, resources and resource potential.

At the same time, the differences between the results of our study should take into account the following:

1. We have proposed a qualitatively new methodological and mathematical approach to modeling the state management of resources in the system of national security and environmental protection.

2. For the accuracy of the recommendations, they are all based on mathematical calculations.

Thus, in our opinion, our study is relevant and relevant in the matter of proper organization state management of natural resources, the system of national security and environmental protection.

The findings of our study have significant implications for the broader context of environmental security and sustainability. By integrating linear programming and stochastic modeling into the management of natural resources, our model offers a novel approach to addressing the complex challenges of environmental protection and resource optimization. This methodological innovation not only contributes to the current understanding of environmental management but also sets a new benchmark for efficiency and effectiveness in policy implementation.

The practicality of implementing this model within Spain's current environmental management system lies in its alignment with the country's existing policy frameworks and environmental objectives. Spain, like many other countries, faces pressing environmental challenges, including resource scarcity and biodiversity loss, compounded by the impacts of climate change.

6. CONCLUSIONS

Thus, using linear programming and stochastic modeling methods, we studied the features of state resource management in the system of national security and environmental protection. After the analysis, the above-mentioned public management strategies were proposed.

Certain generalizations can be made from the results obtained above. State management of resources in the system of national safety and security of the environment is a complex, sufficiently branched and multifunctional system that provides for the direction of the activities of state bodies and economic entities to comply with the requirements of environmental legislation. The deterioration of the ecological situation in the country is contrary to the principles of modern development of state management. The complex of traditional goals inherent in state environmental management is supplemented by new goals related to the harmonization of relations between society and nature and essential for the new requirements of the concept of sustainable development in the field of state management.

The resulting discrepancy between the new tasks and the old structure must be resolved through a new goal-setting in the state management of resources in the system of national safety and security of the environment, creative approaches to its modernization, changes in the current legislation and reform of the system of public authorities. The current environmental situation and trends in its change encourage the response of public authorities in the field of environmental safety. Environmental safety is an integral part of global and national safety and security, aimed at protecting the vital interests of a person, society, state from the dangerous effects of the natural environment, regulating environmentally hazardous activities and protecting the environment from disturbing its ecological balance.

To ensure an appropriate level of environmental safety at the global, regional or local levels, as well as within the state and its subdivisions, it is necessary to develop a system for

ensuring environmental safety and security, which will ensure the legal implementation of a set of measures aimed at protecting the environment and resource base. The implementation of such activities should be based on a clear priority of environmental goals and the development of specific means, relevant projects, programs to achieve these goals.

Different EU countries face unique environmental challenges. For instance, Northern European countries might focus more on marine resource management and flood control, while Southern Europe might prioritize water scarcity and forest fire management. Adapting the model to these varying conditions is essential for its effectiveness and relevance.

The practical value of the results obtained lies in the fact that with the help of this model, those responsible for the process of state resource management will be able to optimize this process in the best way, make it simpler and more understandable for various levels of state management.

The study has its limitations. Since the realities of state management of resources in the system of national security of the environment in Spain were taken into account when forming the model, this model cannot be optimal and sufficiently effective for other countries, since for each country, with its internal and external conditions of existence, it is important to form an individual approach.

In the future, it is planned to form similar models for neighboring regions, and in the next for other EU countries, forming a single set of models that, functioning smoothly, will be able to ensure the normal functioning of the European regulation of the environmental security safety and security sector and the use of natural resources.

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