REMEDIATION AND SOCIO-ECONOMIC REVIVAL OF WAR-AFFECTED REGIONS IN UKRAINE: ATTRACTING HUMAN CAPITAL

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Abstract

The article focuses on the post-war recovery of Ukraine's territory, as well as the restoration of human capital and the prospects for the return of the population from abroad. The core of the research is the remediation process—a comprehensive set of measures aimed at restoring the infrastructure, environment, and socio-economic systems of territories affected by the war. The author emphasizes that the foundation for the return of internally displaced persons and refugees from abroad is primarily the restoration and creation of living conditions, economic opportunities, and access to social infrastructure. Comprehensive remediation can lead to a multiplicative effect, which, like a chain of cascading positive impulses, offers opportunities for interconnected development in related areas of human activity. This effect implies that each action taken to restore territories generates new economic opportunities, ultimately contributing to long-term growth. The author concludes that the remediation of devastated areas is not only a vital part of the recovery process but also a decisive factor for the return of the emigrated population. The successful implementation of a remediation strategy can create favorable conditions for Ukrainians to return, and in this regard, a system of government support for such citizens is crucial.

Key words: remediation, multiplier effect, human capital, population migration, recovery strategy

JEL Code: Q24, J61, H54

Introduction

As a result of the full-scale war, Ukraine has faced unprecedented population migration, with people forced to leave their homes due to destruction, economic hardships, and threats to their lives. These migration processes have led to catastrophic consequences, weakening the potential for socio-economic development necessary for post-war recovery. This situation has become a challenge not only for the Ukrainian government but also for the international

community. Experts, scholars, and practitioners both in Ukraine and abroad are seeking ways to successfully restore the affected territories and encourage the return of the emigrated population.

In such conditions, remediation, which serves as a comprehensive set of measures to restore the environmental, social, and economic balance of territories after the elimination of military contamination, can become a key factor in attracting human capital and a catalyst for the revival of affected regions.

The aim of this article is to explore the relationship between the remediation of affected territories and the restoration of Ukraine's human capital. This objective can be achieved through a comprehensive and thorough analysis, viewing remediation as not only a catalyst for restoring territorial structure and infrastructure but also as a motivational factor for encouraging the return of the population to areas that have been cleared of military contamination and rebuilt. Specifically, the author proposes the hypothesis that remediation can have a multiplicative effect, contributing to socio-economic development and the recovery of human capital.

1 Remediation of Territories and Population Return: Challenges and Opportunities for Ukraine's Recovery

One of the most devastating consequences of the second-largest war in Europe in terms of scale and destruction (after World War II – author's note) is the mass migration of the population. According to data from the UN and the International Organization for Migration (IOM), more than 14 million people, which accounts for nearly 35 percent of the population, have been forced to leave their homes in search of shelter both within Ukraine and beyond its borders. This has led to family separations, abandonment of homes, and loss of property, as well as exacerbated the protection risks for displaced persons. The number of casualties in this war to date exceeds ten thousand people among the civilian population, including more than 560 children (IOM, 2024).

In the first few days after the war began (from February 24, 2022), approximately 500,000 people left Ukraine. This was one of the fastest migration waves recorded by Ukraine's border management authorities and neighboring countries such as Poland, Hungary, Romania, Czech Republic and Moldova.

Fig. 1: Mass Migration of Ukrainians in the First Days of the War: Queues at Ukraine's Borders

Source: https://ua.pl/potiah-viina-varshava-vyrushaie-ne-za-rozkladom

According to UNHCR data, in the first month of the war, by the end of March 2022, more than 4 million people had fled Ukraine. The main refugee flows were directed to neighboring countries, particularly Poland, which received the largest number of Ukrainian migrants. A significant number of people also moved to the Czech Republic, Hungary, Romania, and Slovakia.

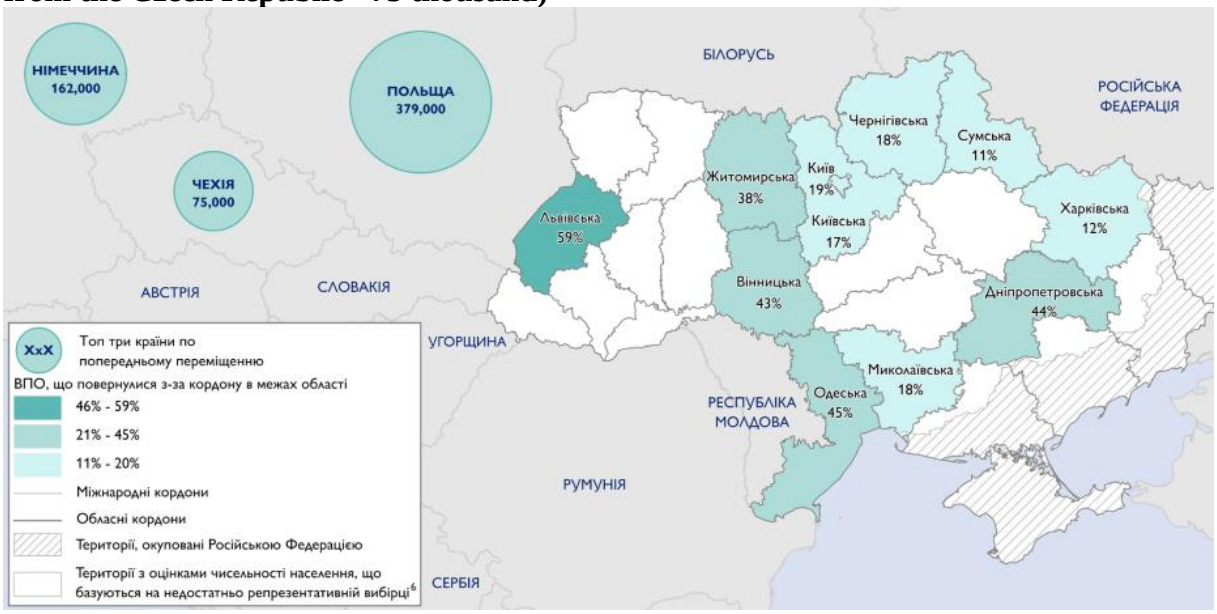
Two years later, in the first half of 2024, approximately 394,000 Ukrainians became new internally displaced persons within their country as the war with the Russian Federation continues. The lack of safety for life, destruction of homes and essential infrastructure, and power outages are forcing people to leave the Donetsk, Kherson, and Kharkiv regions. Another 375,700 individuals have received temporary protection or asylum, primarily in European countries (UNHCR, 2024).

According to estimates by the P. Ptukha Institute of Demography and Social Studies of the National Academy of Sciences of Ukraine, potential volumes of irreversible migration losses, depending on the impact of military and economic factors, are projected by experts to range from 600,000 to 700,000 individuals to between 5.0 and 5.5 million individuals. Additionally, the number of Ukrainians who have been forcibly displaced within the country is estimated at 5.0 to 5.5 million. Researchers identify mass migration as one of the key challenges

for the long-term recovery of the country's socio-economic development. They emphasize that the loss of a significant portion of the working-age population and skilled labor reduces the potential for rapid socio-economic recovery after the war.

What are the implications of this situation for Ukraine? First and foremost, mass migration threatens the restoration of the national economy. The situation is exacerbated by demographic challenges and a shortage of working-age individuals. Beyond these issues, one of the key consequences of the current circumstances is the predominance of individuals of non-working age within the population structure and the overall aging of the nation (Libanova et al., 2022).

Fig. 2: Estimation of the number of persons who returned from abroad (out of the total immigrated population: from Poland - 379 thousand; from Germany - 162 thousand; from the Czech Republic - 75 thousand)



Source: https://dtm.iom.int/reports?f%5B0%5D=report_country%3A1088

In the general understanding of the conceptual meaning in the context of the problem studied by the author, remediation is the key factor, as it is focused on the restoration of devastated areas, which includes the decontamination of land from military pollutants, the rebuilding of infrastructure, and the recovery of the environment. It is important to note that without the restoration of essential living conditions (housing, environment, infrastructure), the process of population return will be slowed. We propose viewing remediation as a systemic process that creates the conditions for long-term economic growth and the return of migrants.

Remediation of war-affected territories in the socio-economic context is a comprehensive recovery process aimed at creating optimal conditions for living, economic

activity, and sustainable development. This process goes beyond merely restoring the environment and/or infrastructure; it focuses on creating a safe, productive, and resilient environment that fosters the restoration of human capital, improves the quality of life, and revitalizes the economy.

In this regard, the author proposes a multiplication model that describes a set of positive multidirectional effects, which ultimately result in the achievement of strategic goals.

1.1 Mathematical Formalization of the Remediation Multiplier Effect Model for War-Affected Territories

To mathematically express the multiplier effect of remediation in the context of human capital recovery and, consequently, economic recovery, a model can be built using the following variables:

1. Key Variables:

$R(t)$ — the number of returned citizens at time t;

$I(t)$— resources invested in remediation at time tt;

G(t) — overall economic growth of the region (an integral indicator reflecting a set of key parametric indicators to verify development trends);

$W(t)$ — increase in total employment and creation of new jobs as a result of remediation;

$C(t)$ — increase in overall consumption by the population in the region (related to the return of the population and the increased demand for goods and services);

M(t) — the multiplier effect of remediation on socio-economic development.

2. Multiplier Effect Model:

The multiplier effect of remediation, $M(t)$, can be expressed through the combined influence of achieved economic growth, increased overall employment, the creation of new jobs, and the rise in population consumption levels. This effect demonstrates how initial investments of all types of resources into remediation impact socio-economic development through several cycles.

$$M(t) = \alpha \cdot I(t) + \beta \cdot W(t) + \gamma \cdot C(t) \quad (1)$$

where:

α, β, γ — coefficients reflecting the contribution of remediation to socio-economic development through all types of investments, the creation of new jobs, and the growth in consumption levels.

3. Relationship between Remediation and Human Capital Recovery:

The number of returned citizens $R(t)$ will depend on the improvement of infrastructure, employment levels, and the increase in opportunities for consumption growth, as people return to places where there are conditions for living and working.

$$R(t) = \delta \cdot M(t) + \varepsilon \quad (2)$$

where:

δ — a coefficient that reflects how strongly the multiplier effect influences people's decision to return;

ε — a random error accounting for external factors such as the political situation or security level.

4. The full model will look as below:

The full model describing the multiplicative effect of remediation on human capital recovery and socio-economic development aggregates all of the above presented, namely:

$$R(t) = \delta \cdot (\alpha \cdot I(t) + \beta \cdot W(t) + \gamma \cdot C(t)) + \varepsilon \quad (3)$$

5. Conceptual sense of the model:

$I(t)$ — is the initial resource investment in remediation, which triggers a chain reaction of job growth and increased consumption.

$W(t)$ and $C(t)$ represent secondary effects such as the creation of new jobs (e.g., infrastructure rehabilitated or built - note) and the scaling and augmentation of further consumption growth, which in turn strengthen the position and performance of the region's socioeconomic development.

The multiplier effect $M(t)$ is scaled through economic linkages and the interconnectedness of economic sectors and activities in a single process of reproduction of goods and services, thus creating new opportunities and improving conditions for population return and human capital recovery, as reflected in the variable $R(t)$.

A mathematical approach that describes the multiplicative effect of remediation can be practically applied in public administration to develop targeted programs for the restoration of human capital, specifically through the following:

1. *In assessing the outcomes of remediation and the effectiveness of invested resources in the recovery of affected territories,* the model allows for a quantitative evaluation of how investments in remediation (infrastructure restoration, pollution cleanup, environmental improvement) impact the economy and the recovery of human capital. This approach can help

the government make more informed strategic decisions by directing resources to areas where they can yield the greatest impact.

It should be acknowledged that, prior to the war, Ukraine was already experiencing significant developmental disparities, with a substantial part of its territory facing unfavorable socio-economic and environmental conditions. Even despite the implementation of certain reforms, the overall disproportions in the spatial framework largely remained unchanged, and the processes aimed at European integration were progressing rather slowly de facto (Maruniak et al., 2024).

2. *In optimizing tactical planning and the distribution of resource potential,* the proposed approach enables the government to streamline the allocation of actual resources (financial resources, material and technical resources, workforce, etc.) for recovery efforts.

3. *In forecasting and modeling human capital recovery scenarios,* the proposed model enables the government to implement scenario-based forecasting for recovery efforts. This provides the ability to assess different strategies in advance and select the most optimal one (Maidanik, 2023).

4. *In the organization of control and the measurement of operational, ongoing, and final results,* the model enhances the ability to monitor progress and adjust recovery strategies as needed (Maruniak et al., 2024).

5. *In optimizing the organization of communication* with the population, partners, and investors, government bodies can use substantiated forecast data to present recovery results and prospects to international partners, donors, and investors. By demonstrating how resources invested in remediation will help achieve strategic goals. This will increase the level of trust and can attract additional funds for the implementation of territorial remediation projects (Antoniuk, 2023).

6. *In integration into government programs and strategies,* this approach can be incorporated into Ukraine's national recovery and development strategies. The proposed model holds practical value as it can enhance the efficiency of managing government programs by focusing on key performance indicators (KPIs) and goals related to the return of the population and the restoration of human capital (Radionov, 2023).

The author of the study conducted a thorough literature review in the context of the potential implementation of international experience in restoring territories after conflicts and natural disasters. It can be stated with full confidence that successful examples of remediation and economic recovery from other countries that have faced similar situations can serve as a valuable guide for Ukraine.

Global examples that can serve as benchmarks for Ukraine's recovery and remediation efforts include:

Germany's Reconstruction After World War II is one of the most successful examples of utilizing labor to rebuild a war-torn country. One notable initiative was the "Work for Housing" program, which allowed people to participate in restoration efforts in exchange for housing subsidies and other social benefits (Diefendorf, 1993).

Poland After World War II also implemented similar mechanisms to mobilize labor for the reconstruction of destroyed cities and infrastructure. The government provided incentives and benefits to participants in building and restoration projects (Bugalski & Lorens, 2023).

Modern Examples of programs offering housing in exchange for participation in restoration work have also been applied in some developing countries, such as India and Brazil, for housing reconstruction after natural disasters (Rahmayanti & Rukmana, 2024; Maly et al., 2022; TV BRICS, 2024).

Conclusion

The research conducted above leads to the conclusion that the remediation of territories in Ukraine affected by military aggression is a key element in the recovery of both the country's economic and social systems. Comprehensive restoration of destroyed infrastructure, ecosystems, and key elements of social support will create favorable conditions for the return of the emigrated population (Danylyshyn et al., 2023; Onyshchenko, 2023). This, in turn, can trigger a multiplicative effect of economic growth and social stabilization. Investing resources in the implementation of comprehensive remediation in Ukraine will not only contribute to the recovery of the national economy but also help achieve the restoration of human capital.

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