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# The Impact of the Cost of Demining on the Trajectory of Socio-Economic Systems Recovery in the Post-Conflict Period

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**Yuliia Rohozian**

Doctor of Economic Sciences, Senior Researcher,  
Deputy Head at the Department of Interregional Cooperation Issues,  
State Organization “V. Mamutov Institute of Economic and Legal Research  
of the National Academy of Sciences of Ukraine”, Ukraine  
E-mail: j.s.rohozian@gmail.com  
ORCID: <https://orcid.org/0000-0001-5325-4213>

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**Abstract.** *The problem of demining is becoming increasingly prevalent in all areas of life at the international, national and local levels of government. For several decades, demining has been a global task that should be considered not only from a technical perspective, but also through the socio-economic lens of restoration and further development of territorial systems. In this context, it is of particular importance to study the cost of demining, which, from an economic perspective, has a direct impact on the speed and quality of this process, and therefore on the pace of recovery and the trajectory of further socio-economic development in areas devastated by armed conflict. For Ukraine, this area of study has become particularly pertinent in light of the necessity to restore the potential of local socio-economic systems, which are already facing challenges due to the ongoing conflict. International experience can offer insights into the prospects for accelerating the stabilization of internal processes within the state, which justifies the relevance of this research topic. The objective of this study is to investigate the correlation between the cost of demining and the restoration of post-conflict socio-economic systems on a global scale. The research methodology is based on a set of methods and principles of scientific knowledge, including general and special methods and techniques used in the study. These include systemic and process approaches, historical and logical methods, comparative analysis, grouping and typology, and logical generalization. The main results of the research are based on the connection between the peculiarities of demining, which form the cost of this process, and the pace of recovery of socio-economic systems in the post-conflict period. The study found that the imperfect nature of the information base for the cost of demining correlates with the adoption of imperfect and erroneous management decisions that delay this process and the transition of socio-economic systems from conflict to post-conflict period, then to reconstruction phase and, finally, to development period. The practical value of the article lies in providing an informational and analytical basis for further recommendations to be formulated by state authorities and local self-government bodies in Ukraine on the prospects for implementing international experience in demining to restore the country's territorial potential from a socio-economic perspective.*

**Keywords:** demining, cost, recovery, socio-economic systems.

**JEL Classification:** H56, P51, Q56

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## 1 Introduction

Since February 2022, the issue of demining has become increasingly pertinent to the global community, given the full-scale invasion of Ukrainian lands by Russia. This has led to a heightened focus on the political, economic, legal, social, environmental and other aspects of this process, with the economic component occupying a prominent position as a driver of the recovery and reintegration of affected territorial systems. In order to mitigate the negative impact of the war

and possibly accelerate the clearance of mines and other explosive ordnance from the territories of Ukraine, it is important to analyze the key economic features of demining through the prism of international experience that has already been gained by a significant number of countries. In this context, the cost of demining represents a significant economic category that affects not only demining itself but also the pace of recovery of socio-economic systems affected by armed conflicts (especially at the local level).

The analysis of scientific literature in the field of demining indicates that foreign experts tend to focus on issues of a primarily military and technical nature. This is exemplified by the work of D. Ambruš, D. Vasić and V. Bilas (Ambruš, 2020), T. Bechtel, L. Capineri, G. Pochanin, F. Crawford, P. Falorni and V. Ruban (Bechtel, 2021), I. Cruz, L. Jaupi, S. Sequesseque, N. Kassanga and O. Cottray (Cruz, 2018), N. Ibrahim, S. Fahs and A. AlZoubi (Ibrahim, 2021), J. Killeen, L. Jaupi and B. Barrett (Killeen, 2022), who examine these aspects through the lens of state policy in the field of national defense and civil protection. The significance and necessity of examining the economic and legal aspects of demining in the post-conflict period are highlighted in select foreign scientific and analytical sources by D. Arias Henao and J. Ospina Perdomo (Arias Henao, 2020), U. Hofmann and P. Rapillard (Hofmann, 2017), J. Macías Montoya and M. Corcione Nieto (Macías Montoya, 2020), though these works lack sufficient depth in the context of this topic.

In Ukrainian science, studies have been conducted on the potential utilization of the land and resource assets of war-affected territories (Ustymenko, 2023). These studies have highlighted the issue of demining and the necessity to address it in the context of war and the transformation of the post-war economy. However, due to the limitations of the economic plane, the data presented has not been sufficiently analyzed. Consequently, a separate in-depth study is required to examine the correlation between the cost of demining and the restoration of post-conflict socio-economic systems worldwide.

## **2 The global dimension of the cost of demining through the prism of restoring post-conflict socio-economic systems**

In March 2023, the Geneva International Centre for Humanitarian Demining (GICHD) published the results of a study on a number of issues related to the economic aspects of mine action in a number of countries (Operational efficiency in mine action, 2023). The report's central focus is the analysis of demining costs, which is based on the examination of data from open sources and information provided directly by stakeholders in the countries under study. The sample included data from the countries with the highest incidence of landmines, as identified by the GICHD as of 31 December 2022. This provided relevant statistics, including: The countries included in the study were Afghanistan, Angola, Bosnia and Herzegovina, Cambodia, Croatia, Western Sahara, Iraq, Iraq, Laos, Lebanon, South Sudan, Sri Lanka, Serbia,

Sudan, Sri Lanka, Thailand, Tajikistan, Thailand and Vietnam. Ethiopia and Ukraine were not included in this list due to ongoing active hostilities that make it impossible to make payments to date.

The experts at the Center have identified several key indicators that can be utilized to track and assess the financial impact of demining on socio-economic systems that have been affected by armed conflict. The initial indicator in this list is *the cost per square meter of territory released of the local socio-economic system*. The released territories (land) are the result of demining activities that are transferred to the use of socio-economic systems at the local government level in the post-conflict period. As such, their value represents an important indicator of the economic efficiency of demining, as it assesses the total cost of the release of territories that can be used for recovery, reconstruction, resettlement and further economic development of territorial systems. The subsequent indicator that is considered in the aforementioned study is *the cost per square meter of territory that has been cleared in the local socio-economic system*. The process of land clearance entails the utilization of technical resources, which are subject to varying costs contingent upon the intricacy of the clearance task. Consequently, the unit costs associated with land clearance are typically higher than those associated with land reduction or cancellation. Another crucial economic indicator in the field of demining is *the cost of a single found explosive item in the local socio-economic system*. This allows us to ascertain the average level of expenditure per unit of explosive.

The research of the three indicators in the context of the cost of mine clearance by country allows us to summarize the results in Table 1 and draw the relevant conclusions.

The highest value in this list is demonstrated by Lebanon, with a cost per square meter of 5.87 USD. This is 293 times higher than the lowest value of Thailand, with a cost per square meter of 0.02 USD. The disparity in the cost per square meter of the territory released by the local socio-economic system is in part attributable to the differing costs of resources involved in this process, as well as to political aspects and decision-making in numerous countries. For instance, the proportion of land released as a consequence of clearing, reduction, and cancellation varies between countries, reflecting disparate approaches to the generation of each type of product. The process of clearing entails the individual, animal, or mechanical processing of each square meter, which consequently gives rise to augmented costs. In contrast, only a small proportion of the

**Table 1** Key indicators of the cost of demining on an international scale as of 30 November 2022

Number in order	State	Indicators		
		cost per square meter of territory released of the local socio-economic system, USD	cost per square meter of territory that has been cleared in the local socio-economic system, USD	cost of a single found explosive item in the local socio-economic system, USD
1	Angola	0,32	7,88	9042
2	Afghanistan	0,79	1,48	911
3	Bosnia and Herzegovina	0,36	<b>19,06</b>	6059
4	Vietnam	0,28	0,65	500
5	Western Sahara	0,41	0,51	2183
6	Zimbabwe	1,89	4,49	289
7	Iraq	0,81	1,32	4437
8	Cambodia	0,22	<b>0,37</b>	678
9	Laos	0,99	0,99	356
10	Lebanon	<b>5,87</b>	10,65	2204
11	South Sudan	0,49	4,07	5667
12	Serbia	1,07	1,96	9757
13	Sudan	2,89	5,78	457
14	Tajikistan	1,29	1,98	1721
15	Thailand	<b>0,02</b>	2,25	281
16	Croatia	1,03	1,23	<b>13450</b>
17	Sri Lanka	2,26	3,65	274

Source: compiled by the author based on data (Operational efficiency in mine action, 2023)

areas to be cleared necessitate physical visits by demining specialists, while land that has been cancelled does not require any such visits at all. Consequently, countries where the majority of land is cleared, such as Lebanon, exhibit elevated unit costs per square meter of land cleared due to elevated transaction costs. Conversely, in countries such as Angola and Thailand, where extensive areas are released through cancellation, unit costs are likely to be lower due to the implementation of rigorous re-survey processes.

Furthermore, these data are also influenced by demining remuneration factors. The remuneration of deminers in Lebanon is approximately five times that of their counterparts in Cambodia, while the average salary of a work supervisor is approximately three times higher. According to the International Labour Organization, the average earnings per worker across the country in Lebanon are approximately three times higher than in Cambodia. Although slightly higher than the average earnings per worker in Cambodia (1.08 times), the salary of a sapper is approximately twice as high as the average worker in Lebanon (1.7 times). Furthermore, there are discrepancies in the remuneration of the entire demining team. The average total remuneration of a demining team in Cambodia for one month is USD 3,298, while in Lebanon it is USD 21,588, which is 6.5 times

higher (Operational efficiency in mine action, 2023). These facts substantiate the importance of maintaining equilibrium between the number of demining team members and the total cost of the process, which plays a significant role in the total amount of land released. This allows for the utilisation of more basic production resources within the total personnel costs.

Although the ranking of countries by the indicators of cost per square meter of land released and cost per square meter of cleanup of the local socio-economic system is similar in dynamics, it is nevertheless worth noting that there have been some changes. These countries are associated with high ratios between the area of cleared land and the area of released land, including Angola, Bosnia and Herzegovina, and Lebanon. All three countries exhibited a notable shift in ranking, moving from the bottom third of the scale in terms of the value of land released to the top half of the scale in terms of the value of land cleared. While this increase in value may give the impression that clearance operations are less efficient than land release operations in general, this is not the case, as the process must be seen in context. For instance, while Bosnia and Herzegovina and Lebanon have the highest costs per square meter of land released, they also have some of the lowest rates of land cleared per explosive ordnance found.

This indicates that in these countries, the clearance of territories is extremely thorough. This is confirmed in practice by the fairly rapid recovery of these socio-economic systems (return of internally displaced persons, resumption of business entities, introduction of certain economic preferences, etc.). The type of contamination of the territory also affects the cost of clearance. For example, an entire minefield is more expensive to clear than a territory from several explosive devices.

A cost-benefit analysis of the value of the cost per explosive ordnance recovered reveals that Zimbabwe is situated at the lower end of the indicator. This is due to the fact that the country benefits from a very small area being cleared and released per explosive ordnance recovered, combined with a low average salary for deminers (Operational efficiency in mine action, 2023). In contrast, in South Sudan, the average rate of cleared and released area per explosive ordnance found, combined with relatively higher salaries for deminers, justifies the higher cost per explosive ordnance found (with the exception of Colombia).

In the global context, the data on the cost of one found explosive item exhibits considerable fluctuations in the studied indicator, depending on the country. It is advisable to consider the example of Lebanon and Cambodia in more detail, as the difference in cost between these countries per found explosive item is more than three times. This discrepancy is also attributable to the smaller area required to locate one explosive item in Lebanon than in Cambodia (349 square meters on average compared to 3,360 square meters in Cambodia). Consequently, Cambodia is responsible for clearing nine times more land per explosive ordnance found than Lebanon. Similarly, operators in Cambodia are required to clear an average of 1,830 square meters of land per explosive item found, in comparison to 252 square meters in Lebanon. Consequently, Cambodia is responsible for approximately seven times (7.3) more land per explosive ordnance detected than Lebanon (Operational efficiency in mine action, 2023).

These results can be attributed to two primary factors. Firstly, mine action operators in Lebanon have demonstrated an enhanced capacity for the identification of hazardous areas. This is particularly evident in the context of conventional minefields, many of which are characterized by the existence of detailed maps. Maps can be employed to accurately predict the location of a mine, thereby enabling mine action operators to direct resources in an efficient manner. In states where this process is established at a sufficiently high level, the return of mined areas to peaceful use is accelerated,

which in turn helps to restore the competitiveness and potential of socio-economic systems.

In Cambodia, for instance, the identification of hazardous areas is more challenging due to the unpredictability of the contamination and the lack of pertinent documentation. Furthermore, differences in the timing of contamination also affect the identification of hazardous areas, as local informants in Cambodia either no longer reside in the area or have relocated from areas in proximity to mined areas. In Lebanon, the time spent is compared with the number of explosive ordnances detected, the number of areas released during the year and their rate of release in the dynamics is estimated, and the results of land release are compared with the annual work plan and mine action strategy. This allows for better results in this area and creates conditions for the restoration of the vital functions of socio-economic systems.

### **3 The Croatia case on the cost of demining for the recovery of socio-economic systems**

The cost of demining is a key concern in Croatia, where the price per square meter of demined area has historically been relatively low compared to other countries. International donors play a significant role in this process, with the World Bank financing demining in Croatia since 1997. At that time, the average price per square meter of demined area was USD 3, but by 2003 it had dropped to USD 1.8.

In its strategy for 2009–2019, the Croatian Mine Action Center (CROMAC) predicted that the release of 756.5 square kilometers of land over 11 years would cost 4,187,000 Croatian Kuna (the national currency of Croatia until 31 December 2022), which is approximately 0.9 USD per square meter. The data on land release obtained from CROMAC for the period 2015–2019 indicates an average of USD 1.03 per square meter, which is slightly closer to the planned level of the indicator in the strategy. This is particularly noteworthy given that different currencies (Croatian Kuna, US dollar, euro) are used in the calculations and exchange rate fluctuations are not taken into account (Operational efficiency in mine action, 2023).

Over the past few years, the cost of demining in Croatia has increased slightly, which may indicate that the majority of the flat, less problematic areas have been cleared, and that the vast majority of remaining tasks are being carried out in inaccessible terrain. To illustrate, the 2022 work plan allocated Croatian Kuna 215,000,000 for the clearance of 23,300,000 square meters of land at one of the sites visited by the Geneva International Centre for Humanitarian Demining. This equates to an

estimated cost of Croatian Kuna 9.2 (or USD 1.44) per square meter. The clearance rates observed during the visit were compared to those of another project (funded by Switzerland) in the Kotar-Stari Gaj forests in 2018. In the aforementioned project, 294 deminers were able to clear 1.8 square kilometers of land in 39 working days, with an average productivity of 157 square meters per deminer per day and a cost of USD 1.71 per square meter. This contributed to the rapid restoration of the tourism potential of forest areas in the context of local socio-economic systems in Croatia (Operational efficiency in mine action, 2023).

Furthermore, Croatia introduced a method of land release called "additional non-technical survey." This hybrid method combines non-technical and technical surveys on a smaller scale to obtain additional information about a specific suspected area in order to release the area without using additional resources.

The manner in which land release operations are planned and implemented in Croatia also affects the cost per square meter of cleared land. During the planning phase, CROMAC employs a combination of topographic maps, digital orthophotos and vector layers containing mine action and other relevant data to model the nominal operational complexity of demining. This helps determine the scope of tasks and the type of equipment that is suitable for a particular hazardous area. Furthermore, it provides more accurate information on the accessibility of planned hazardous areas and a deeper knowledge of local terrain conditions. Additionally, the comparison of topographic maps from the Balkan conflict with more modern digital orthophotography can identify changes in the terrain that may be useful in future mine action planning processes, as well as restoring the optimal level of livelihoods in the affected socio-economic systems.

#### 4 Conclusions

In almost all the countries studied, the indicator of the cost per square meter of cleared land is higher than the same indicator of released land. This is due to the specifics of this process, where different amounts of resources are required and, as a result, their cost. The release of land as a result of clearing, reduction and cancellation is a process that exhibits its own peculiarities. Clearing involves the processing of each square meter by a person, animal or mechanism, which leads to an increase in costs. In contrast, cancellation does not involve additional financial injections or physical visits. The only exception to this pattern is Laos, where the two indicators are identical and amount to a relatively small value (USD 0.99).

The countries with the highest costs of land release are Lebanon (5.87), Sudan (2.89), and Sri Lanka (2.26). In contrast, the lowest costs are recorded in Thailand (0.02), Cambodia (0.22), Vietnam (0.28), Angola (0.32), Bosnia and Herzegovina (0.36), Western Sahara (0.41), and South Sudan (0.49). The cost of land clearance is subject to change at the hands of those in positions of authority. In this context, the countries with the highest values are Bosnia and Herzegovina, Lebanon, Angola and Sudan. In contrast, Cambodia, Western Sahara, Vietnam and Laos have the cheapest land clearance per square meter. Despite the relatively moderate values of the two preceding indicators, Croatia and Serbia have the highest cost per explosive ordnance found, followed by Angola, Bosnia and Herzegovina, South Sudan and Iraq. The considerable disparity in the values of the indicators is contingent upon a multitude of factors and the idiosyncrasies of demining in a given country. These include the area and geographical characteristics of land plots, the number of demining operators and support personnel, their remuneration, the type and method of demining, and other considerations. Two primary factors influence the area cleared or cleared of explosive ordnance: the ease or difficulty of determining the extent of contamination from explosive ordnance and the efficacy of decision-makers in making this determination. The quantity of data available on mined areas is also significant, as when decision-makers have limited or inaccurate information, they prolong and expand demining operations, which increases the cost of demining and, as a result, delays the process of restoring socio-economic systems in the post-conflict period.

The study revealed a correlation between the cost of demining territories affected by armed conflicts and the restoration of socio-economic systems, particularly at the local government level. It was found that the imperfect information base on the cost of demining leads to the implementation of imperfect and erroneous management decisions that delay the transition of territories from conflict to post-conflict, reconstruction, and development. Consequently, further scientific and applied research in this area should be aimed at outlining the prospects and ways of implementing international demining experience in Ukrainian realities through the prism of post-war reconstruction. This is because the practice of clearing territories of explosive ordnance. Moreover, the planning of the restoration of socio-economic systems in wartime conditions is a distinctive feature of our country. It is likely that our state's experience will serve as a foundation for the advancement of scientific and applied developments in other countries.

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