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FORMATION OF AN AGRO-ECOLOGICAL NETWORK IN TERRITORIES ADJACENT TO BORDERS WITH UNFRIENDLY COUNTRIES

Abstract: the article examines the key prerequisites for establishing an agro-ecological network in territories adjacent to borders with unfriendly countries, identifying the primary issues and priority directions of this research. Theoretical insights in the outlined research areas are analyzed, highlighting leading scientists who have addressed issues related to security, ecology, agro-ecological urban formations, and sustainable green production. Key concepts underlying the formation of an agro-ecological network in territories near borders with unfriendly countries are defined. The classification and main elements of such agro-ecological networks are analyzed, as well as practical experiences in shaping border territories with a focus on military considerations. Based on the analysis, primary recommendations are formulated for developing agro-ecological networks in these territories.

Keywords: border territories; border zone; agroecology; network; sustainable development; smart green production.

Problem statement. Key preconditions for the formation of an agro-ecological network near borders with unfriendly countries. Before the war, Ukraine prioritized land use development, focusing on community spatial planning. Notably, in 2020, the Law of Ukraine «On Amendments to Certain Legislative Acts of Ukraine Regarding Land Use Planning» [10] came into force, establishing a framework for integrated territorial development planning. The Cabinet of Ministers' Resolution «On Approval of the Procedure for Developing, Updating, Amending, and Approving Urban Planning Documentation» [11] also remained a consistent foundation for spatial planning. Despite the challenging circumstances, communities have continued to implement comprehensive spatial planning as much as conditions allow.

The onset of the full-scale war in 2022 caused significant shifts in the structure of regional centres, profound social changes, and further transformations of policies at all levels. Territories affected by the war to varying degrees now exhibit different patterns of resilience and potential development, as well as diverse visions for growth, leading to functional transformations.

The Russia-Ukraine war has fundamentally altered the approach to planning. Communities present diverse examples: some suffered extensive destruction and drastic population loss due to migration, while others faced the challenge of providing space and assistance to internally displaced persons and relocated businesses. Recognizing these challenges underscores the necessity of pilot projects with communities and developing methodologies for comprehensive spatial planning that account for long-term security risks.

Thus, a key priority for land management during wartime and post-war periods is utilizing land for Ukraine's defensive purposes. This creates a need to identify the specific features of forming an agro-ecological network in border areas with unfriendly countries and to develop scenarios for its adaptation to critical national situations.

Analysis of recent research and publications. Urban planning factors influencing territorial land use development have been studied by K.A. Mamonov, V.S. Kovalchuk, V.V. Goi, and V.K. Mamonov. Their research emphasized the necessity and relevance of urban planning factors for regional land use development, identifying and evaluating local factors through expert methods. It revealed a low, insignificant, or moderate influence of these factors on regional territorial development systems [7].

P. Ostapenko, S. Ostapenko, O. Bonchkovsky, and R. Perkhalyuk created an interactive guide for regional development, identifying key functional territory types, including areas with special development conditions and sustainable development zones [15].

A monograph led by Doctor of Economics, Prof. I.Z. Storonyanska, explored the identification of border areas under adverse conditions, evaluating their challenges and proposing key directions for stimulating their development [2].

S. Shutyak developed methodological recommendations for creating comprehensive community recovery programs. The work identified functional territory types and established criteria for assigning territories to these categories [17].

T.O. Mukha's research defined principles and methods for the functional and planning organization of agro-recreational eco-settlements, considering ecological factors. The study analyzed the network of such settlements, factoring in the ecological stability coefficient of landscapes and fostering sustainable green production [8].

Materials and methods. While conducting the research, the integrated basics approach, the simulation mode, theoretical methods of analysis, synthesis, generalization, and abstraction techniques have been applied.

The purpose of the research. The aim of this work is defining the features for establishing an agro-ecological network in border areas adjacent to unfriendly countries.

The main part. Key concepts in establishing an agro-ecological network in border areas adjacent to unfriendly countries. The basic concepts of border territories are defined in various legislative and regulatory acts of Ukraine [1]:

- ***Border regions*** – regions directly adjacent to the state border;
- ***Border territory***:

1) A territory within 30 kilometers of the shared land border between Ukraine and a member state, including seaports (e.g., customs zones) and international airports in Ukraine and member states.

2) A 10-kilometer-wide zone established along land and border water sections for border surveillance and control between Ukraine and the Republic of Moldova.

3) A 30-kilometer-wide zone on either side of the shared state border between the parties;

- ***Border territories in adverse conditions*** – territorial communities near borders with countries requiring additional border security, restricted movement of goods and people, and limitations on local economic development and investment attraction (e.g., the Russian Federation, the Republic of Belarus, and Transnistria in Moldova). These areas fall within a 30-kilometer accessibility range or the demarcation line as defined by the Law of Ukraine «On temporary measures during the anti-terrorist operation period»;
- ***Border zone*** – a strip of land directly along the state border on its land sections or along the shores of border rivers, lakes, and other water bodies. It lies within the territories of village and town councils adjacent to the state border and cannot be

narrower than the distance from the state border line to the line of border engineering structures [2]:

- *territories of active hostilities and adjacent areas* (security factors, business relocation and labor migration, large-scale displacement of the population to other regions and foreign countries);
- *territories with international security restrictions*, located along the borders with the Russian Federation, the Republic of Belarus, and the Transnistrian region of Moldova, as well as those adjacent to temporarily occupied territories (withdrawal of land from agricultural use, potential destruction of enterprises and infrastructure, loss of logistical capacity).

In addressing this issue, it is important to define the concept of «agroecology» (derived from agro... and ecology) – a science that studies the structure and functioning patterns of agroecosystems on agricultural lands with the aim of developing mechanisms and management methods. These involve various agronomic and forest reclamation techniques and methods of agricultural production that enable environmentally sustainable use of agricultural lands [9].

Network – 1) a union of homogeneous objects that establishes rules for behavior both within (among its members) and outside the network (toward a single unit or the whole network). It requires rules for the use of individual units and the network as a whole. The homogeneity of network members allows for unilateral operation of each, while their union enables the network to function as a single cohesive entity. Networks can be part of a broader network, thereby forming a hierarchy; 2) a collection of routes, communication lines, channels, etc., distributed across a specific area [8].

Smart green production – a network of interconnected high-tech symbiotic productions functioning analogously to the biogeochemical cycling of substances in self-regulating natural ecological systems [19].

Thus, ***the agro-ecological network in border areas adjacent to unfriendly countries*** is a set of agro-ecological formations (settlements, connections, and territories between them) located along the border with the Russian Federation, the Republic of Belarus, the Transnistrian region of the Republic of Moldova, and areas bordering temporarily occupied territories and/or conflict lines. This network ensures an additional level of security, restrictions on the movement of goods and people, and incorporates smart green production.

Classification of Agro-Ecological Networks in Border Areas Adjacent to Unfriendly Countries. The creation of agro-ecological networks of various types near settlements is one of the promising directions for Ukraine's development and reconstruction. Particular attention in the study is given to areas near the borders with unfriendly countries, considering the following key influencing factors:

- *security measures* for the formation and development of settlements and other community areas;
- *environmental solutions* focusing on quality control of the surrounding environment, increasing the ecological stability coefficient of the landscape, and implementing smart green production;
- *economic conditions* for the development of public services and the improvement of social infrastructure (within safety limits);
- *inclusion and accessibility* to the environment, essential services, and comprehensive (within safety limits) recovery of the population.

A sustainable agro-ecological network should be established hierarchically at the following levels [8]:

- agro-ecological region;
- agro-ecological district;
- agro-ecological hub;
- agro-ecological center;
- agro-ecological point.

Thus, the formation of an agro-ecological network in border areas adjacent to unfriendly countries has specific functional characteristics and requires fundamental clarification considering key influencing factors.

Conducting an in-depth analysis of the development of border areas during martial law necessitates the indispensable study of international experience in this field.

It is well known that North and South Korea remain in a state of ongoing political tension. These countries differ significantly in their systems of governance,

approaches to administration, and ways of life for their populations.

After prolonged battles during the Korean War, a decision was made to establish the Demilitarized Zone (DMZ). Demilitarized territories are specific areas (land, sea, or airspace) designated by agreements between states, where military activities are prohibited, and they cannot be used for military purposes. The legal status of a demilitarized zone can be established during both peacetime and wartime. Such zones require the removal of military facilities or, if removal is not feasible, a prohibition on their military use [16].

In the case of the Democratic People's Republic of Korea (North Korea) and the Republic of Korea (South Korea), the DMZ is a neutral zone located approximately along the 38th parallel, serving as a buffer between the two hostile nations. It stretches from coast to coast, covering a length of 250 km, with a width of approximately 2-4 km on each side of the border.

The Demilitarised Zone is virtually uninhabited and primarily serves as a venue for occasional meetings and negotiations between representatives of the respective countries [16]. On the South Korean side, local residents are granted exemptions from

land-use fees and provided with extensive tracts of land for cultivation. However, these benefits are offset by constant threats and limited opportunities for development compared to other regions of the country. Regarding the management of the zone on the North Korean side, no information is available due to restricted access.

It is important to emphasise that the establishment of buffer zones should be implemented strictly out of necessity and for a defined period to avoid future international disputes.

An analysis of the border zone between Israel and Palestine [16] reveals that boundary regulation is based on the «Green Line», a demarcation line established on 23 March 1949 under the terms of the armistice agreements between Israel and its neighbours – Egypt, Jordan, Lebanon, and Syria – following the Arab-Israeli War of 1948-1949. Subsequently, after the Six-Day War of 1967, the Green Line became the de facto boundary separating Israeli-controlled areas from Palestinian territories, including the West Bank and the Gaza Strip.

Currently, the Green Line serves not as a physical border but as a «marker» for international negotiations. However, physical barriers such as fences and concrete walls have been constructed around the Gaza Strip and partially in the West Bank to control movement and enhance security.

In Ukraine, a significant step toward organizing the development of territories facing high military-political risks and requiring specific solutions (prior to the full-scale invasion in 2022) was the initiation of strategic planning. With support from the World Bank and the President's initiative, Ukraine developed the Eastern Ukraine Recovery Program, «The Economy of Winning Hearts and Minds». This program outlined key approaches for crafting development strategies for Donetsk and Luhansk regions, proposing three fundamental pillars: balance, differentiation, and transformation. It is recommended that strategies be designed with a differentiated approach, focusing on measures for two scenarios: (1) conflict (status quo) and (2) peace (reintegration).

Subsequently, in 2020, Development strategies for Donetsk and Luhansk regions were formulated for the period up to 2027. These strategies presented three potential development scenarios, with the selection depending on the situation surrounding the armed conflict in the regions, the implementation of nationwide and sectoral reforms, and other influencing factors.

Recommendations for establishing an agroecological network in border areas with hostile countries. Considering the analysis of regulatory and legal frameworks and noting the functional features of the border zone, the following recommendations for the agroecological network in territories near borders with hostile countries are proposed (see Fig. 1):

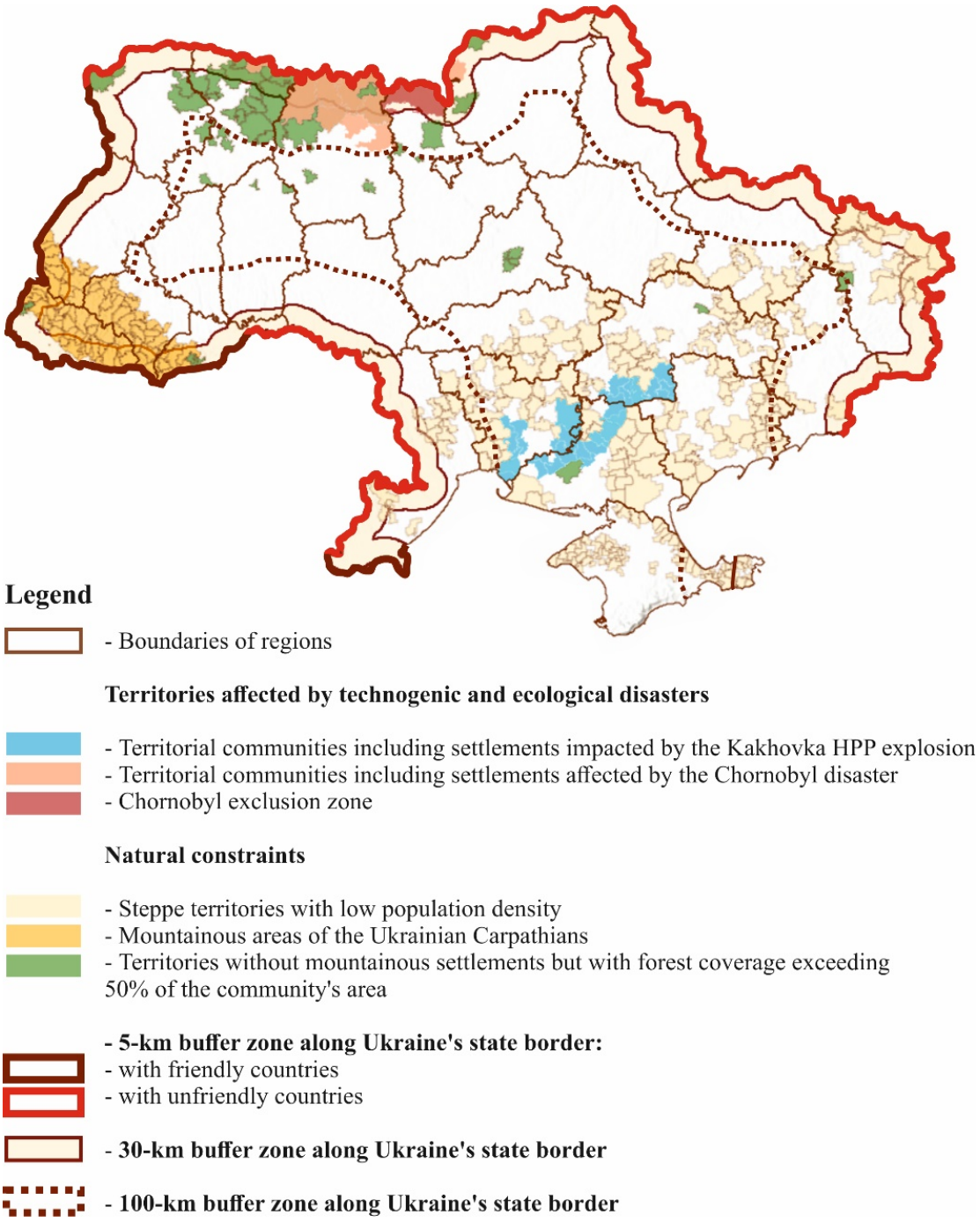

Fig. 1. Agroecological network of territories near the borders with neighbouring countries (on the example of Ukraine's borders in 1991) (author's development)

- allocation of a 5-km zone along the state border and/or line of combat engagement, with enhanced security measures for border crossings near borders with friendly countries and maximum fortification, including the construction of defensive strips using artificial and natural means near borders with hostile countries; no settlements within this zone;
- allocation of a 30-km zone along the state border and/or line of combat engagement, with minimally urbanized territories of dual purpose (agro-military rapid-response hubs) and necessary infrastructure for their servicing, including armored mobile equipment;
- allocation of a 100-km zone along the state border and/or line of combat engagement, with the relocation of community centers further from this zone; land conservation; creation of protected areas; establishment of defensive lines through artificial and natural means; and incorporation of these measures into community development strategies, comprehensive plans, and recovery plans for territories;
- definition of relevant functions for such territories based on the natural and climatic zone, including afforestation using specialized tree and shrub species with protective functions; wetland creation; utilization of natural relief; and certain types of agricultural production (crop cultivation and livestock farming) requiring minimal personnel and safety measures (e.g., mobile shelters);
- formation of smart green production.

Conclusions. Hence, the development of an agroecological network in territories near the borders with hostile countries, considering key influencing factors, is a crucial strategic direction for Ukraine's reconstruction and growth.

A sustainable agroecological network near these borders may be structured as follows, based on ***hierarchical levels***:

- *agroecological region*: a region adjacent to the state border with a specialised comprehensive plan and a territorial recovery plan emphasising security measures and the establishment of smart green production;
- *agroecological district* (amalgamated territorial community): a community area fully or partially within a 100-km zone, governed by a tailored development strategy that prioritises enhanced security and smart green production;
- *agroecological hub* (community centre/sub-centre with neighbouring settlements): settlements fully or partially within the 100-km zone, with a dedicated community development strategy focusing on security reinforcement and smart green production;
- *agroecological centre* (community centre/sub-centre): a settlement fully or partially within the 100-km zone, incorporating strengthened security measures and smart green production;

- *agroecological point:* a settlement fully or partially within the 100-km zone, emphasising reinforced security measures and smart green production.

The spatial organisation of the agroecological network near hostile borders requires further research to establish precise parameters and quantitative characteristics of its elements.

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Анотація

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Формування агроекологічної мережі територій біля кордонів з недружніми країнами

В статті розглядаються основні передумови формування агроекологічної мережі територій біля кордонів з недружніми країнами з визначенням основної проблематики та пріоритетні напрямки даного дослідження. Проаналізовано

теоретичний досвід у представлених напрямках дослідження, визначені передові науковці, які розглядали питання безпеки, екології, агроекологічних містобудівних утворень, розумного зеленого виробництва тощо. Визначено пріоритетний напрямок дослідження відносно землеустрою у воєнний і післявоєнний періоди – використання земель в захисних цілях України. Виявлені основні матеріали та методи дослідження: метод моделювання, теоретичні методи аналізу, синтезу, узагальнення та методи абстрагування. Визначена основна мета даної роботи, яка полягає у визначенні особливостей формування агроекологічної мережі територій біля кордонів з недружніми країнами. Визначені основні поняття при формуванні агроекологічної мережі територій біля кордонів з недружніми країнами: прикордонні регіони, прикордонна територія, прикордонні території у несприятливих умовах, прикордонна смуга, території підвищеної небезпеки, території активних бойових дій та прилеглі до них території, території з міжнародними безпековими обмеженнями, які розташовані вздовж кордону з російською федерацією, республікою білорусь, мережа, розумне зелене виробництво, агроекологічна мережа територій біля кордонів з недружніми країнами. Проаналізовано класифікацію та основні елементи агроекологічної мережі територій біля кордонів з недружніми країнами. Проаналізовано практичний досвід формування прикордонних територій в фокусі військового характеру. На основі проведеного аналізу визначені основні рекомендації щодо формування агроекологічної мережі територій біля кордонів з недружніми країнами. Сформовані загальні висновки та перспективи подальших досліджень у більш ширшому розкритті представленої тематики.

Ключові слова: прикордонні території; прикордонна смуга; агроекологія; мережа; сталий розвиток; розумне зелене виробництво.